

INTERNATIONAL JOURNAL OF **ENGINEERING** SCIENCES AND MANAGEMENT



A Bi-annual Research Journal of
DRONACHARYA
GROUP OF INSTITUTIONS
GREATER NOIDA, U.P., INDIA

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES AND MANAGEMENT

Volume II / Issue I / Jan-Jun 2012

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INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES AND MANAGEMENT

A Bi-annual Research Journal of
DRONACHARYA
GROUP OF INSTITUTIONS
GREATER NOIDA, U.P., INDIA

Volume II / Issue II / Jul-Dec 2012

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES AND MANAGEMENT

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FROM THE DESK OF EXECUTIVE EDITOR...

Dear Readers,

We are very happy to present to you the current issue of our biannual research journal, “International Journal of Engineering Sciences and Management (IJESM, Vol. II, Issue II, Jul-Dec 2012). Authors from different parts of India, besides USA, have joined us in this Issue. We sincerely hope that their papers will be appreciated and cited by a large section of the academia across the globe.

We are indebted to the unflinching support and cooperation of our honourable Chairman, the Management Board, our Director, the members of “Advisory Board”, “Editorial Board” and all the authors who sent their research papers for consideration of publication in our journal. The Reviewers of all the communicated papers for this Issue of the journal took lot of pains in critically perusing the manuscripts and sent their expert comments within the stipulated time. They really deserve a bountiful of thanks from us. We also express our thanks to those readers of the earlier issues of this Journal who have communicated very kind words about the quality of papers published in these issues. Your encouragement will act as catalyst in accelerating our efforts for continuously enhancing the standard of our Journal.

We invite all the readers and their professional colleagues to send their research papers for consideration of publication in the forthcoming issues of our journal as per the “Scope and Guidelines to Authors” given at the end of this Issue.

Wishing you a highly stimulating reading,

Sincerely,

Prof. (Dr.) Jai Paul Dudeja

Executive Editor

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July 2012

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A HYBRID APPROACH TOWARDS INTRUSION DETECTION BASED ON ARTIFICIAL IMMUNE SYSTEM AND SOFT COMPUTING

(Invited Paper)

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ABSTRACT

A number of works in the field of intrusion detection have been based on Artificial Immune System and Soft Computing. Artificial-Immune-System-based approaches attempt to leverage the adaptability, error tolerance, self-monitoring and distributed nature of Human Immune Systems. The Soft-Computing-based approaches are instrumental in developing fuzzy-rule-based systems for detecting intrusions. They are computationally intensive and apply machine learning (both supervised and unsupervised) techniques to detect the intrusions in a given system. A combination of these two approaches could provide significant advantages for intrusion detection. In this paper we attempt to leverage the adaptability of Artificial Immune System and the computation intensive nature of Soft Computing to develop a system that can effectively detect intrusions in a given network.

Keywords: Intrusion Detection; Artificial Immune System; Soft Computing; Surface Barrier; Innate Immune System ; Adaptive System.

1.INTRODUCTION

1.1 BACKGROUND The average volume of internet traffic has increased many-fold in recent times. Some primary reasons for the increase in the internet traffic are: advancement of the cloud infrastructure for hosting service, emergence of a number of social networking websites and tremendous increase in the use of mobile platform for accessing services hosted on the web [1] [2]. With such increase in the volumes of internet traffic, security has become a major concern. Data loss, malicious usage of computing resources and illegal data access are some of the problems that enterprise systems suffer from [3]. There exists a need for intelligent and adaptive systems that can not only detect malicious activities in the network but also evolve over time to mitigate the effects of ever increasing security threats and attacks.

The similarity between an intrusion detection system and the human immune system is quite remarkable. The primary function of the human immune system is to identify malicious external agents like viruses and pathogens from the native healthy tissue and cells. The sample space with which the Human Immune System works is huge since the human body interacts with innumerable external agents. The Human Immune system also evolves over time to tackle the ever evolving pathogens and other malicious external agents. The Human Immune System employs a layered defence approach with the specificity of the defences increasing with each level. Like the Human Immune System an Intrusion Detection System is also expected to defend the network or the distributed computing infrastructure from malicious attacks like DDoS attack, key-logging attack and Ping-of-Death attack to name a few. An Intrusion Detection System is also expected to evolve over time to combat new attacks that emerge over time. Thus an Intrusion Detection System design, based on a Human Immune System can provide significant advantages. Like the Human Immune System, the Intrusion Detection System has to work with a large amount of data (network traffic traces). With such high volume of data, it is extremely difficult to predict exactly the occurrence of an intrusion. This is primarily because the malicious activities (traffic data) form a very small portion of the sample space (internet traffic) and the pattern it follows varies based on the type of intrusion or attack that the system is suffering from. Moreover there exists a high level of uncertainty in the sample data; as a result, it is impossible to predict the occurrence of an intrusion with a probability of 1. Due to such high volumes

and the existence of uncertainty in the data, a technique that is designed along the lines on the Human Immune System but employs Soft Computing techniques at each defence layer can be effective in detecting an intrusion in a given system. In this paper we propose a system based on the above mentioned technique.

1.2 RELATED WORK

Artificial Immune System : A number of works related to intrusion detection have been inspired by the human immune system. [4] presents one of the first lightweight intrusion detection systems based on AIS (Artificial Immune System) [5]. [6] presents an intrusion detection system based on the emerging 'Danger Theory' [7]. Previously suggested Intrusion detection Systems based on AIS models have used one of the following algorithms; negative selection algorithm, clonal selection algorithm, artificial immune network, danger theory inspired algorithms and dendritic cell algorithms [8]. [9] attempts to solve the problems with contemporary intrusion detection systems using autonomous agents. [10] is based on AIS and attempts to detect abnormality in electromagnetic signals in a complex electromagnetic environment. [11] presents an analogy between the human immune system and the intrusion detection system. It is important to note that this work attempts to evolve the Primary Immune Responses to a Secondary Immune Response using genetic operators like selection, cloning, crossover and mutation. [12] focuses on specifically static clonal selection with a negative selection operator. [13] describes a genetic classifier-based intrusion detection system.

Soft Computing and Machine Learning: The lack of exactness and inconsistency in the network traffic patterns has encouraged a number of attempts towards intrusion detection based on 'Soft Computing' [14], [15]. 'Soft Computing' techniques attempt to devise inexact and approximate solutions to the computationally-hard task of detecting abnormal patterns corresponding to an intrusion. [16] proposes a Soft Computing based approach towards intrusion detection using a fuzzy rule based system. [17] suggests an approach based on machine learning techniques for intrusion detection. [18] applies a combination of protocol analysis and pattern matching approach for intrusion detection. [19] proposes an approach towards intrusion detection by analyzing the system activity for similarity with the normal flow of system activities using classification trees. [20] presents a proactive detection and prevention technique for intrusions in a Mobile Ad hoc Networks (MANET).

The rest of the paper is structured as follows: Section 2 introduces the design of the proposed system, followed by detailed explanation of each of the components of the system in sections 3, 4 & 5. Section 6 explains the techniques used for secure propagation of information to other instances of the system in a typical network deployment followed by the conclusion in Section 7.

2.THE DESIGN

The design of the proposed system is inspired by the Human Immune System; as a result the components of the system have one-one correspondence with the components of the Human Immune System. The system is divided into three primary components:

- 1) Surface Barrier
- 2) Innate Immune system
- 3) Adaptive system

The network traffic entering the system has to pass through each of the three components. Figure.1 shows orientation of the three components and the flow of network traffic through the three components.

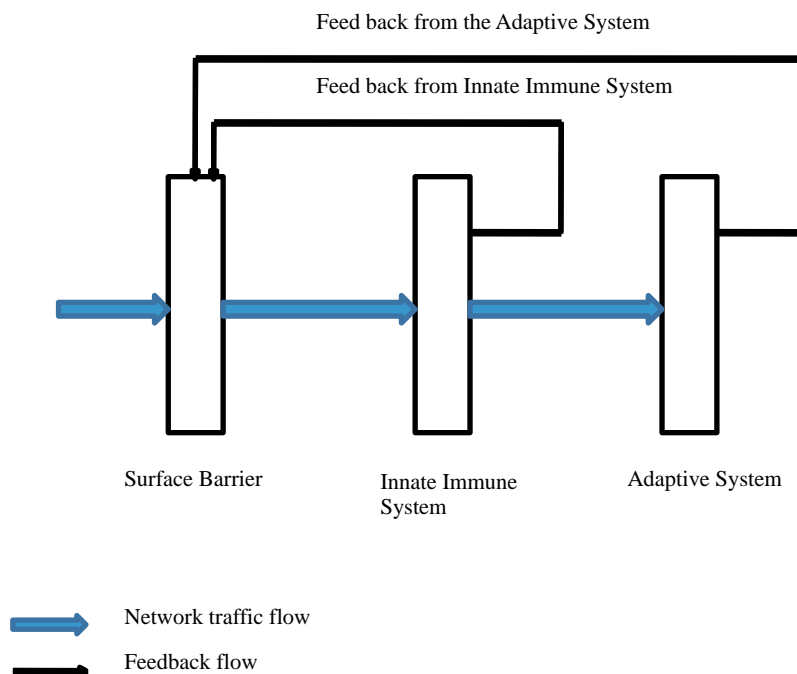


Figure1 Three primary components of the system

For each component we define a probability value P which is the probability with which the component detects an intrusion in the system. The value for P is determined and improved based on the training of the system as well as the feedback from the previous executions of the system. The system thus exhibits a self-improving adaptive nature. The proposed system goes through the following three phases:

1) Training Phase: During this phase each of the three components of the system are trained using training data set. Results of the training phase enable each of the three components to detect abnormalities and hence intrusion in live production network traffic data.

2) Detection Phase: This phase involves the actual detection of intrusion in the system. The system encounters live network traffic in this phase.

3) Feedback Phase: Data encountered during the detection phase is fed back to the system to improve the performance and efficiency of the components of the system. Even though the generation of the feedback to improve the efficiency of the system is mentioned as a separate phase, the generation and assimilation of the feedback data into the system is a continuous process.

There exists an instance of the system running on every host of a given network. Information deduced during the training and the detection phase by these instances is broadcasted to other instances of the system to ensure that all the instances are in sync with each other. Figure 2 shows a diagrammatic representation of the instances of the proposed system in a typical network deployment. A detailed explanation of the techniques used for secure transmission of information across the network to other instances of the system is presented in Section 6.

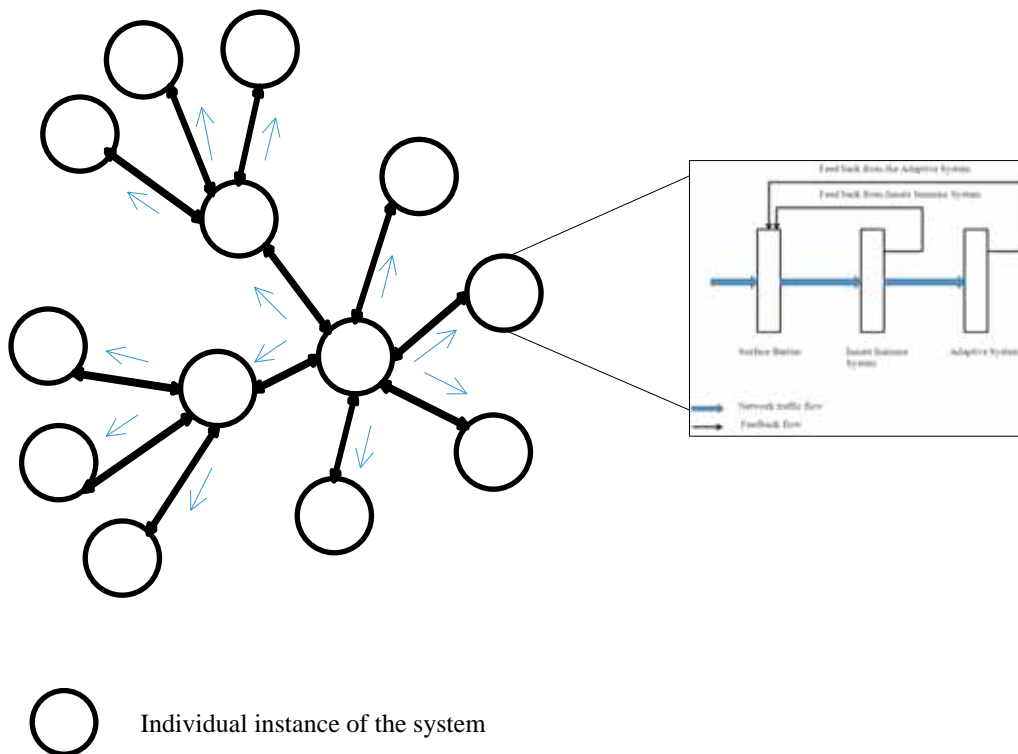


Figure2. Network deployment of the instances of the system

Succeeding sections explain the functioning of the three components in each of the three phases mentioned above.

3. SURFACE BARRIER

Surface barriers constitute the first line of defence of the system. This component is analogous to the human skin which acts as the first line of defence against infection. The detectors in this component perform on absolute detection. The term 'absolute detection' indicates that the component detects intrusions based on precise and crisp values, the concept is similar to hard computing wherein the rules defined can detect occurrences with absolute certainty. Thus the value for P in case of surface barrier is 1. Surface barrier uses the following set of information for detecting intrusions at a primary level:

- 1) IP addresses of malicious hosts in the network
- 2) Malicious TCP ports used for performing standard attacks like DDoS, Ping-of-Death, etc. For example IRC bots use port 6667 to perform attacks based on the commands issued by the bot master.

It must be noted that surface barrier does not possess any intelligence or computational capability; it attempts to detect intrusions at a primary level merely based on value matching operation.

Surface barrier starts with an empty set of data that it uses to match the parameter values for network traffic data. Over a period of multiple executions of the system in the training phases, surface barrier builds an extensive data set consisting of values for parameters like IP addresses and TCP ports from the feedback from the other two components in the training phase itself. The

standard set of data against which surface barrier operates is thus derived initially from the training data and externally fed information and then grows over a period of time as the system encounters more network traffic.

4. INNATE IMMUNE SYSTEM

Network traffic that successfully passes through the surface barriers, encounters the second line of defence called the Innate Immune System. The Innate Immune System attempts to detect intrusions in the system based on pattern recognition. This component is superior to the surface barriers because it possesses the capability and computational power for performing pattern recognition. The responses issued by Innate Immune System based on the results of the pattern recognition task and the responses initiated by the Surface Barrier form the Primary Immune Response. It is important to note that the each Innate Immune System detector operates on the stream of network traffic data based on specific characteristics of the network traffic. Thus each detector is characterized by a specific network parameter C , where C could be incoming data rate in bytes/sec, outgoing data rate in bytes/sec, time required to handle incoming request etc. The patterns inferred during the training phase and the previous executions of the system are added to the pattern set of the individual detectors appropriately based on the network traffic parameter that characterizes the detector. For example, a pattern inferred, of the incoming network traffic in bytes/sec is added to the pattern set of the receptor that characterizes the incoming network data traffic.

Innate Immune System starts with some standard self and non-self patterns fed to the system externally. Over multiple executions in the training phase it develops new self and non-self patterns that are used during the detection phase. Data encountered during the detection phase is fed back to the system to improve the already inferred self and non-self patterns. A detailed explanation of the pattern recognition process is as follows:

4.1 PATTERN ANALYSIS BASED ON DYNAMIC TIME WARPING The detectors in Innate Immune System use Dynamic Time Warping (DTW) algorithm; often used in speech recognition techniques, for pattern matching. [21] presents a distributed approach for detecting botnets in an enterprise network. It uses DTW algorithm to detect abnormal flow patterns. Use of DTW algorithm by the Innate Immune System for pattern recognition is on similar lines as suggested in [21]. Each detector tries to match the network traffic data stream with each of the patterns in its pattern set using DTW. DTW is an algorithm that measures the similarity between two sequences which may vary in time or speed. The detectors use DTW algorithm primarily because:

The sequences that can be compared using this algorithm may vary in time and speed.

The algorithm provides a non-linear (elastic) alignment, which produces a more intuitive similarity measure, allowing similar network traffic patterns to match even if they are out of phase across the time axis [22].

The kind of sequences that DTW algorithm can analyze is similar to network traffic sequences that the Innate Immune System detectors analyze.

To calculate the similarity index for two sequences A, B having m, n data points, respectively, the following formula is used [23], [24]:

$$D(A, B) = \frac{\sum_{s=1}^k d(P_s) * W_s}{\sum_{s=1}^k W_s} \quad (1)$$

where D is distance between sequences A and B ; $d(P_s)$ is distance between i_s and j_s ; P is the function representing points across the optimized (least distance) path between the two sequences; $W_s > 0$ is weighting coefficient. Detectors use the weighting coefficient such that

$$C = \sum_{s=1}^k W_s \quad (2)$$

Here $C = n + m$ as we use the symmetric form for the weighting coefficient

$$D(A, B) = 1/C \sum_{s=1}^k d(P_s) * W_s \quad (3)$$

The detectors calculate the optimized value for $D(A, B)$ using dynamic programming. Dynamic programming is a method for solving complex problems by breaking them down into simpler sub-problems [21], [23]. Dynamic programming is applied in the calculation as follows [21]:

Initial condition: $g(1, 1) = 2d(1, 1)$.

$$g(i, j) = \min \left\{ \begin{array}{l} g(i, j-1) + d(i, j) \\ g(i-1, j-1) + 2d(i, j) \\ g(i-1, j) + d(i, j) \end{array} \right\} \quad (4)$$

Where $g(i, j)$: min. is value of function Pat point (i, j)

$$D(A, B) = g(n, m)/C \quad (5)$$

where $d(i, j)$ is Euclidian distance between point i of sequence 1 and point j of sequence 2.

Thus, if $D(A, B) < D(B, C)$ then the sequences A and B are more similar as compared to sequences B and C [21]. The sequences mentioned in the above formulae could either be patterns in the pattern set of detectors or could be the stream of network traffic data encountered during the actual execution of the system or the data fed during the training phase.

In case of the Innate Immune System the value of P with which an intrusion is detected, is dependent on the value of D calculated using the DTW algorithm for the network traffic data stream. It is important to note that since Innate Immune System is based primarily on pattern recognition using the pattern sets for detectors, it is generic in nature i.e. it is not specific to any particular type of attack. As a result the primary response of an Innate Immune System is non-specific similar to the Innate Immune System in Human Immune System.

5. ADAPTIVE SYSTEM

Adaptive system is the most intelligent and computationally intensive component of the suggested system. As opposed to the Innate Immune System, Adaptive System does not work on the network traffic in its raw form. Data corresponding to the network traffic that pass through the Innate Immune System is first transformed to include only relevant feature sets in the data to be analyzed. The Adaptive System then analyses this transformed data based on mature functions generated during the training phase. These mature functions are generated using various machine learning techniques (both supervised and unsupervised data). Since Adaptive System works on transformed datasets and uses mature functions to analyze network traffic for intrusion, the responses initiated by this component correspond to secondary immune responses.

Adaptive system consists of two sub-components: Data Optimizer and Data Analyzer. We refer to the sub-component that transforms the network traffic data before it is fed to the Adaptive System as Data Optimizer. The details of Data Optimizer are as follows:

5.1 DATA OPTIMIZER Network traffic data consists of multiple parameters like source, destination IP Addresses, incoming and outgoing data rate etc. It is important to note that in spite of the existence of the above mentioned parameters, the variability in the network traffic data is characterized by a limited feature set. This feature set characterizes the network traffic data and is instrumental in inferring patterns in the network traffic data. Thus projecting the data along these feature sets rather than using the raw data is more efficient. Data Optimizer thus performs feature selection [24] on the network traffic data before the network traffic data is passed to the Data Analyzer. The Data Optimizer applies Principal Component Analysis [25] to identify features that account for the variability in the training dataset and hence potential patterns that describe the training data set. Data Optimizer uses Principle Component Analysis primarily for dimension reduction, similar to the technique suggested in [26], which may be defined as the process of reducing the number of random variables under consideration in a given data set using feature selection and feature extraction techniques. During the training phase the Data Optimizer calculates the covariance matrix for the data set consisting of n variable. Corresponding to this covariance matrix; the Data Optimizer records n different eigenvectors and their corresponding eigenvalues [27]. Eigenvectors corresponding to p highest eigenvalues are chosen as they account for the maximum variability of the network traffic data. Using these eigenvectors, a feature vector is calculated such that each column of the feature vector corresponds to one of the eigenvectors. The Data Optimizer transforms the network traffic data by projecting the original data along the p new features. The motivation of the Data Optimizer behind using Principal Component Analysis is that it enables us to efficiently perform analysis on the transformed dataset for only those features that characterize the network traffic data.

5.2 DATA ANALYZER The optimized network traffic data fed to the Data Analyzer by the Data Optimizer during the training phase is analyzed using various machine learning techniques. The concept of data dimensionality is used by the Data Analyzer. A data dimension may be defined as a data element that categorizes each item in a data set into non-overlapping regions [28].

Analysis of data sets along multiple dimensions plays an important role in Business Intelligence (BI). Analysis of business critical data along multiple dimensions reveals Key Performance Indicators (KPI) that are important for understanding various trends and patterns in businesses [29]. Multi-dimensional analysis of data yields significant advantages not only in businesses but also in various fields of study such as engineering, medicine, geology etc. [29], [30]. The Data Analyzer incorporates the multi-dimensional view of network traffic data to analyze network traffic features for intrusion detection as follows:

Each of the features extracted by the Data Optimizer in the training phase is considered as different dimensions. For each of these dimensions the Data Analyzer infers a mature function using supervised learning techniques [31]. Apart from inferring mature dimension functions the Data Analyzer also generates a global mature n variable function, where n is the number of features. During intrusion detection for live traffic, the Data Analyzer applies the dimension values to each of the dimension functions to infer the existence of an intrusion in the system with respect to that dimension. The output of the individual dimension functions is then applied to the global function to determine the existence of an intrusion in the system by taking into consideration all the dimensions together.

In order to generate the mature dimension functions and the global mature function considering all the features together, Data Analyzer uses supervised learning techniques [31]. The primary reason for using supervised learning techniques is that network

traffic data available is labeled data which is extracted using network traces from earlier well known attacks or publicly available datasets, like the KDD Cup 1999 Data [32]. The Data Analyzer primarily uses the following supervised learning techniques for generation of the mature functions:

- 1) Decision Tree
- 2) Sequential Learning

The primary reason for considering these two techniques is as follows:

- 1) Values for network traffic and system usage parameters and hence the derived features represent continuous and sequential labeled data, sequential learning techniques help to detect the label corresponding to an unknown observation based on the sequence encountered till the unknown observation [33], [34].
- 2) Abnormality with respect to the features derived using Principal Component Analysis can be effectively expressed using if then rules. These if then rules can be effectively developed using a decision tree [35].
- 3) Regression trees not only help to infer if then rules but also help in determining potential dimensions that can be used for detecting the abnormality in system usage [22].

6. PROPAGATION OF INFORMATION TO OTHER INSTANCES OF THE SYSTEM

As explained earlier a typical network deployment of the proposed system involves multiple instances of the system operating on individual hosts of the network. These instances propagate system specific information to other instances of the system at regular intervals. The information that each of the instances is required to propagate consists of the following:

- 1) The values for malicious IP addresses and TCP ports that the instance has inferred (Surface Barrier).
- 2) The self and non-self patterns that the Innate Immune System of the instance has inferred.
- 3) The mature functions for the features inferred by the Adaptive System of the instances

In a distributed environment, the effective functioning of the system is dependent on the effective co-operation of the multiple instances of the system. Each instance of the system propagates information to other instances using the reputation based approach suggested in [36], wherein each instance will propagate the information to only its immediate neighboring instances. Individual components of the instances on receiving this information take the following actions:

- 1) The surface barrier updates its reference detection data set with new values for malicious IP addresses or TCP ports.
- 2) The Innate Immune System updates its self and non-self patterns based on the additional patterns inferred by other instances.
- 3) The Adaptive System improves its mature function set for each feature in the feature set based on the information received from other instances.

It is important to note that individual instances of the system must identify each other to avoid any incorrect or irrelevant information being fed to other instances of the system. Each instance uses a multi-factor authentication mechanism suggested in [37] to authenticate other instances and receive information from only authenticated instances. Apart from the technique suggested in [37], the instances also use a challenge-response based authentication system suggested in [38]. Security of the information exchanged between the instances of the system is ensured by transforming and fragmenting the data packets that carry the necessary information before transmitting them as suggested in [39]. An alternative technique used by the instances for secure information transfer is based on the concept of jigsaw puzzle suggested in [40]. Apart from fragmenting the information exchanged between multiple instances of the system, each of the instances hide the fragmented information in the TCP packets using either the LSB data hiding technique suggested in [41] or the steganography technique suggested in [42]. The rationale behind using the approaches suggested in [39], [40] is that, they ensure the confidentiality and integrity of the transferred information. Thus no intermediate node or any unauthorized party can access the information being transferred to its completeness. The data fragments at each of the receiving instances are then combined and actions mentioned above are performed based on the received combined information. Instances of the suggested system deployed in a mobile network exchange system information with each other using mobile routing protocols like; Destination-Sequenced Distance-Vector (DSDV) and Dynamic Source Routing (DSR) [43].

7. CONCLUSION

In conclusion, the suggested hybrid approach based on Artificial Immune System and Soft Computing is instrumental in detecting intrusions and malicious activities in a given network. The three primary components of the system: surface barrier, innate immune system and adaptive system provide a layered defense mechanism, which evolves over multiple executions to combat new emerging attacks. Pattern matching performed by the Innate Immune System using Dynamic Time Warping provides efficient recognition of the self and non-self patterns in the network traffic data stream. The use of computationally intensive soft computing and machine learning techniques by the Adaptive System, provides additional advantage as far as analyzing complex network traffic data is concerned.

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MAINTAINING SECURITY IN ANONYMIZING WIRELESS MESH NETWORKS

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ABSTRACT

Wireless security has been the hot topic for various network technologies such as cellular networks, Wireless Local Area Networks (WLANs), wireless sensor networks, Mobile Ad hoc Networks (MANETs), and Vehicular Ad hoc Networks (VANETs). Anonymity and privacy issues have gained considerable efforts in the system, which have focused on investigating anonymity in different context or application scenarios. One requirement for anonymity is to unlink a user's identity to his or her specific activities, such as the anonymity fulfilled in the untraceable e-cash systems and the P2P payment systems, where the payments cannot be linked to the identity of a payer by the bank or broker. Anonymity is also required to hide the location information of a user to prevent movement tracing, as is important in mobile networks and VANETs. Security in anonymizing networks are implemented for honest users and tracing of misbehaving users for network authorities in Wireless Mesh Networks (WMNs). The guaranteeing fundamental security requirements, including authentication, confidentiality, data integrity, and no repudiation is also proposed. Thorough analysis on security and efficiency is incorporated, demonstrating the feasibility and effectiveness of the proposed system.

Keywords: Anonymity, traceability, pseudonym, revocation, wireless network

1.INTRODUCTION

WIRELESS Mesh Network (WMN) is a promising technology and is expected to be widespread due to its low investment feature and the wireless broadband services it supports, attractive to both service providers and users. However, security issues inherent in WMNs or any wireless networks need be considered before the deployment and proliferation of these networks because it is unappealing to subscribers to obtain services without security and privacy guarantees. Wireless security has been the hot topic in the literature for various network technologies such as cellular networks, wireless local area networks (WLANs), wireless sensor networks, mobile ad hoc networks (MANETs) and vehicular ad hoc networks (VANETs) [1]. Recently, new proposals on WMN security have emerged. In [2], the authors describe the specifics of WMNs and identify three fundamental network operations that need to be secured. We propose an attack-resilient security architecture (ARSA) for WMNs, addressing countermeasures to a wide range of attacks in WMNs. Due to the fact that security in WMNs is still in its infancy as very little attention has been devoted so far, a majority of security issues have not been addressed and are surveyed in. Anonymity and privacy issues have gained considerable research efforts in the literature which have focused on investigating anonymity in different context or application scenarios[3], [4]. One requirement for anonymity is to unlink a user's identity to his or her specific activities, such as the anonymity fulfilled in the untraceable e-cash systems and the P2P payment systems where the payments cannot be linked to the identity of a payer by the bank or broker. Anonymity is also required to hide the location information of a user to prevent movement tracing, as is important in mobile networks and VANETs. In wireless communication systems, it is easier for a global observer to mount traffic analysis attacks by following the packet forwarding path than in wired networks. Thus, routing anonymity is indispensable, which conceals the confidential communication relationship of two parties by building an anonymous path between them [5]. Nevertheless, unconditional anonymity may incur insider attacks since misbehaving users are no longer traceable. Therefore, traceability is highly desirable such as in e-cash systems where it is used for detecting and tracing double-spenders. In this paper, we are motivated by resolving the above security conflicts, namely anonymity and traceability, in the emerging WMN communication systems. We have proposed the initial design of our security architecture in [1], here the feasibility and applicability of the architecture were not fully understood. As a result, we provide detailed efficiency analysis in terms of storage, communication, and computation in this paper to show that our SAT is a practically viable solution to the application scenario of interest. Our system borrows the blind signature technique from payment systems and hence, can achieve the anonymity of unlinking user identities from activities, as well as the traceability of misbehaving users. Furthermore, the proposed pseudonym technique renders user location information unexposed. Our work differs from previous work in that

WMNs have unique hierarchical topologies and rely heavily on wireless links, which have to be considered in the anonymity design. As a result, the original anonymity scheme for payment systems among bank, customer, and store cannot be directly applied. In addition to the anonymity scheme, other security issues such as authentication, key establishment, and revocation are critical in WMNs to ensure the correct application of the anonymity scheme.

2. PRELIMINARIES

2.1 IBC FROM BILINEAR PAIRINGS ID-based cryptography (IBC) allows the public key of an entity to be derived from its public identity information such as name and e-mail address, which avoids the use of certificates for public key verification in the conventional public key infrastructure (PKI). Boneh and Franklin introduced the first functional and efficient ID-based encryption scheme based on bilinear pairings on elliptic curves. Specifically, let G_1 and G_2 be an additive group and a multiplicative group, respectively, of the same prime order p . The Discrete Logarithm Problem (DLP) is assumed to be hard in both G_1 and G_2 . Let P denote a random generator of G_1 and G_2 . $e: G_1 \times G_1 \rightarrow G_2$ denote a bilinear map constructed by modified Weil or Tate pairing with the following properties:

1. Bilinear: $e(aP, bQ) = e(P, Q)^{ab} \quad \forall P, Q \in G_1$ and $\forall a, b \in \mathbb{Z}_p^*$ where \mathbb{Z}_p^* denotes the multiplicative group of \mathbb{Z}_p , the integers modulo p . In Particular, $\mathbb{Z}_p^* = \{x | 1 \leq x \leq p-1\}$ since p is prime.
2. Nondegenerate: $\exists P, Q \in G_1$ such that $e(P, Q) \neq 1$.
3. Computable: there exists an efficient algorithm to compute $e(P, Q), \forall P, Q \in G_1$.

2.2 BLIND SIGNATURE Blind signature is first introduced by Chaum. In general, a blind signature scheme allows a receiver to obtain a signature on a message such that both the message and the resulting signature remain unknown to the signer. We refer the readers to for a formal definition of a blind signature scheme, which should bear the properties of verifiability, unlinkability, and unforgeability according to. Brands developed the first restrictive blind signature scheme, where the restrictiveness property is incorporated into the blind signature scheme such that the message being signed must contain encoded information. As the name suggests, this property restricts the user in the blind signature scheme to embed some account-related secret information into what is being signed by the bank (otherwise, the signing will be unsuccessful) such that this secret can be recovered by the bank to identify a user if and only if he double-spends. The restrictiveness property is essentially the guarantee for traceability in the restrictive blind signature systems.

3. SYSTEM MODEL

3.1 DEFINITIONS First, we give a list of definitions that are frequently used in this paper.

Anonymity (Untraceability): the anonymity of a legitimate client refers to the untraceability of the client's network access activities. The client is said to be anonymous if the TA, the gateway, and even the collusion of the two cannot link the client's network access activities to his real identity.. **Traceability:** a legitimate client is said to be traceable if the TA is able to link the client's network access activities to the client's real identity if and only if the client misbehaves, i.e., one or both of the following occurs: ticket reuse and multiple deposit.

Ticket reuse: one type of misbehavior of a legitimate client that refers to the client's use of a depleted ticket (val ¼ 0).

Multiple deposit: one type of misbehavior of a legitimate client that refers to the client's disclosure of his valid ticket and associated secrets to unauthorized entities or clients with misbehavior history, so that these coalescing clients can gain network access from different gateways simultaneously.

Collusion: the colluding of malicious TA and gateway to trace a legitimate client's network access activities in the TA's domain (i.e., to compromise the client's anonymity).

Framing: a type of attack mounted by a malicious TA in order to revoke a legitimate client's network access privilege. In this attack, the TA can generate a false account number and associate it with the client's identity. The TA can then create valid tickets based on the false account number and commit fraud (i.e., misbehave). By doing so, the TA is able to falsely accuse the client to have misbehaved, and thus, to revoke his access right.

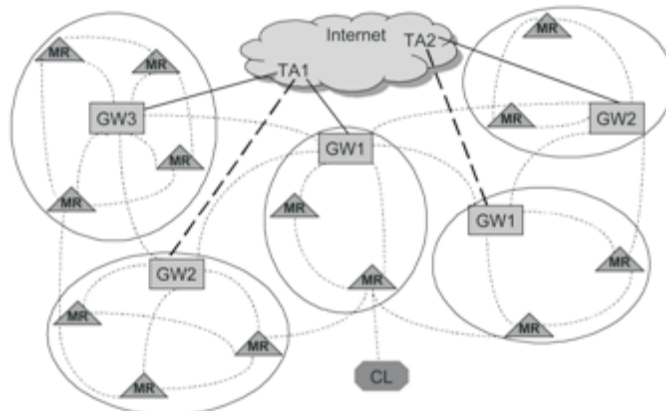


Fig. 1. Network topology of a typical WMN.

3.2 NETWORK ARCHITECTURE Consider the network topology of a typical WMN depicted in Fig. 1. The wireless mesh backbone consists of mesh routers (MRs) and gateways (GWs) interconnected by ordinary wireless links (shown as dotted curves). Mesh routers and gateways serve as the access points of the WMN and the last resorts to the Internet, respectively. The hospital, campus, enterprise, and residential buildings are instances of individual WMN domains subscribing to the Internet services from upstream service providers, shown as the Internet cloud in Fig. 1. Each WMN domain, or trust domain (to be used interchangeably) is managed by a domain administrator that serves as a trusted authority (TA), e.g., the central server of a campus WMN. The TA and associated gateways are connected by high-speed wired or wireless links, displayed as solid and bold dashed lines, respectively. TAs and gateways are assumed to be capable of handling computationally intensive tasks. In addition, they are assumed to be protected in private places and cannot be easily compromised due to their important roles in the WMN. The WMNs of interest here are those where the TA provides free Internet access but requires the clients (CLs) to be authorized and affiliated members generally for a long term, as the employees or students in the case of enterprise and hospital WMNs or campus WMNs.

3.3 TRUST MODEL The trust model comprising trust relationships and the trust domain initialization will be described in this section.

3.3.1 TRUST RELATIONSHIP In general, the TA is trusted within the WMN domain. There is no direct trust relationship between the client and the gateway/mesh router. We will use standard IBC for authentication and secure communications both at the backbone and during network access inside a trust domain (i.e., intradomain). We further assume the existence of preshared keys and secure communication channels between entities (TAs, gateways, mesh routers) at the backbone and will solely consider the authentication and key establishment during the network access of the clients. The client presents his ID upon registration at the TA, which assigns a private key associated with the client's ID. The client selects a unique account number $_$ computed by a randomly chosen secret number u_1 (cf., Section 4.1.1). The account number is stored with the client's ID at the TA. The TA also assigns an ID/private key pair to each gateway and mesh router in its trust domain before deployment. Advantages of this general trust relationship with the TA stem from the direct authentication of the clients traveling among gateways/mesh routers in the same domain, which reduces network access latency and communication overhead that is expected to be overwhelming in future WMNs due to the large user population and high mobility.

3.3.2 TRUST DOMAIN INITIALIZATION We apply the domain initialization of the hierarchical IBC. Specifically, the root public key generator (PKG) at level 0 in the HT performs the following domain initialization algorithm when the network is bootstrapped, where P_0 is a generator of G_1 :

1. Input security parameter $\xi \in \mathbb{Z}^+$ into domain parameter generator PG and output the parameter tuple $(p, G_1, G_2, e, P_0, H_1)$
 2. Randomly select a domain master secret p and $s_0 \in \mathbb{Z}_p^*$ and calculate the domain public key $P_{pub} = s_0 P_0$.
- The root PKG (e.g., the SDE or SDH) publishes the domain parameters $(p, G_1, G_2, e, P_0, H_1, \overline{P_{pub}})$ and maintains s_0 confidential. Suppose that a child CH_j is located at level j . The lower level setup is performed by the parent as follows:
1. compute $K_j = H_1(ID_1, \dots, ID_j)$;
 2. compute CH_j 's private keys $\psi_j = \psi_{j-1} + s_{j-1} K_j = \sum_{i=1}^j s_{i-1} K_i$, and $\Gamma_j = \pi H_1(ID_j)$; and
 3. distribute $QT = \{Q_l : 1 \leq l < j\}$ to CH_j , where $Q_l = s_l P_0$.

4. SECURITY ARCHITECTURE

4.1 TICKET-BASED SECURITY ARCHITECTURE First, we restrict our discussion to within the home domain. The interdomain protocols in our security architecture, which are executed when the client roams outside his home domain, will be presented in Section The ticket-based security architecture consists of ticket issuance, ticket deposit, fraud detection, and ticket revocation protocols. In what follows, we will describe these protocols in detail, together with the fulfillment of authentication, data integrity, and confidential communications that may take place during the execution of these protocols[1].

4.1.1 TICKET ISSUANCE In order to maintain security of the network against attacks and the fairness among clients, the home TA may control the access of each client by issuing tickets based on the misbehavior history of the client, which reflects the TA's confidence about the client to act properly. Partially blind signatures alone allow the blind signature to carry explicit information on commonly agreed terms (i.e., ticket value, expiry date, misbehavior, etc.) which remains publicly visible regardless of the blinding process. Restrictive blind signatures place restrictions on the client's selection of messages being signed which contain encoded identity information (in TN) instead of completely random numbers, allowing the TA to recover the client's identity by computing $_$ if and only if misbehavior is detected. As a result, the anonymity of an honest client is unconditionally [3] ensured. Restrictive partially blind signature schemes can be adopted as the building block of the ticket generation algorithm in our ticket issuance protocol [6].

4.1.2 TICKET DEPOSIT After obtaining a valid ticket, the client may deposit it anytime the network service is desired before the ticket expires, using the ticket deposit protocol shown below. Our scheme restricts the ticket to be deposited only once at the first encountered gateway that provides network access services to the client according to

1. $CL \rightarrow GW : PS_{CL}, m', W, c, \quad \sigma = (U', V', X', \rho, \sigma'_1, \sigma'_2), t_5,$
 $SIG_{\Gamma_{CL}} \sim (m' \parallel W \parallel c \parallel \sigma \parallel t_5);$
2. $GW \rightarrow CL : ID_{GW}, d = H_3(R \parallel W \parallel ID_{GW} \parallel T), t_6, HMAC_k(d \parallel t_6);$

The ticket is deemed valid if both the signature verification and the above equality check succeed. The deposit gateway (DGW), where the ticket is initially deposited, will then generate a signature on the client's pseudonym, the DGW's ID, and the associated misb and exp values extracted from c . The signature is required to be present in order for other access points in the trust domain to determine whether and where to forward the client's access requests, if the deposited ticket will be further used from other access points. This is the reason why the client is not allowed to change his pseudonym while still using a deposited ticket to which the pseudonym is associated, since the DGW will refuse to offer access services to the client if the present pseudonym mismatches the one recorded with the ticket. As a result, the ticket value need to be set to a relatively small quantity in order to allow frequent update of the pseudonym if the client has high requirement on his anonymity. It will not place extra signaling overhead into the system since the TA can grant a batch of small-valued tickets during one single ticket issuance protocol. Due to the limited ticket value, the client is expected to have minimal mobility during the usage of the deposited ticket. However, there are also cases where the client moves to other gateways after the ticket is deposited. To address this issue, possible decision making functionalities may be incorporated into gateways. For instance, if the client temporarily moves to a new gateway in the DGW's vicinity, the new gateway can merely forward all the traffic of this client to the DGW, which then services the client based on the deposited ticket. If the client permanently moves to a new gateway, the new gateway may request the DGW to transfer the ticket record so that the new gateway can directly service the client. We do not intend to further address this issue. Instead, a simple and efficient solution can be employed to abandon the usage of the remaining ticket and deposits a new one at the new gateway since the ticket value is generally not large. This solution is also effective when the ongoing service is disrupted due to channel impairments, route failures, or mobility, as well as when the client tries to avoid mistaken multiple deposit. Adopting this solution, Step 4, in the above procedure can be omitted. On the other hand, if anonymity is not strictly required by the client, he can request tickets with higher values that can be used for longer time under a same pseudonym.

4.1.3 FRAUD DETECTION Fraud is used interchangeably with misbehavior in this paper, which is essentially an insider attack. Ticket reuse generally results from the client's inability to obtain tickets from the TA when network access is desired, primarily due to the client's past misbehavior, which causes the TA to constrain his ticket requests. Multiple -deposit can also be termed client coalition, which is beneficial when the coalescing parties are unauthorized users or clients with misbehavior history having difficulty in acquiring tickets from the TA. Note, however, that since a client is able to obtain multiple tickets in one ticket issuance protocol and self-generate multiple pseudonyms, he can distribute these pseudonym/ticket pairs to other clients without being traced as long as each ticket is deposited only once. A possible remedy to this situation is to specify the no overlapping active period of a ticket instead of merely the expiry date/time such that each time, only one ticket can be valid. This approach, in general, requires synchronization. Another solution is to adopt the tamper-proof secure module so that a client cannot disclose his secrets to other parties since the secure module is assumed to be expensive and impractical to access or manipulate. This approach will eliminate the multiple deposit fraud but requires the deployment of secure modules. In the following discussion, we will still consider multiple deposit as a possible type of fraud (e.g., in case that secure modules are unavailable).

These two types of fraud share a common feature, that is, a same ticket (depleted or valid) is deposited more than once such that our one-time deposit rule is violated. This is where the restrictiveness of the blind signature algorithm takes effect on revealing the real identity of the misbehaving client. Specifically, when the TA detects duplicate deposits using the ticket records reported by gateways, the TA will have the view of at least two different challenges from gateways and two corresponding sets of responses from the same client. By solving the equation sets below based on these challenges and responses, the TA is able to obtain the identity information encoded in the message, and hence, the real identity of the misbehaving client. The fraud detection protocol is shown as [4].

$$\begin{aligned}
 &GW \rightarrow TA : ID_{GW}, m', W, c, \\
 &\sigma = (U', V', X', \rho, \sigma'_1, \sigma'_2), r_1, r_2, T, t_9, H, \\
 &HMAC_k((m' \parallel W \parallel c \parallel \sigma \parallel r_1 \parallel r_2 \parallel T \parallel t_9))
 \end{aligned}$$

By far, we have presented the techniques to resolve the conflicts between anonymity and traceability. As long as the client is a well-behaved user in this network, his anonymity can be fully guaranteed. This is achieved by the blinding process of the ticket issuance protocol, which breaks the linkage between the ticket and the identity, i.e., the TA knows the client's real ID but does not know which ticket/ pseudonym pairs belong to this client, while the gateway knows the linkage between the ticket and the pseudonym but learns no information on the real identity of the owner of these pairs. On the other hand, if the client misbehaves (i.e., fraud occurs), the client's anonymity can no longer be guaranteed since the TA may tend to identify this client, and subsequently, punish him possibly by revoking the client's network access privilege, leveraging the traceability property offered by our security architecture. In addition, our system enables authentication at the access points and meets the access control security requirement that is not satisfied in, where no authentication of the client is performed at the access point in the controlled connection protocol.

4.1.4 TICKET REVOCATION Ticket revocation is necessary when a client is compromised, and thus, all his secrets are disclosed to the adversary. In our system, the adversary is motivated by gaining network services using tickets once the ticket associated secrets are obtained from the compromised clients. Therefore, the compromised client needs to be able to revoke the ticket and prevent the adversary from acquiring benefits. The compromised client and the adversary are the only two parties that are in possession of the ticket-related secrets, a valid revocation request must be sent by the compromised client for genuine revocation purpose since the adversary gains nothing in doing so. The ticket revocation protocol consists of two cases as follows:

1. Revocation of new tickets: the client may store a number of unused tickets, as mentioned previously. When revoking these tickets that have not been deposited, the client sends PSCL, TN, t_{10} , $SIG_{T_{cl}}$ the revocation request to any encountered gateway. This gateway authenticates the client using PSCL and records the ticket serial number TN as revoked.

2. Revocation of deposited tickets: the client simply sends PSCL, IDGW, t_{11} , $SIG_{T_{cl}}$ in the revocation request to the DGW. The DGW authenticates the client and marks the associated ticket revoked. When gateways have records in the revocation database, they immediately report the revocations to the home TA, which will update and distribute the revocation list for all gateways in the trust domain to reference.

When gateways have records in the revocation database, they immediately report the revocations to the home TA, which will update and distribute the revocation list for all gateways in the trust domain to reference.

4.2 PSEUDONYM GENERATION AND REVOCATION The use of pseudonyms has been shown in the ticket-based protocols. This section copes with the pseudonym generation technique and the related revocation issue. The pseudonym is used to replace the real ID in the authentication, which is necessary for both anonymous network access and location privacy. Compared to [7], [8], [9] where a batch of pseudonyms are assigned to each client by the TA, the self-generation method vastly reduces the communication overhead in the system. Moreover, the client is able to frequently update his pseudonyms (with tickets) to enhance anonymity by using this inexpensive method. When accessing the network from a foreign domain, suppose a client CL_j residing at level j is requesting Network access from a foreign mesh router MR in a visiting Trust domain. As a final note on the self-generation algorithm, it would render the pseudonym revocation impossible by using the pseudonym alone. The reason is that any adversary who has compromised a client can generate valid pseudonym/ key pairs that are only known to the adversary by running the self-generation algorithm. However, this pseudonym self-generation technique is appropriate in our system because the pseudonym revocation can be realized via revoking the associated ticket since the pseudonym is active only when its associated ticket is actively in use (deposited and not depleted).

5. SECURITY ANALYSES

In this section, we analyze the security requirements our system can achieve as follows: Again, we use theorems in for demonstration and the analysis using theorems in can be carried out in a similar fashion. Fundamental security objectives. It is trivial to show that our security architecture satisfies the security requirements for authentication, data integrity, and confidentiality, which follows directly from the employment of the standard cryptographic primitives, namely digital signature, message authentication code, and encryption, in our system. We are only left with the proof of nonrepudiation in this category. A fraud can be repudiated only if the client can provide a different representation he knows of m from what is derived by the TA. If the client has misbehaved, the representation he knows will be the same as the one derived by the TA which ensures nonrepudiation. Anonymity. First of all, it can be easily shown that a gateway cannot link a client's network access activities to his real identity. Due to the use of pseudonyms in authentication which reveals no information on the real ID, the gateway learns nothing about the identity of the client requesting network access. Since the pseudonym is generated by the client using his secret number, solving for the real identity from the pseudonym is equivalent to solving the DLP. Furthermore, the client's deposit gateway (DGW) cannot deduce the client's ID from the deposited ticket, which has been blinded by the client and does not reveal any identification information unless misbehavior occurs. Finally, we show that even the collusion of the home TA and the DGW cannot carry out the linking. It is obvious that by collusion, the TA can learn no more from the gateway than the client's pseudonym used in association with a deposited ticket. The hardness of deducing a real identity from a pseudonym has been mentioned above. On the other hand, the gateway can learn the following from the TA Traceability (conditional anonymity). According to its definition, this requirement is twofold: 1) Anonymity for honest clients is unconditional, which can be proved following 2) A misbehaving client is traceable where the identity can be revealed. The proof of point 2 follows from [1, Theorem 2] that the adopted restrictive partially blind signature scheme in our security architecture achieves restrictiveness. In other words, point 2 states that the client can only obtain signatures on messages of which the client knows a representation for which the structure in the representation (where the identity information is encoded) remains, proved by using [10] and two extra requirements on the representations the client knows of m and m_0 (see [2] for detailed description of the two requirements). Framing resistance. If the client is honest, with overwhelming probability, the representation he knows is different from that the malicious TA falsely generated. Since the client could not have come up with this representation by himself; it proves that the TA attempts to frame the client. Therefore, innocent clients can exculpate themselves to prevent malicious TAs from revoking their network access privilege. Unforgeability. The proof of unforgeability (formally defined in [6]) is essentially the proof of [1] that the adopted restrictive partially blind signature scheme is existentially unforgeable against adaptively chosen message and ID attacks under the assumption of the intractability of CDHP in G1 and the random oracle. We conclude that the proposed security architecture satisfies the security requirements for anonymity, traceability, framing resistance, and unforgeability, in addition to the fundamental objectives including authentication, data integrity, confidentiality, and nonrepudiation, under the assumption that CDHP in G1 is hard and the random oracle.

6. CONCLUSION

We propose a security architecture mainly consisting of the ticket-based protocols, which resolves the conflicting security requirements of unconditional anonymity for honest users and traceability of misbehaving users. By utilizing the tickets, self-generated pseudonyms, and the hierarchical identity-based cryptography, the proposed architecture is demonstrated to achieve desired security objectives and efficiency.

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IMPLEMENTATION OF A REAL TIME PASSENGER INFORMATION SYSTEM

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ABSTRACT

Intelligent Transportation Systems (ITS) are gaining recognition in developing countries like India. This paper describes the various components of our prototype implementation of a Real-time Passenger Information System (RTPIS) for a public transport system like a fleet of buses. Vehicle-mounted units, bus station units and a server located at the transport company premises comprise the system. The vehicle unit reports the current position of the vehicle to a central server periodically via General Packet Radio Service (GPRS). An Estimated Time of Arrival (ETA) algorithm running on the server predicts the arrival times of buses at their stops based on real-time observations of the buses' current Global Positioning System (GPS) coordinates. This information is displayed and announced to passengers at stops using station units, which periodically fetch the required ETA from the server via GPRS. Novel features of our prototype include: (a) a route-creator utility which automatically creates new routes from scratch when a bus is driven along the new route, and (b) voice tagging of the stops and points of interest along any route. Besides, the prototype provides: (i) web-based applications for passengers, providing useful information like a snapshot of present bus locations on the streets, and (ii) web-based analysis tools for the transport authority, providing information useful for fleet management, like number of trips undertaken by a specific bus. The prototype has been demonstrated in a campus environment, with four-wheelers and two-wheelers emulating buses. The automatic real-time passenger information system has the potential of making the public transport system an attractive alternative for city-dwellers, thereby contributing to fewer private vehicles on the road, leading to lower congestion levels and less pollution.

Keywords: *Passenger Information Systems, Estimated Time of Arrival (ETA), General Packet Radio Service (GPRS), Global Positioning System (GPS).*

1. INTRODUCTION

With the advent of GPS and the ubiquitous cellular network, real time vehicle tracking for better transport management has become possible. These technologies can be applied to public transport systems, especially buses, which are not able to adhere to predefined timetables due to reasons like traffic jams, breakdowns etc. The increased waiting time and the uncertainty in bus arrival make public transport system unattractive for passengers. A Real-Time Passenger Information System (RTPIS) uses a variety of technologies to track the locations of buses in real time and uses this information to generate predictions of bus arrivals at stops along the route. When this information is disseminated to passengers by wired or wireless media, they can spend their time efficiently and reach the bus stop just before the bus arrives, or take alternate means of transport if the bus is delayed. They can even plan their journeys long before they actually undertake them. This will make the public transport system competitive and passenger-friendly. The use of private vehicles is reduced when more people use public transit vehicles, which in

turn reduces traffic and pollution.

Reference [1] describes some of the existing RTPISs in different parts of the world -- UK, USA, Ireland, Taiwan and Italy. It also compares them in terms of the vehicle location technology, ETA prediction and mode of information dissemination. Reference [2] describes details about a European RTPIS project, INFOPOLIS 2. It presents a survey about different passenger information systems present in European countries. Reference [3] describes a project study in implementing passenger information system in the city of Los Angeles. Reference [4] describes the RTPIS of Helsinki, Finland. Reference [5] presents a commercially available passenger information system that has features like information delivery via SMS (Short Messaging Service), webpages, on-board and at-stop displays, location-based advertisements, alerts about schedule changes and a journey planner. Reference [6] is another commercial system with only onboard and at-stop displays for next stop and waiting time display. References [7]-[13] describe arrival time prediction algorithms. Reference [14] describes the preferred mode of information for passengers in buses, at stops and passengers who are planning to travel. Reference [15] and [16] describe future work plan, related to security issues and also about how to apply this methodology for other possible fleet management.

The application scenario of RTPIS is shown in Figure 1.

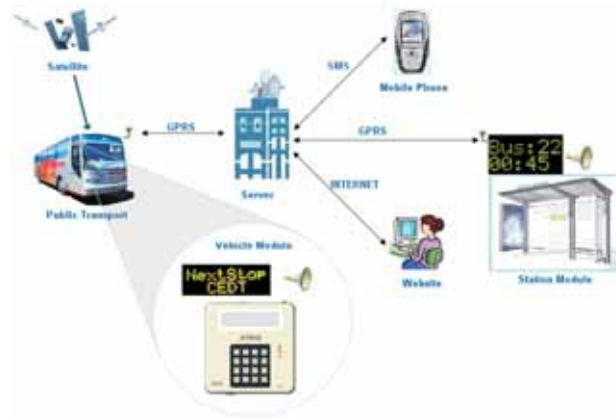


Figure 1 RTPIS Scenario

RTPIS provides travel information to passengers and tourists enabling them to make informed decisions about modes, routes and departure times. The RTPIS framework can be broadly divided into two contexts: Pre-trip context and On-trip context. The former provides information like timings, fares and routes well before the commencement of travel, through the Internet or the Short Messaging Service (SMS). The On-trip context provides information like location and places of interest (POI) while on the move. This is achieved using on-board and at-stop terminals (displays and audio announcement units).

Novel features of our prototype include:

Route creation utility: Information about bus routes can be built up from scratch using this. The new route is created automatically when the bus is driven along the new route. The number of nodes used to describe a route is determined adaptively, depending on whether the route features many short linear segments, or few large linear segments. To the best of our knowledge, the route creation feature of our system is not found even in commercial implementations.

Voice tagging: Our system enables the driver to tag a bus stop with a name, by recording its name during the process of route creation. This voice tag will be replayed when the bus approaches the bus stop next time.

The paper starts with an overall description of the system implementation (Section 2). The route creation and voice tagging features are covered next (Section 3). ETA is the main travel information provided to passengers. Using the current known position of the buses and their routes, the ETA predictor (Section 4) calculates the ETA at every bus stop. A host of different server utilities have been developed which includes, a relatively new feature of ETA retrieval by SMS (Section 5). In Section 6, we provide estimates of the server load and fleet size that can be managed by the system. Section 7 covers future work plan.

2. SYSTEM DESCRIPTION

The main parts of RTPIS are vehicle units in buses, station units at bus stops and a central data processing server. These parts are briefly described in the subsequent sections.

A. VEHICLE UNIT

The main functions of the vehicle unit are as follows.

Pre-trip context

To download names and coordinates of stops and points of interest from the server

On-trip context

To compute current location, direction and speed of the bus.

To transmit the computed information to the central server using GPRS.

To display “next stop/point of interest” information on the vehicle, and play out corresponding announcements

To provide a “user interface” consisting of a display and keypad for the driver, enabling bus management actions, like route number changes and breakdown indications.

The block diagram and photograph of the vehicle unit are shown in Figure 2 and Figure 3 respectively.

The hardware platform for this unit is described in Appendix A.

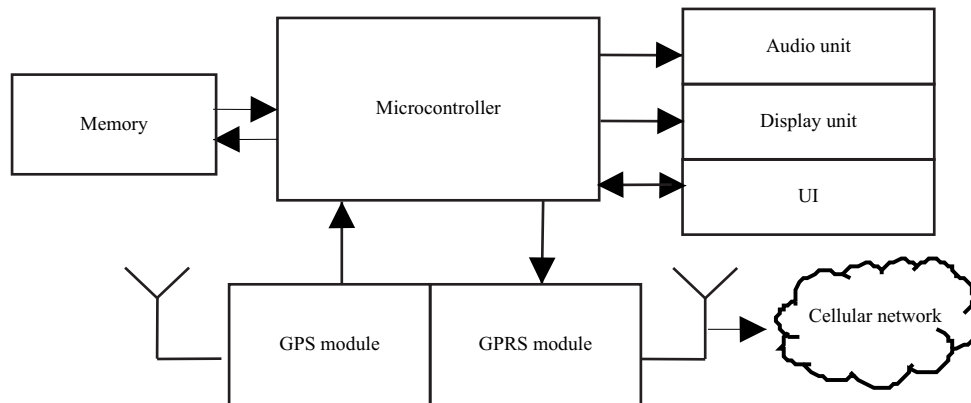


Figure 2 Vehicle unit Block Diagram



Figure 3 Photograph of vehicle unit

The vehicle unit operates as follows – the GPS receiver in this unit computes the current location of the vehicle. The latitude, longitude and speed of the bus are transmitted periodically to a central server using GPRS. The vehicle unit initially downloads the names and coordinates of stops and POIs on the current route from the server. This is used to display and announce the name of stop or POI when it is approached, for the benefit of passengers inside the bus. The configuration parameters and audio files for announcement are stored in memory. The microcontroller sequences the series of operations --- periodic transmission of GPS coordinates, audio and display operations. The UI (keypad and display) is meant for the bus driver, and is used to change the route number of the bus, indicate breakdown and trace a new route.

The Firmware for the vehicle unit consists of a Real Time Operating System (RTOS), application tasks that run on the microcontroller and Python scripts that run on the GPS/GPRS module which is used as a coprocessor. RTOS has been used in the vehicle unit for modular firmware development. Functions related to positioning and communications with the server are

handled by Python scripts running on the GPS/GPRS module, and microcontroller application tasks handle the remaining functions of the vehicle unit. This task partitioning across microcontroller and the module reduces load on the former. This is significant because when audio files are being played, the microcontroller will not be able to process the position/ETA updates efficiently.

B. SERVER

The server is at the center of our RTPIS. The functions of the server are listed below:

To maintain a database of all the routes, the buses that ply on a route, the stops along each route etc. (Table 1)

To continuously receive location and speed from the vehicle units of all the buses

To calculate the ETA of all the buses at their next and subsequent bus stops

To reply to SMS-based queries requesting ETA at specific stops from users; a GSM modem connected to the server transfers these queries to the server which processes them and sends the reply message

To host Internet web pages, which allow users to track buses in real time, see the route map of any route, and get the ETA for any route-stop pair and plan trips from any source to any destination stop, at any time

1) SERVER DATABASE The server maintains a database of information pertaining to the buses, routes and stops in the form of tables (Table.1). The server database [12] can be organized in many ways, to reduce memory requirement, improve access speed, or reduce the number of queries. To improve the query speed, the tables related to buses are partitioned into static and dynamic ones. The Bus table stores static data while the bus position and log tables store dynamic data. The relation between the unique bus id, bus type (ordinary/luxury/...) and route number is stored in the Bus table. The position updates from the bus are stored in the Bus Position and the Bus Position Log tables. The “direction” field indicates the direction in which the bus is headed (Terminus A to Terminus B, or reverse). The direction is calculated in the vehicle unit by comparing time-separated position values with route details. The average speed is the weighted average of the current speed and the previous average speed. The status of the bus changes to invalid, when its driver signals a breakdown. This helps the transport company to take suitable actions. The bus is excluded from ETA calculations based on this field. The Bus Position Log table stores a copy of the position update sent by buses. This log can be backed up and used for future analysis (Analysis tools, section 5).

TABLE 1: DATABASE TABLES

Table name	Contents
Bus	Bus ID, type and route
Bus Position	Bus ID, current coordinates, speed, average speed, direction, current link, link entry time, estimated end time, status
Bus Position Log	Log of changes made to bus position table
Node	Node ID, coordinates, name
Link	Link ID, node pair, travel time
Route	Route number, sequence of links
Stop	Stop name, node ID, route number, ETA

To store the route information, a route is modelled as a set of nodes, which can be stops, POIs or critical bends. Adjacent nodes form links. Thus, a route is characterised by an ordered set of links as in Figure 4. The current link position of each bus and the estimated time to reach the link end are calculated and stored in the Bus Position table upon reception of an update from the vehicle unit.

Details about the links and nodes are stored in the Link and Node tables, respectively. The link travel time is dynamically updated when a bus reaches the end of the link. Each stop has details of buses that pass through them along with their estimated time of arrival at the stop.

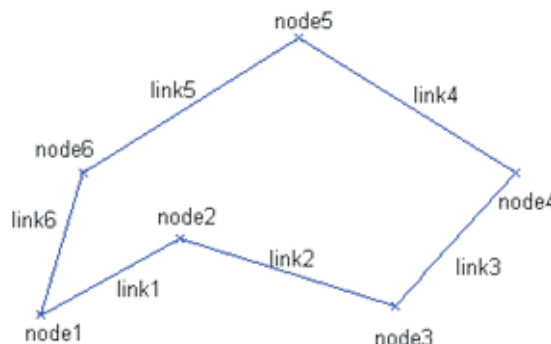


Figure 4 A typical route identified by links

C. STATION UNIT

The station units are installed at all major bus stops. The station unit functions are listed below.

- To fetch ETA for all routes through the stop
- To announce and display the fetched ETA

The architecture, as shown in Figure 5, is similar to that of the vehicle unit, except for the absence of the GPS receiver and the UI. Reuse of the same PCB design reduces the manufacturing cost. The station unit operates as follows. The GPRS module periodically fetches ETA information for all routes through the stop, from the server via GPRS and the microcontroller sequences this information to the audio and display units. Since the station unit is similar to the vehicle unit, the PCB designed for the vehicle unit, shown in Figure 11, is reused. This is done by using a GPRS-only module in place of GPS/GPRS module and not mounting the Liquid Crystal Display (LCD) and keypad.

As for the vehicle unit, the firmware for the station unit is split into microcontroller application tasks for control and sequencing, and Python scripts for communication with server.

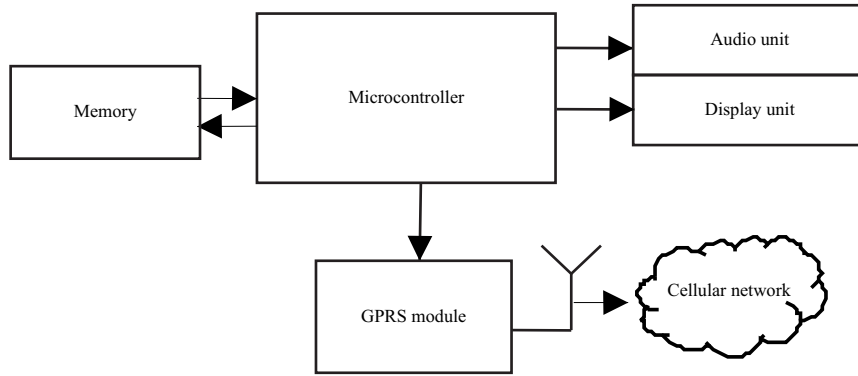
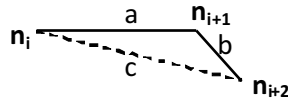


Figure 5 Station unit Block Diagram

3. ROUTE CREATION

A novel method has been developed to automate the process of creating new routes and populating the database, with little human intervention. To create a new route, the vehicle unit is taken along the required route. The unit keeps logging the position coordinates along the route in the local memory at a fast rate. Whenever a stop needs to be indicated, the driver can attach a voice tag to the position information. The tag serves the purpose of attaching a name to a coordinate later. A server utility takes the data collected by the vehicle unit and creates new tables in the database for the created route. This program applies a piece wise linear (PWL) approximation algorithm to the raw set of nodes, and optimises the number of nodes and links by retaining only the critical nodes. The algorithm has the built-in feature that nodes are introduced whenever required, according to the threshold set by the user (the transport authority). If the route involves many turns (zigzagging route), then more nodes are introduced; if the route involves long stretches of straight lines, then fewer nodes are introduced. A smaller error threshold results in accurate representation of the route.



*Figure 6 A node tuple used in the route creation algorithm.
a, b and c denote the distances between the indicated nodes*

The algorithm considers three nodes (n_i, n_{i+1}, n_{i+2}) at a time and checks how collinear they are. If the linearity error (defined as $a+b-c$ in Figure 6) is less than a threshold (25m in the implementation), the second node is skipped and a new node tuple (n_i, n_{i+2}, n_{i+3}) is considered. If the error crosses the threshold, the second node in the tuple is added to the list of nodes, and the algorithm repeats starting with the second node in the tuple. However, all stops are included irrespective of the linearity constraint. The pseudocode for the route creation algorithm is given in Appendix B.

After optimising the set of nodes (Figure 7), node and link information must be entered in the database. For this, the new nodes are compared with the existing nodes in the database. If there is a match (their distance is within a threshold, 25m in the implementation), the existing node is reused. If no match is found, an entry for the node that does not exist in the database is added to the Nodes table. Similarly, existing links are checked for matches. If a link is already in the database, it is reused; else, a new link is added to the Link table.

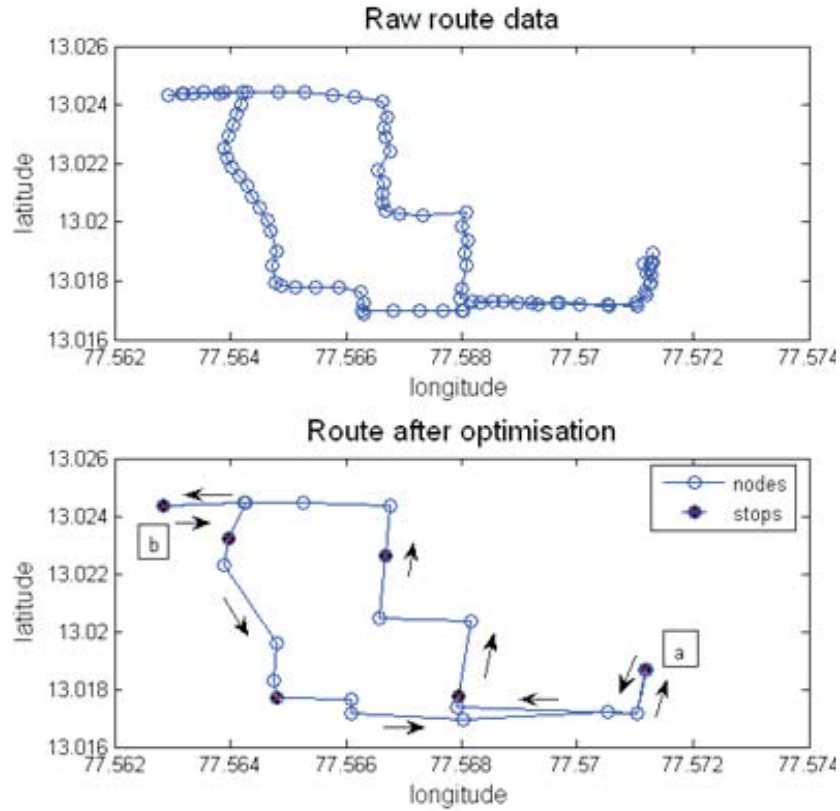


Figure 7. Route Creation

4. ETA PREDICTION

Arrival time prediction forms the core of any RTPIS system. The algorithm can be very simple, involving only a bus schedule table [7], zone based [8] or could be very complicated, involving Artificial Neural Networks [9], space-time correlation [10] and time series modeling [11]. Bus schedule table and past location data can be used to predict arrival time, as in [13].

Our system provides a platform for executing any ETA algorithm, though we have implemented our own simple one that adapts to changing traffic conditions. Our algorithm works by recording the time it takes to traverse each link. Predictions are based on the present and past observations of a bus passing through each link. The past observations get lesser weight as time progresses; this reflects current traffic conditions better. The pseudocodes for these algorithms are given in Appendix B.

The predicted ETA at bus stops is bounded by an upper limit of one round trip time of the route, though the ETA can be predicted infinitely into the future by simply adding integral number of round trip times to the smallest ETA.

The ETA algorithm has two parts:

1. Link updater, which estimates the travel time for each link
2. ETA calculator, which calculates the ETA for every bus stop.

A. LINK UPDATER

Link updater calculates the link travel times required by the ETA calculator. Whenever a bus position update is received from the vehicle unit, the link updater calculates the travel times for all links traversed by the bus from the previous known position. The weighted average of the previous value and the actual travel time obtained for the current bus is stored as the link travel time in the Link table. To compute the average velocity, the weights are 90% for the previous average velocity and 10% for the current velocity. To compute average link travel time, the weights are 70% for the previous average and 30% for the current value. For an update rate of two per minute used in our trial runs, these weights give a good approximation of the average values, as well as track the recent trends. The link travel time is also common to all routes containing the link, so as to get the latest time estimate. This is the reason for sharing links between routes during route creation.

Link updater locates the bus position along the current route of the bus. The link updater then calculates the time required to reach the end of the current link and updates the estimated end time information in the Bus Position table. If the bus enters a new link, the

entry time for the new link is stored in the Bus Position table against the bus and the travel time for all the crossed links is calculated. This time is also the exit time for the previous link. The time difference between the exit time and the previously recorded link entry time gives the link travel time for the crossed links. The travel times for links are a function of their lengths. Thus, when more than one link is traversed between updates, the individual link travel times are computed as fractions of the total travel time, with the fraction for link i being the ratio of the length of the i th link to the sum of lengths of traversed links. This makes sure that among the traversed links, shorter links have smaller travel times and longer links have larger travel times. The computed link travel times are averaged with their previous values and the Link table is updated.

Suppose that the last position update received from a bus corresponds to position B_I (Figure 8), and the position update received just now corresponds to position B_F . We discuss the actions of the link updater algorithm for this example. The route section consists of the links N_1-N_2 , N_2-N_3 , N_3-N_4 , N_4-N_5 , where N_i are the nodes comprising the route. In the first pass of the link updater algorithm, the latest bus position is mapped onto the route by checking every link in the route, starting from the current link. In this case, the bus is found to be in the link N_4-N_5 . Since it is a new link, the entry time into that link (for this bus) is set to the current time. In the second pass of the algorithm, travel time for the crossed links --- N_1-N_2 , N_2-N_3 , N_3-N_4 --- are updated by partitioning the total travel time among individual link travel times, based on their lengths. Hence, link N_1-N_2 gets a larger travel time than link N_2-N_3 . For the final link, the time to reach the end of the link (node N_5) is found by dividing the Euclidean distance between the bus position and N_5 , by the average velocity of the bus. Database updates for bus position, current link, link travel times, estimated end time and average velocity happen at every iteration of the algorithm.

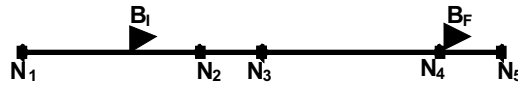


Figure 8 Link travel time calculation scenario

E. ETACALCULATOR

This program takes the current bus position, link travel times and estimated time to link-end to predict the ETA for all bus stops. ETA at a stop is the time taken for the nearest bus to reach the bus stop. It is calculated as the sum of travel times of the links, starting from the current bus position, up to the given bus stop.

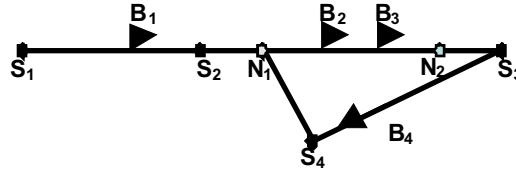


Figure 9 Scenario for ETA calculation

An example scenario for ETA calculation for a route is shown in Figure 9. The circular route consists of links S_1-S_2 , S_2-N_1 , N_1-N_2 , N_2-S_3 , S_3-S_4 , S_4-N_1 , N_1-S_2 , S_2-S_1 where, N_i are intermediate nodes and S_i are stops. ETA calculation starts by checking for buses in links of the route. In the example, a bus is present in the first link S_1-S_2 and the end node of the link is a stop. Hence, the ETA at stop S_2 is just the estimated time to link-end for the bus B_1 . Since no bus is present in link S_2-N_1 , ETA at N_1 is the sum of ETA at S_2 and the link travel time of S_2-N_1 . In the link N_1-N_2 there are 2 buses and bus B_3 is closer to N_2 than B_2 , and hence ETA at N_2 is estimated time to link-end of bus B_3 . ETA at other nodes is calculated in a similar manner and they are listed in Table. 2.

TABLE 2: EXAMPLE ETA VALUES

Stop	ETA
S_1^*	$ETA(S_2, \text{return}) + ltt(S_2-S_1)^{**}$
S_2	Estimated-end-time(B_1)
S_3	Estimated-end-time(B_3)+ $ltt(N_2-S_3)$
S_4^*	Estimated-end-time(B_4)
S_2, return^*	$ETA(S_4) + ltt(S_4-N_1) + ltt(N_1-S_2)$

*eta is for returning bus B_4

**ltt – link travel time

5. SERVER UTILITIES

Internet based utilities have been developed to help online users get travel information. This has been designed along the lines of the Helsinki City Transport website [4].

A. Website

Pre-trip information, like routes connecting different places, route map, current position of buses and bus arrival times are provided to users through the RTPIS website. Additional web pages have been created for the system administrators to create new routes, perform bus-wise and route-wise analysis and manage the RTPIS database.

B. Trip Planner

Trip planner allows passengers to plan their journeys beforehand. The web page allows passengers to enter the source and destination stops and the start time for the trip. For enquiries regarding potential trips, the trip planner finds the routes that are common to the source and destination stops. It then chooses the predicted ETA which is closest in time to the time of interest, from the list of ETAs separated by integral multiples of round trip times.

C. Bus Arrivals

Through this web page, users can request ETA at a bus stop, for any or every route passing through it. This page queries the database for ETA and displays it to the user.

D. Route Map

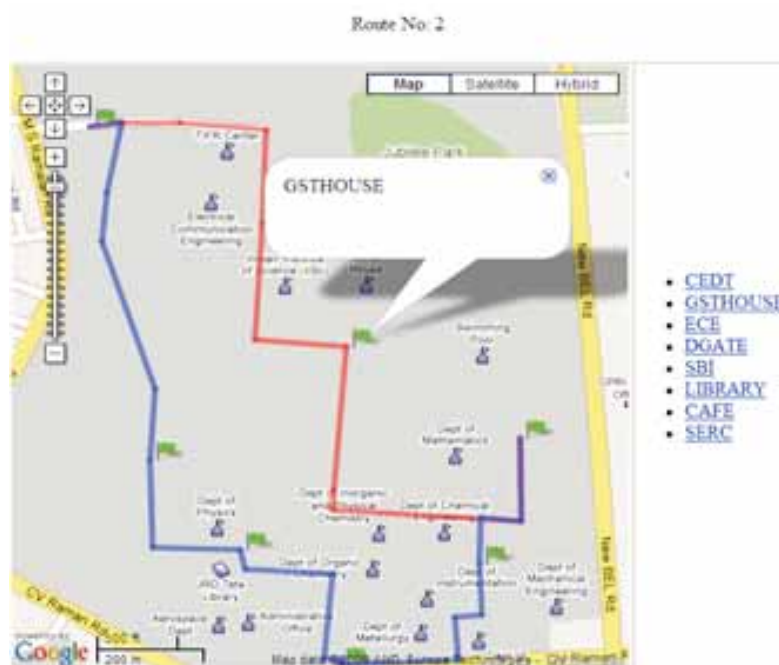
Through this web page, users can request to view the map of the selected route. The displayed map shows the forward and reverse paths and stops along the route. The Google maps Application Programming Interface (API) has been used for this purpose as in Figure 10.

E. Tracking Buses

Through this web page, users can view the present position of all the buses for the selected route, on the route map. This is done by getting the position of all the buses of a route from the database and then plotting it on the route map.

F. Analysis Tools

Using the bus position log table, information regarding the usage pattern of buses and routes can be obtained. This page enables the administrator to find the number of trips a specific bus has undertaken, the total distance travelled and adherence to schedule by drivers. Similarly, information for a particular route, like buses that used that route and number of trips made in that route can be obtained. This helps to develop the infrastructure of critical routes.



I. Database Manager

This page provides unrestricted access to the RTPIS database and hence it is password-protected. Using this page, the administrators can create, edit and delete any table in the database.

M. SMS Handler

SMS requests from users are handled by this application running at the server. In the SMS request, users should mention the name of the stop for which they want the ETA and optionally, give their desired route number. After querying the database for the ETA, the results are sent back to the sender via SMS.

6. ESTIMATING SERVER LOAD AND FLEET SIZE

The RTPIS system was tested in the Indian Institute of Science campus. Route used for the test is shown in Figure 10. The source stop is CEDT and the destination stop is DGATE. The onward path consisting of the stops CEDT, Guest House, ECE, and DGATE is shown in red, and the return path consisting of the stops DGATE, SBI, Library, Café, and SERC is shown in blue. Initially, when the vehicle unit is powered up at CEDT, it downloads the route information from the server and waits for a GPS position fix. After getting the position fix, it identifies itself to be at CEDT. When the vehicle moves away from CEDT, the direction is automatically inferred as “onward.” This helps the vehicle unit to match the current vehicle coordinates with the stops of the route, so as to identify the next stop. The vehicle unit announces the name of the next stop and displays it, about 50m before the stop. When the destination is reached, the direction is automatically reversed to “return path,” and the process repeats. Meanwhile, the station unit placed at CEDT announces and displays the ETA at CEDT, and the present position of the vehicle is shown, live, on the tracking webpage of the server. The campus wide test is the source of the experimental data.

RTPIS capacity is limited by the number of queries to the centralised MySQL server. Link updater and ETA calculator are very processing-intensive tasks. Link updater has to query the Bus, Bus Position, Route, Link and Node tables to find link travel times, current link, estimated end time, etc. The ETA calculator has to query the Bus, Route, Link, Node and Stop tables to find the link travel time and the estimated end time, and then update the ETA. This section studies the complexities of algorithms in terms of the number of queries to the server, and arrives at an estimated fleet size based on reasonable assumptions.

N. Server load estimation

Notations

B, L, R, S – number of buses, links, routes and stops, respectively, in the database

We use the big 'O' notation to quantify the complexity in terms of the number of queries generated. For instance, $O(x)$ signifies that the number of queries is bounded by a linear function of x .

1) Load from Link Updater

For every position update, the link updater tries to locate the bus in one of the links of its route. To do this, it retrieves the links which form the route and has a worst-case complexity of $O(L)$. But most of the buses are likely to be in the next few links from the current link, resulting in a practical value of $O(1)$. Since link updater works whenever a bus position update occurs, resulting in a total complexity of $O(B)$ in practice.

2) Load from ETA calculator

For every execution, the ETA calculator queries the database for all the links for every route and has a complexity of $O(L)$.

3) Load from SMS handler

For every SMS requesting ETA at a stop, the SMS handler queries the corresponding stop table for the required route. If no route is mentioned, it retrieves the ETA for all routes corresponding to the stop in one query. Hence, the complexity is $O(1)$ for each SMS handled. The query complexity of the website program is similar to SMS handler.

4) Load from Station unit

Every station unit retrieves all the ETA for a stop in one query, resulting in a complexity of $O(1)$. For all the station units the total load is $O(S)$.

O. Fleet size estimation

Fleet size can be estimated by relating the load on the server and the capacity of the server. To arrive at the actual load, the big 'O' notation is replaced by scaled values of the complexity, i.e. $O(x)$ by kx . The mathematical relation and the fleet size estimate are described below.

Assumptions

Server capacity, r_{SERVER}	= 30000 queries/min
Position update rate for a bus, r_B	= 2 /min
ETA calculation rate, r_{ETA}	= 1 /min
No. of SMS queries, r_{SMS}	= 20 /min
No. of queries from website, r_W	= 50 /min
No. of queries from a station unit, r_S	= 1 /min

Total no. of queries generated for all buses, routes, stations, user requests etc...:

Link updater	= αr_{BB} /min
ETA calculator	= βr_{ETAL} /min
SMS handler and website	= $\gamma (r_{\text{SMS}} + r_W)$ /min
Station units	= δr_{SS} /min

The server capacity number was arrived at experimentally by giving continuous updates covering one route to the server and finding the execution time. For faster servers, this number can be much higher. α is the observed value, from the execution of “current link updater” program. β , γ and δ are obtained mathematically based on the algorithmic implementation.

Number of queries generated per minute by the whole system should be less than the total number of queries the server can handle.

$$\alpha r_{BB} + \beta r_{\text{ETAL}} + \gamma (r_{\text{SMS}} + r_W) + \delta r_{\text{SS}} < r_{\text{SERVER}}$$

For a typical case of 100 links per route, 10 buses per route, and 2000 stops in all, and for the scale factors of $\alpha \approx 10$, $\beta \approx 1$, $\gamma \approx 6$, $\delta \approx 1$, we get number of routes, $R \approx 91$ and number of buses, $B \approx 910$.

7. FUTURE WORK

As this system uses a combination of processing elements: PCs, Mobile Phones etc., there is a possibility of the overall system malfunction due to a particular type of attack, it is termed as Denial of Service (DoS) attack by malicious agents who might try to disrupt the function of the system. Reference [15] describes a Distributed Security Scheme for Ad Hoc Networks and it also proposes a proactive scheme to prevent this kind of attack. Similar methodology will be studied to make this Real Time Passenger Information System more robust.

The proposed system is also quite universal in nature and it is possible to extend the methodology for other type of fleet movement where security is of paramount importance. Reference [16] proposes a novel data hiding technique, based on Steganographic mechanism. Here, the advantage lies in the fact that computationally costly encryption-decryption mechanism is avoided, thus making it suitable for a heterogeneous combination of processing elements, which are being used in our present system. Here, many processing elements e.g. Mobile phone etc. lacks the processing power and battery power, which is required for traditional encryption-decryption system.

8. SUMMARY

We have developed a RTPIS that tracks the current location of all the buses and estimates their arrival time at different stops in their respective routes. Estimates are updated every time the bus sends an update. It distributes this information to passengers using display terminals at bus stops, web based GUI and SMS. This system serves the needs of passengers, vehicle drivers and administrators of the transport system. The system can be deployed in any city with approximately 1000 buses, 100 routes and 2000 stops. New routes can be added without the need for detailed maps, using a user friendly GUI and data from vehicle drivers. Starting from scratch, all routes can be added to the database, in a few days without any major data entry work at the server. In addition, real time traffic data from link travel time statistics can also aid city traffic information systems.

APPENDIX

P. PCB block schematic

The block schematic of the four-layer PCB designed for the vehicle unit is shown in Figure 11. Vehicle and station units have the common functionalities of announcements, display and communication. The vehicle unit has the additional requirement of calculating the current position. The components of the PCB have been chosen to perform the above said functionalities.

The microcontroller (μC) is connected to the combo GPS/GPRS module through the Universal Asynchronous Receiver

Transmitter (UART) interface. AT commands are issued across this interface, to get GPS coordinates and perform GPRS data transfer. The Secure Digital (SD) card adapter interfaces an SD card to the μC , via the Serial Peripheral Interface (SPI). The codec is interfaced to the μC through the Inter Integrated Circuit (I2C) interface for configuring the codec registers and SPI for transferring audio data. The SD card and codec are jointly used to play and record audio files. LCD and keypad are interfaced through General Purpose Input Outputs (GPIO) and provide a user interface to the driver. The power section generates the necessary supply voltages for all the components from the 12V input. A DIN connector carries data for the external LED display and speaker. The JTAG interface is to program the μC .

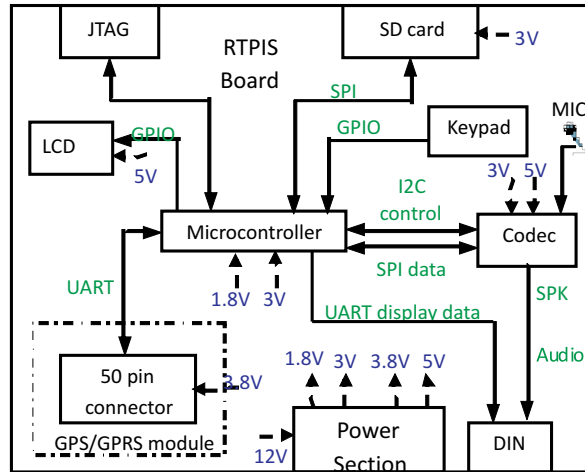


Figure 11 RTPIS PCB block schematic Algorithms

General notation -

i, j, n, p : any node

$\text{dist}(i, j)$: Euclidean distance between i and j

$\text{error}(n_0, n_1, n_2) : \text{dist}(n_0, n_1) + \text{dist}(n_1, n_2) - \text{dist}(n_0, n_2)$

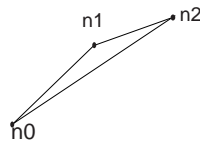
l : any link

$\text{start}(l)$: first node of link l

$\text{end}(l)$: second node of link l

dl : length of link l

TTl : time to traverse link l



1) PWL Algorithm

a) Notations

$n[]$ - list of nodes from node file

$\tilde{n}[]$ - list of optimised nodes

b) Initialisations

$N \leftarrow \text{length}(n)$

$\tilde{n}[0], n_0 \leftarrow n[0]$

$n_1 \leftarrow n[1]$

$j \leftarrow 0$, link counter

$l \leftarrow []$, list of links

$\text{err} \leftarrow 0$, accumulated error

c) Algorithm

for $i \leftarrow 2$ to $N-1$

$n_2 \leftarrow n[i]$

$\text{err} = \text{err} + \text{error}(n_0, n_1, n_2)$

if n2 is stop/POI or $\text{err} > \text{threshold}$

$\text{err} = 0$

$\tilde{n}[j+1] \leftarrow n1$

$l[j] \leftarrow \text{link } n0 - n1$

$j \leftarrow j + 1$

$n0 \leftarrow n1$

$n1 \leftarrow n2$

2) Link Updater

a) Notations

$\text{clnk} \leftarrow$ last known link of the bus

$p \leftarrow$ position of bus, sent by the vehicle unit

$\text{lnk} \leftarrow$ list of links that need to be updated

$\text{LST} \leftarrow$ link entry time for clnk

$\Delta t \leftarrow$ current time – LST

$dT \leftarrow$ total length of completed links

$\text{threshold} \leftarrow$ constant, 60m in implementation

b) Algorithm

//pass1 - find the links to be updated

$dT \leftarrow 0$

for $l \in \text{links in route starting from clnk}$

if $\text{error}(\text{start}(l), p, \text{end}(l)) < \text{threshold}$

$\text{new_clnk} \leftarrow l$

$dT \leftarrow dT + dl$

if $\text{new_clnk} \neq \text{clnk}$

$\text{LST} \leftarrow$ current time

//pass2 - update the links

$\text{avg_vel} = \text{avg_vel} * a + \text{cur_vel} * (1-a)$

$\text{lnk} \leftarrow$ set of links along the route from clnk to new_clnk

for $l \in \text{lnk}$

if $l \neq \text{new_clnk}$

$\text{TTI} \leftarrow b * \text{TTI} + (1-b) * \Delta t * dl / dT$

else

$\text{clnk} \leftarrow \text{new_clnk} \frac{\text{dist}(p, \text{node2}(\text{new_lnk}))}{\text{avg_vel}}$

$\text{est_end_time} \leftarrow$

where, a and b are the averaging factors, implementation values are $a=0.1$ and $b=0.3$

3) ETA Calculator

a) Notations

eta - running variable for ETA

$\text{ETA}(S,R)$ - ETA for stop S and route id R

b) Algorithm

```

for r ∈ Routes in database
eta ← 0
for l ∈ links in route r
B ← set of buses in route r and link l
    if |B| ≠ 0
        eta ← min(estimated time to link end for buses in B)
    else
        eta ← eta + TTI
if end(l) is stop S
    ETA(S,R) ← eta

```

ACKNOWLEDGMENTS

This project was undertaken as part of the M. Tech. program in Electronics Design and Technology, Indian Institute of Science, Bangalore, India. This work was sponsored in part by SiRF Technologies Inc.

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DESIGNING A FRAMEWORK FOR CONCEALING WORM DETECTION

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ABSTRACT

Active worms pose major security threats to the Internet. This is due to the ability of active worms to propagate in an automated fashion as they continuously compromise computers on the Internet. Active worms evolve during their propagation and thus pose great challenges to defend against them. In this paper, we investigate a new class of active worms, referred to as Camouflaging Worm (C-Worm in short). The C-Worm is different from the traditional worms because of its ability to intelligently manipulate its scan traffic volume over time. Thereby the C-Worm camouflages its propagation from existing worm detection systems based on analyzing the propagation traffic generated by worms. We analyze characteristics of the C-Worm and conduct a comprehensive comparison between its traffic and non-worm traffic (background traffic). We observe that these two types of traffic are barely distinguishable in the time domain. However, their distinction is clear in the frequency domain, due to the recurring manipulative nature of the C-Worm. Motivated by our observations, we design a novel spectrum-based scheme to detect the C-Worm. Our scheme uses the Power Spectral Density (PSD) distribution of the scan traffic volume and its corresponding Spectral Flatness Measure (SFM) to distinguish the C-Worm traffic from background traffic. Using a comprehensive set of detection metrics and real-world traces as background traffic, we conduct extensive performance evaluations on our proposed spectrum-based detection scheme. The performance data clearly demonstrates that our scheme can effectively detect the C-Worm propagation. Furthermore, we show the generality of our spectrum-based scheme in effectively detecting not only the C-Worm, but traditional worms as well.

Keywords: Worm, Camouflaging, Anomaly detection

1.INTRODUCTION

An active worm refers to a malicious software program that propagates itself on the Internet to infect other computers. The Spread of the worm is based on exploiting damages or without the secured computers on the Internet. Many active worms are used to infect a large number of computers and recruit them as bots (compromised computers) which are networked together to form botnets (collection of compromised computers to the internet). These botnets can be used to:

- (a) Launch massive Distributed Denial-of-Service (DDoS) attacks that disrupt the Internet utilities
- (b) Access confidential information that can be misused through large scale traffic sniffing, key logging, identity theft etc
- (c) Destroy data that has a high monetary value
- (d) Distribute large-scale unsolicited advertisement emails (as spam) or software [1].

Due to the substantial damage caused by worms in the past years, there have been significant efforts on developing detection and defense mechanisms against worms. A network based worm detection system plays a major role by monitoring, collecting, and analyzing the scan traffic generated during worm attacks [2], [11].

The existing system may have the attackers are crafting attack strategies that intend to defeat existing- worm detection systems. In particular, 'stealth' is one attack strategy used by a recently-discovered active worm called "Attack" worm and the "self-stopping" worm circumvent detection by hibernating with a pre-determined period [12]. Worm might also use the evasive scan and traffic morphing technique to hide the detection. This worm attempts to remain hidden by sleeping. When it suspects it is under detection. Worms that adopt such smart attack strategies could exhibit overall scan traffic patterns different from those of traditional worms. Since the existing worm detection schemes will not be able to detect such scan traffic patterns, it is very important to understand such smart-worms and develop new countermeasures to defend against them.

The C-Worm can:

- (a) Still achieve its ultimate goal of infecting as many computers as possible before being detected
- (b) Position it-self to launch subsequent attacks.

Based on the above observation, we adopt frequency domain analysis techniques and develop a detection scheme against wide-spreading of the C-Worm. Particularly, we develop a novel spectrum-based detection scheme that uses the Power Spectral Density (PSD) distribution of scan traffic volume in the frequency domain and its corresponding Spectral Flatness Measure (SFM) to distinguish the C-Worm traffic from non worm traffic. Our frequency domain analysis studies use the real-world Internet traffic traces. Provided by SANs Internet Storm Center (ISC)[1],[2]. Our results reveal that non-worm traffic has relatively larger SFM values for their PSD distributions. Whereas, the C-Worm traffic shows comparatively smaller SFM value for its respective PSD distribution.

2. BACKGROUND AND RELATED WORK

2.1 ACTIVE WORMS Active worms are similar to biological viruses in terms of their infectious and self-propagating nature. They identify vulnerable computers, infect them and the worm-infected computers propagate the infection further to other vulnerable computers. With this understanding, effective detection and defense schemes could be developed to mitigate the impact of the worms.

Active worms use various scan mechanisms to propagate themselves efficiently. The basic form of active worms can be categorized as having the Pure Random Scan (PRS) nature. In the PRS form, a worm-infected computer continuously scans a set of random Internet IP addresses to find new vulnerable computers. Other worms propagate themselves more effectively than PRS worms using various methods, e.g., network port scanning, email, file sharing, Peer-to-Peer (P2P) networks, and Instant Messaging (IM). In addition, worms use different scan strategies during different stages of propagation[1], [13].

2.2 WORM DETECTION

Worm detection generally classified into two categories:

- (1) host-based detection
- (2) network-based detection.

Host-based detection systems detect worms by monitoring, collecting, and analyzing worm behaviors on end-hosts. Since worms are malicious programs that execute on these computers, analyzing the behavior of worm executables plays an important role in host based detection systems. Many detection schemes fall under this category.

In order to rapidly and accurately detect Internet-wide large scale propagation of active worms, it is imperative to monitor and analyze the traffic in multiple locations over the Internet to detect suspicious traffic generated by worms. The widely adopted worm detection framework consists of multiple distributed monitors and a worm detection center that controls the former. This framework is well adopted and similar to other existing worm detection systems, such as the Cyber center for disease controller, Internet motion sensor, SANS ISC Internet sink, and network telescope[14], [15].

Network-based detection schemes commonly analyze the collected scanning traffic data by applying certain decision rules for detecting the worm propagation in proposed schemes to examine statistics of scan traffic volume, such as the distribution of destination addresses. Other works study worms that attempt to take on new patterns to avoid detection.

3 MODELING OF THE C-WORM

3.1 C-WORM The C-Worm camouflages its propagation by controlling scan traffic volume during its propagation. The simplest way to manipulate scan traffic volume is to randomly change the number of worm instances conducting port-scans. a worm attacker may use an open-loop control mechanism by choosing a randomized and time related pattern for the scanning and infection in order to avoid being detected. Nevertheless, the open-loop control approach raises some issues of the invisibility of the attack. When an attacker launches worm propagation, it is very challenging for the attacker to know the accurate parameters for worm propagation dynamics over the Internet [16].

C-Worm will regulate its overall scan traffic volume such that:

- (a) It is similar to non-worm scan traffic in terms of the scan traffic volume over time
- (b) It does not exhibit any notable trends, such as an exponentially increasing pattern
- (c) The average value of the overall scan traffic volume is sufficient to make the C-Worm propagate fast enough to cause rapid damage on the Internet [17].

3.2 PROPAGATION MODEL OF THE C-WORM Based on existing results, this model matches the dynamics of real worm propagation over the Internet quite well. Since our investigated C-Worm is a novel attack, we modified the original Epidemic dynamic formula to model the propagation of the C-Worm by introducing the $P(t)$ - the attack probability that a worm-infected computer participates in worm propagation at time t . We note that there is a wide scope to notably improve our modified model in the future to reflect several characteristics that are relevant in real-world practice.

Particularly, the epidemic dynamic model assumes that any given computer is in one of the following states:

- (1) Immune,
- (2) Vulnerable,
- (3) Infected.

An immune computer is one that cannot be infected by a worm; a vulnerable computer is one that has the potential of being infected by a worm; an infected computer is one that has been infected by a worm. The simple epidemic model for a finite population of traditional PRS worms can be expressed as,

$$\frac{dM(t)}{dt} = \beta \cdot M(t) \cdot [N - M(t)], \quad (1)$$

where $M(t)$ is the number of infected computers at time t ;

$N(=T \cdot P1 \cdot P2)$ is the number of vulnerable computers on the Internet

T is the total number of IP addresses on the Internet; $P1$ is the ratio of the total number of computers on the Internet over T ;

$P2$ is the ratio of total number of vulnerable computers on the Internet over the total number of computers on the Internet;

$\beta = S/V$ is called the pair wise infection rate

S is the scan rate defined as the number of scans that an infected computer can launch in a given time interval.

The C-Worm has a different propagation model compared to traditional PRS worms because of its $P(t)$ parameter.

Consequently, Formula (1) needs to be rewritten as

$$\frac{dM(t)}{dt} = \beta \cdot M(t) \cdot P(t) \cdot [N - M(t)] \quad (2)$$

$P(t) = \frac{\bar{M}_C}{M(t)} \cdot \bar{M}(t)$ Is the estimation of $M(t)$ at time t , and assuming that $\bar{M}(t) = (1 + \epsilon) \cdot M(t)$ Where ϵ is the estimation error The Formula (2) can be rewritten as $\bar{M}(t) = (1 + \epsilon) \cdot M(t)$ Where ϵ

$$\frac{dM(t)}{dt} = \frac{\beta \cdot \bar{M}_C}{1 + \epsilon(t)} \cdot [N - M(t)]. \quad (3)$$

where $M(0)$ is the number of infected computers at time 0. $1 - (1 - P_m)^{P(t) \cdot S}$ We define that $\frac{\bar{M}_A(t)}{\bar{M}_A(t)}$ is the number of worm instances that have been observed by the worm detection system at time t , then there are $M(t) - \frac{\bar{M}_A(t)}{\bar{M}_A(t)}$ unobserved infected instances at time t . The number of worm instances observed by the worm detection system at time t is [1],[16],[17]

$$M_A(t) = P(t) \cdot M(t) \cdot P_m = \frac{P_m \cdot \bar{M}_C}{1 + \epsilon(t)} \quad (4)$$

3.3 EFFECTIVENESS OF THE C-WORM The effectiveness of the C-Worm in evading worm detection through controlling $P(t)$. Given random selection of \bar{M}_C , we generate three C-Worm attacks that are characterized by different selections of mean and variance magnitudes for \bar{M}_C . In our simulations, we assume that the scan rate of the traditional PRS worm follow a normal distribution $S_n = N(40, 40)$ We also set the total number of vulnerable computers on the Internet as 360,000, which is the total number of infected computers in “Code-Red” worm- incident .

Fig. 1 shows the observed number of worm-infected computers over time for the PRS worm and the above three CWorm attacks. Fig. 2 shows the infection ratio for the PRS worm and the above three C-Worm attacks. These simulations are for a worm detection system discussed in Section 2.2 that covers a 220 IPv4 address space on the Internet. The reason for choosing 220 IP addresses as the coverage space of the worm detection system is due to the fact that the SANs Internet Storm Center (ISC), a representative ITM system, has similar coverage space. In the ITM systems, a large number of monitors are commonly deployed all over the Internet and each monitor collects the traffic directed to a small set of IP address spaces which are not commonly used (also called dark IP addresses). Therefore, the address space of ITM system is not a narrow range address space, rather a large number of small chunks of addresses randomly spread across the global IP address space.

Fig. 1 shows the observed number of worm-infected computers over time for the PRS worm and the above three C-Worm attacks [2].

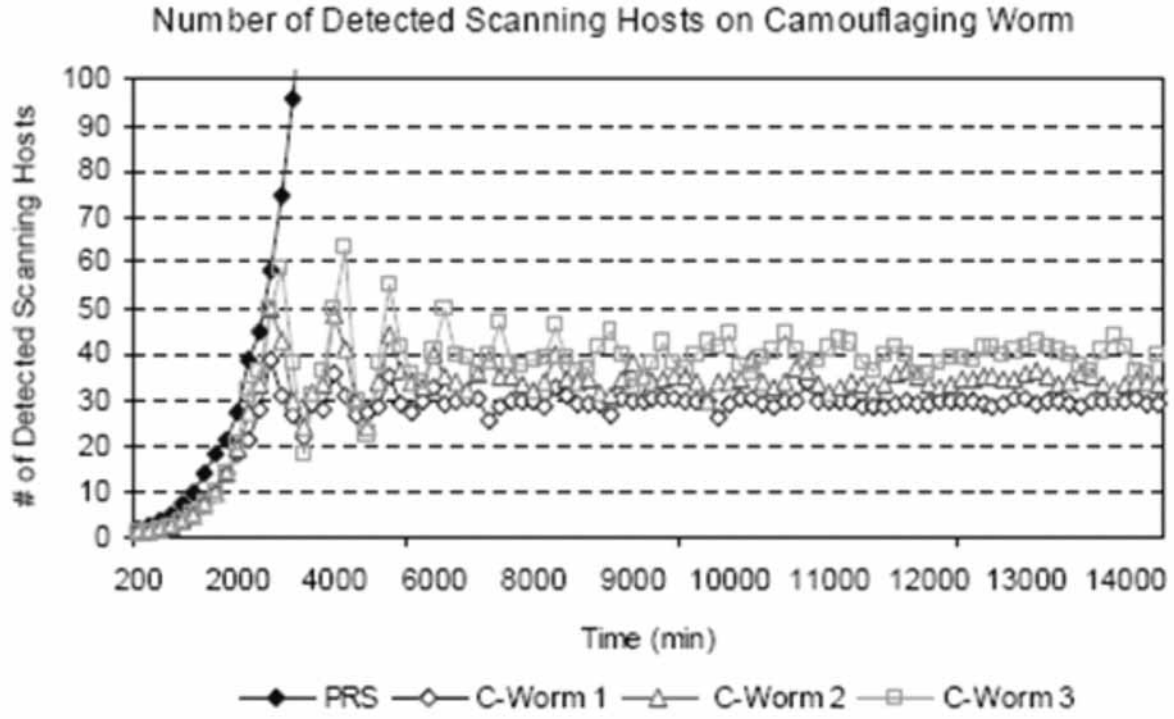


Fig 1: Observed infected instance number for the C – Worm and PRS Worm

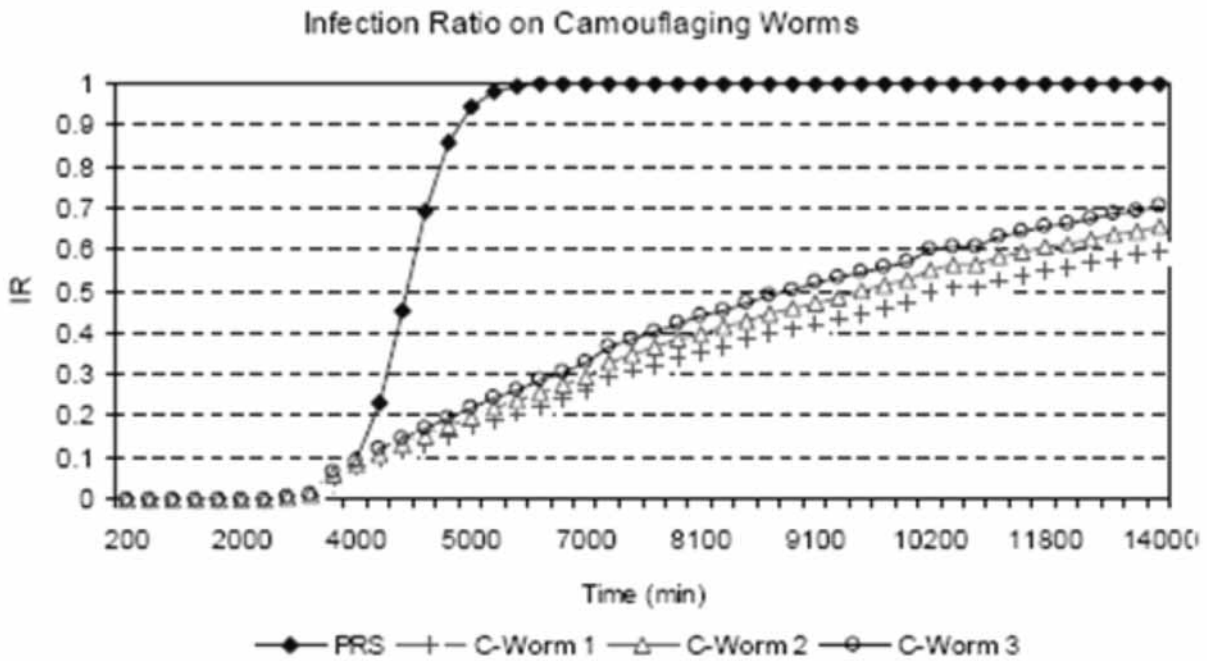


Fig 2: Infected Ratio for the C-Worm and PRS Worm

For the C-Worm, the trend of observed number of worm instances over time ($MA(t)$) is much different from that of the traditional PRS worm as shown in Fig. 2. This clearly demonstrates how the C-Worm successfully camouflages its increase in the number of worm instances ($MA(t)$) and avoids detection by worm detection systems that expect exponential increases in worm instance numbers during large-scale worm propagation. Fig. 3 shows the number of scanning computers from normal non-worm port-scanning traffic for several well-known ports, (i.e., 25, 53, 135, and 8080) obtained over several months by the ISC.

Comparing Fig. 2 with Fig. 1, we can observe that it is hard to distinguish the C-Worm port traffic from background port-scanning traffic in the time domain.

From above Figs. 1 and 2, we also observe that the C-Worm is still able to maintain a certain magnitude of scan traffic so as to cause significant infection on the Internet. As a note regarding the speed of C-Worm propagation, we can observe from Fig. 1 that the C-Worm takes approximately 10 days to infect 75% of total vulnerable hosts in comparison with the 3.3 days taken by a PRS worm5. Hence, the C-Worm could potentially adjust its propagation speed such that it is still effective in causing wide-spreading propagation, while avoiding being detected by the worm detection schemes.

The C-Worm, on the other hand, hides itself even during its propagation and thus keeps the worm detection schemes completely unaware of its propagation.

3.4 DISCUSSION In this paper, we focus on a new class of worms, referred to as the camouflaging worm (C-Worm). The C-Worm adapts their propagation traffic patterns in order to reduce the probability of detection, and to eventually infect more computers. The C-Worm is different from polymorphic worms that deliberately change their payload signatures during propagation[1], [2].

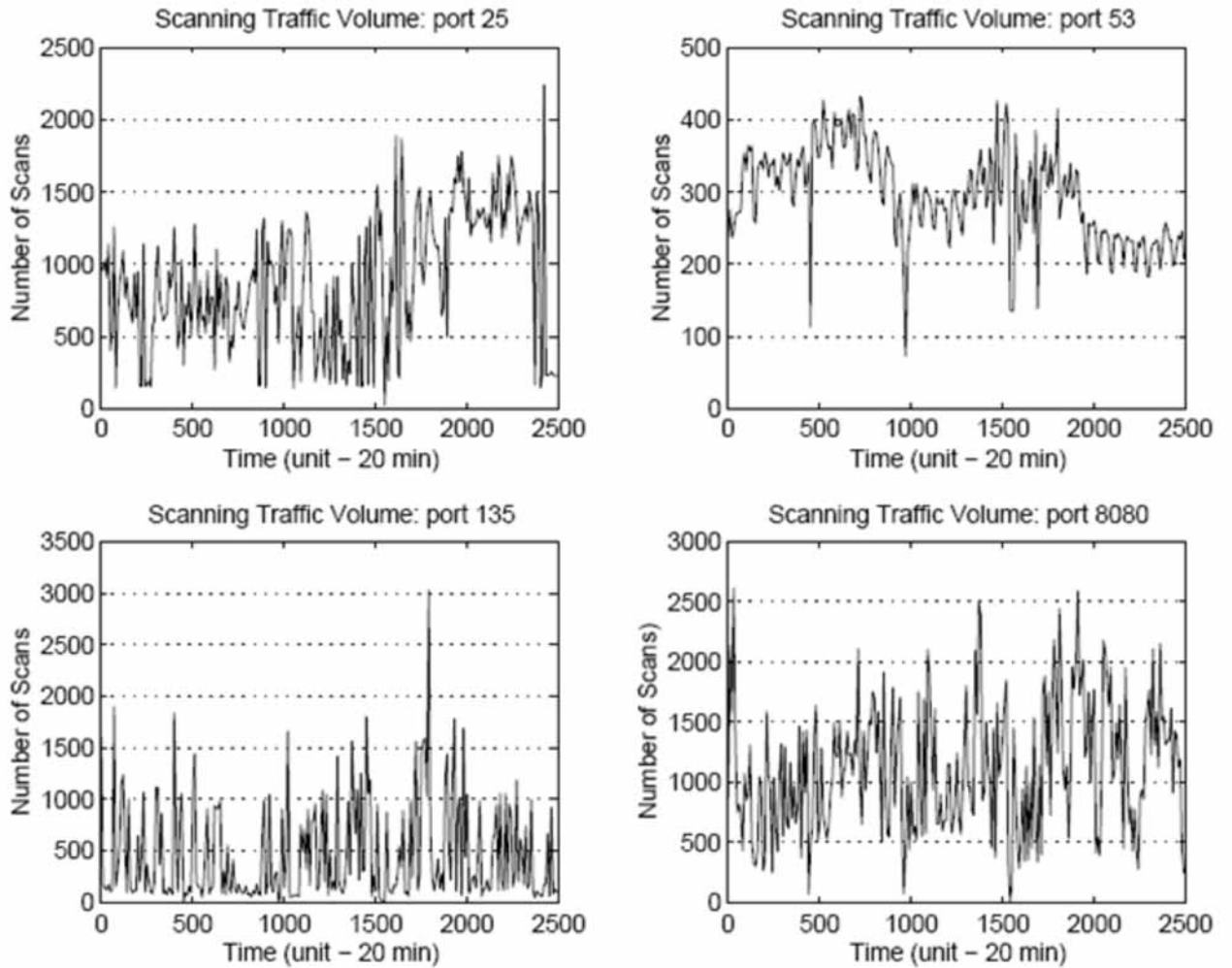


Fig 3: Observed Infected instance number for back ground scanning reported by ISC

4 DETECTING THE C-WORM

4.1 DESIGN RATIONALE We develop a novel spectrum-based detection scheme. Recall that the C-Worm goes undetected by detection schemes that try to determine the worm propagation only in the time domain. Our detection scheme captures the distinct pattern of the C-Worm in the frequency domain, and thereby has the potential of effectively detecting the C-Worm propagation.

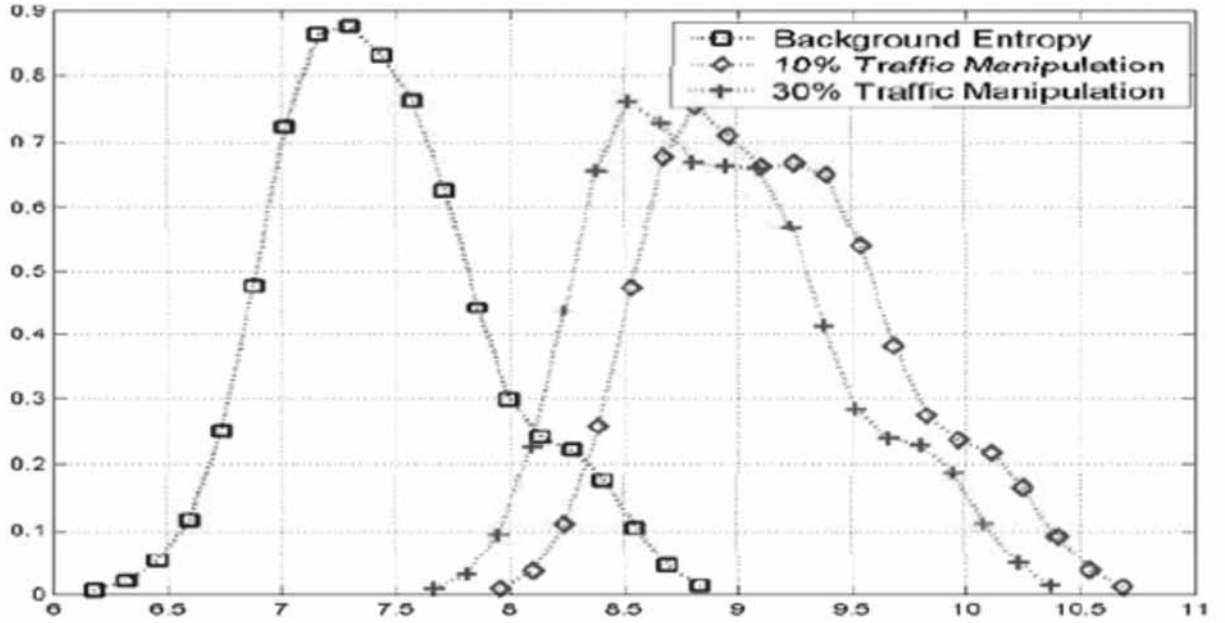


Fig 4: Manipulation of attack target distribution entropy

The C-Worm propagation in the frequency domain, we use the distribution of Power Spectral Density (PSD) and its corresponding Spectral Flatness Measure (SFM) of the scan traffic. Particularly, PSD describes how the power of a time series is distributed in the frequency domain. Mathematically, it is defined as the Fourier transform of the auto-correlation of a time series.

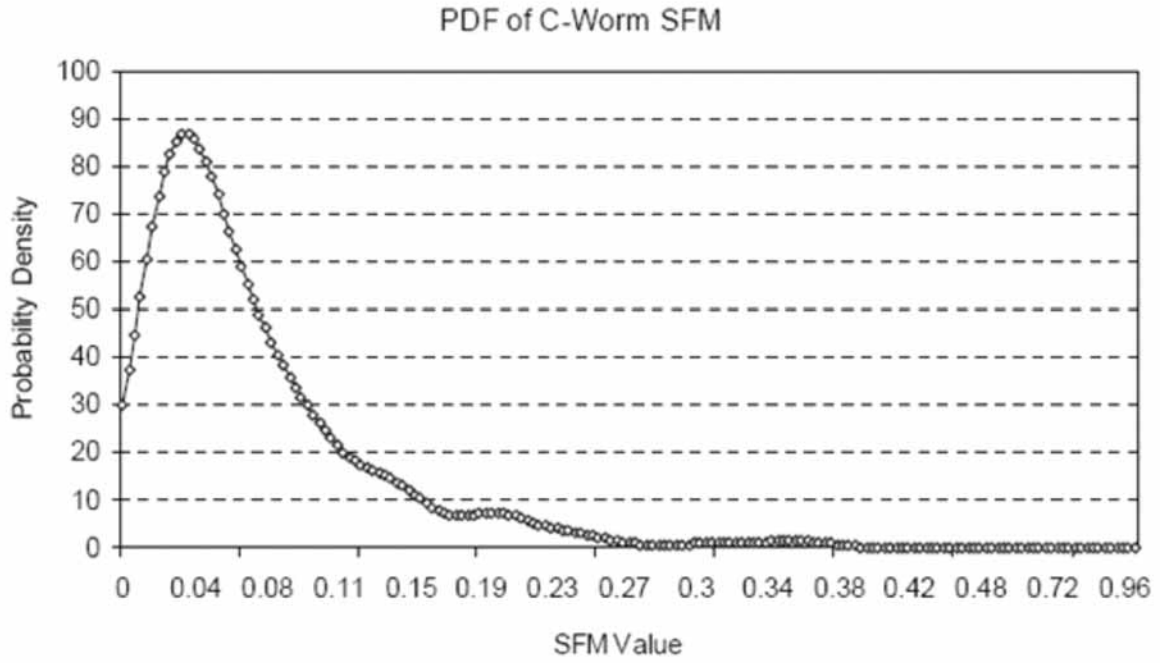


Fig 5: PDF of SFM on C-worm traffic

To illustrate SFM values of both the C-Worm and normal non-worm scan traffic, we plot the Probability Density Function (PDF) of SFM for both C-Worm and normal non-worm scan traffic as shown in Fig. 5 and Fig. 6, respectively.

The normal non-worm scan traffic data shown in Fig. 6 is based on real-world traces collected by the ISC 6. Note that we only show the data for port 8080 as an example, and other ports show similar observations. From this figure, we know that the SFM value for normal non-worm traffic is very small[18],[19]

4.2 SPECTRUM-BASED DETECTION SCHEME The details of our spectrum-based detection scheme, We use a “destination count” as the number of the unique destination IP addresses targeted by launched scans during worm propagation.

To conduct spectrum analysis, we consider a detection sliding window W_d in the worm detection system. W_d consists of q (> 1) continuous detection sampling windows and each sampling window lasts W_s . The detection sampling window is the unit time interval to sample the detection data (e.g., the destination count). Hence, at time i , within a sliding window W_d , there are q samples denoted by

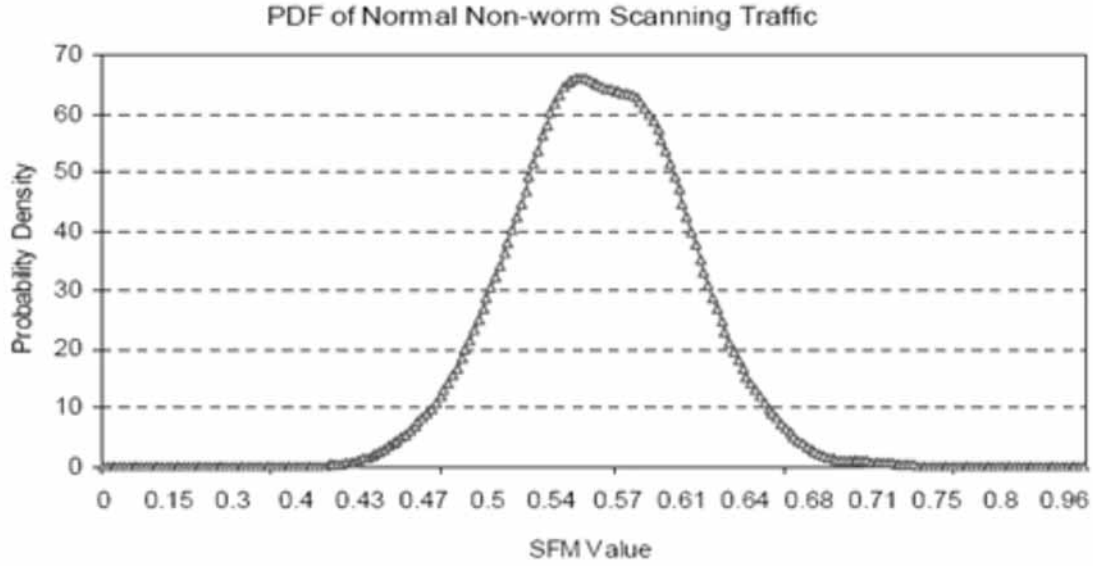


Fig 6: PDF of SFM on normal non-worm traffic

4.2.1 POWERSPECTRAL DENSITY (PSD) To obtain the PSD distribution for worm detection data, we need to transform data from the time domain into the frequency domain. To do so, we use a random process $X(t), t \in [0, n]$ to model the worm detection data. Assuming $X(t)$ is the source count in time $[t-1, t]$ ($t \in [1, n]$), we define the auto-correlation of $X(t)$ by

$$R_x(L) = E[X(t)X(t+L)] \quad (5)$$

In Formula (5), $R_x(L)$ is the correlation of worm detection data in an interval L .

If a recurring behavior exists, a Fourier transform of the auto-correlation function of $R_x(L)$ can reveal such behavior. the scan traffic data is determined using the Discrete Fourier Transform (DFT) of its auto-correlation function as follows,

$$\psi(R_x[L], K) = \sum_{n=0}^{N-1} (R_x[L]) \cdot e^{-j2\pi K n / N} \quad (6)$$

Where $K=0, 1, \dots, N-1$.

As the PSD inherently captures any recurring pattern in the frequency domain, the PSD function shows a comparatively even distribution across a wide spectrum range for the normal non-worm scan traffic. The PSD of C-Worm scan traffic shows spikes or noticeably higher concentrations at a certain range of the spectrum[2].

4.2.2 Spectral Flatness Measure (sfm) We measure the flatness of PSD to distinguish the scan traffic of the C-Worm from the normal non-worm scan traffic. For this, we introduce the Spectral Flatness Measure (SFM), which can capture anomaly behavior in certain range of frequencies. The SFM is defined as the ratio of the geometric mean to the arithmetic mean of the PSD coefficients. It can be expressed as,

$$SFM = \frac{[\prod_{k=1}^n S(f_k)]^{\frac{1}{n}}}{\frac{1}{n} \sum_{k=1}^n S(f_k)} \quad (7)$$

where $S(f_k)$ is an PSD coefficient for the PSD obtained from the results in Formula (6). SFM is a widely existing measure for discriminating frequencies in various applications such as voiced frame detection in speech recognition. In general, small values of SFM imply the concentration of data at narrow frequency spectrum ranges. Note that the C-Worm has unpreventable recurring behavior in its scan traffic.

4.2.3 Detection Decision Rule The method of applying an appropriate detection rule- to detect C-Worm propagation. As the SFM value can be used to sensitively distinguish the C-Worm and normal non-worm scan traffic, the worm detection is performed by comparing the SFM with a predefined threshold[18].

5. PERFORMANCE EVALUATIONS

The evaluation results that illustrate the effectiveness of our spectrum-based detection scheme against both the C-Worm and the PRS worm in comparison with existing representative detection schemes for detecting wide-spreading worms. In addition, we also take into consideration destination distribution based detection schemes and evaluate their performance against the C-Worm.

5.1 EVALUATION METHODOLOGY

5.1.1 Evaluation Metrics In order to evaluate the performance of any given detection scheme against the C-Worm, we use the following three metrics listed in Table II. The first metric is the worm Infection Ratio (IR), which is defined as the ratio of the number of infected computers to the total number of vulnerable computers, assuming there is no worm detection/defense system in place. The other two metrics are the Detection Time (DT) and the Maximal Infection Ratio (MIR).

5.1.2 Simulation Setup In our evaluation we considered both experiments with real world “non-worm” traffic and simulated c-worm traffic. In our evaluation, the scan rates are predetermined and follow a Gaussian distribution $S = N(S_m, S_2\sigma)$. We checked with the SANs website and found that there were no worm attack incidents within those 15 days. Second, we obtained the statistical profile of traffic traces, including the mean value and standard deviation of traffic rates. Based on the statistical profile, we set a threshold which is the summary of mean value and four times that of the standard derivation, and filtered out some data which had unusual large values [1],[2].

5.2 PERFORMANCE OF DETECTION SCHEMES

5.2.1 Detection Performance for C-Worm Attacks Table 2 shows the detection results of different detection schemes against the C-Worm. The results have been averaged over 500 C-Worm attacks. From this table, we can observe that existing detection schemes are not able to effectively detect the C-Worm and their detection rate (PD) values are significantly lower in comparison with our spectrum-based detection schemes (SPEC and SPEC(W)). For example, SPEC achieves the detection rate of 99%, which is at least 3-4 times more accurate than- detection schemes such as VAR and MEAN that achieve detection rate values of only 48% and 14%, respectively.

5.2.2 Detection Performance for Traditional PRS Worms We evaluate the detection performance of different detection schemes for traditional PRS worm attacks. The detection performance results have been averaged over 500 PRS worm attacks. We observe that both our SPEC and SPEC (W) [4] schemes achieve 100% detection rate (PD) while detecting traditional PRS worms in comparison with the existing worm detection schemes that have been specifically designed for detecting the traditional PRS worms. In view of emphasizing the relative performance of our SPEC and SPEC (W) schemes with the existing worm detection schemes, we plot the MIR and DT results in Figs. 7 and 8 for different scan rates S [18].

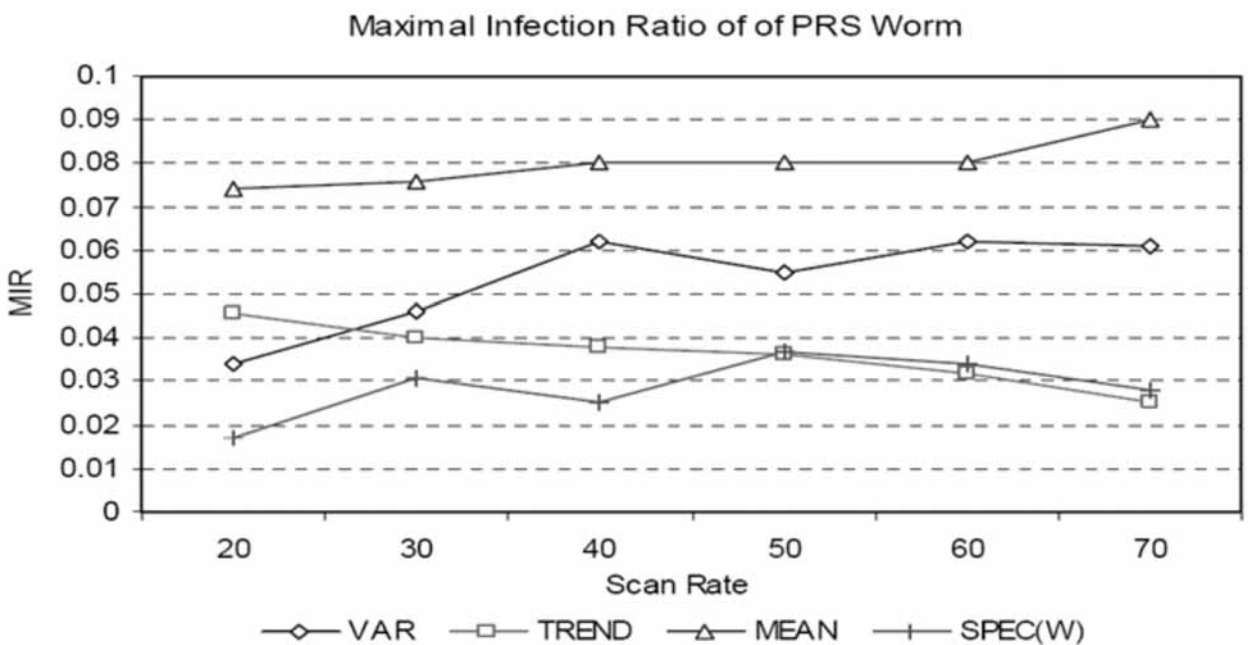


Fig 7: Maximal Infection Ration of detection schemes against PRS worm

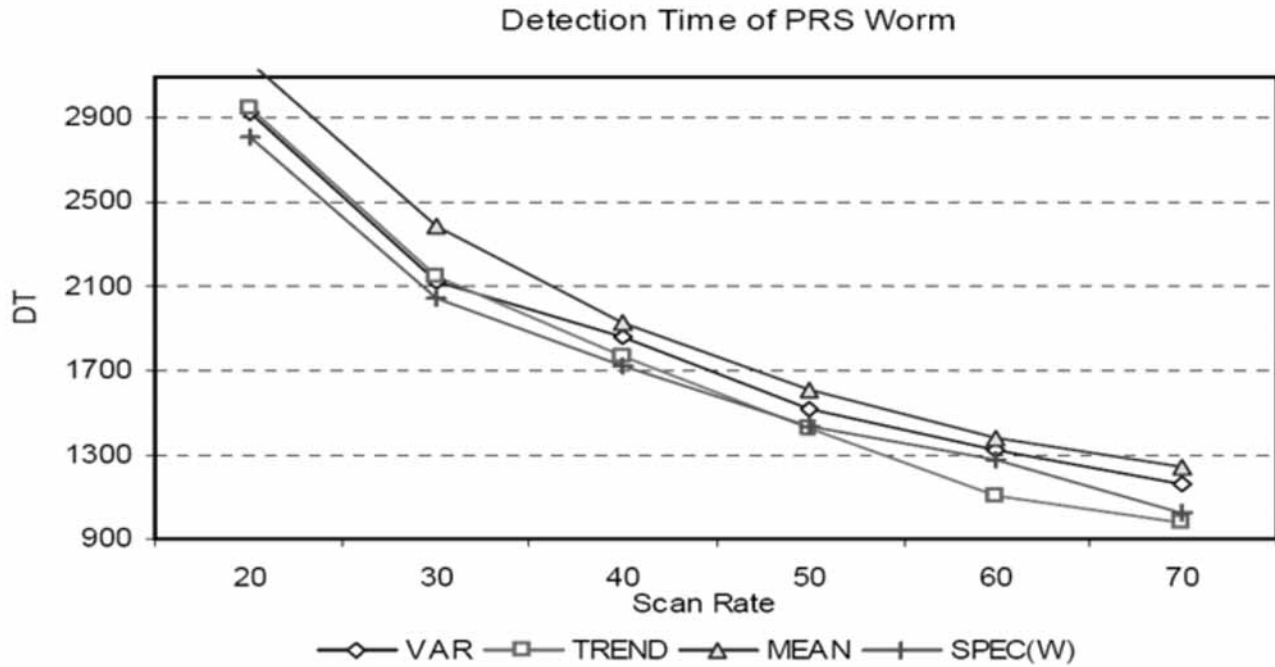


Fig. 8. Detection Time of detection schemes against PRS worm

which is faster than that of VAR and MEAN schemes, whose values are 1239 min and 1161 min, respectively. For the same mean scan rate of 70/min, SPEC (W) achieves a maximal infection ratio of 0.03,

Which is comparable to TREND's MIR value and is less than 50% of the MIR value for the VAR and MEAN detection schemes. The effectiveness of our spectrum-based scheme is based on the fact that traditional PRS worm scanning traffic shows a constantly rapid increase[3].

6. CONCLUSION

In this paper, we studied a new class of smart-worm called C-Worm, which has the capability to camouflage its propagation and further avoid the detection. Our investigation showed that, although the C-Worm successfully camouflages its propagation in the time domain, its camouflaging nature inevitably manifests as a distinct pattern in the frequency domain. Based on observation, we developed a novel spectrum-based detection scheme to detect the C-Worm. Our evaluation data showed that our scheme achieved superior detection performance against the C-Worm in comparison with existing representative detection schemes. This paper lays the foundation for ongoing studies of “smart” worms that intelligently adapt their propagation patterns to reduce the effectiveness of countermeasures

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DESIGN, ANALYSIS AND STUDY OF 2X2 RECTANGULAR MICROSTRIP ANTENNA ARRAY AT 430 MHz FOR WIND PROFILER RADAR

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ABSTRACT

Wind profilers depend upon the scattering of electromagnetic energy by minor irregularities in the refractive index of air. The refractive index determines the speed at which electromagnetic wave propagates through a medium. Atmosphere is the medium for wind profiling. Wind profiling radars, operating in Doppler beam swinging mode, need to have large antenna array in order to have a narrow beam for wind direction accuracy. To meet the above requirement an array with 4 elements configured in an 2X2 is designed in the present work. The antenna inserted is a co-axial probe (Probe feed) to the patch near its resonance in 'L' band is carried out. Principal plane 2-dimensional radiation patterns at 430MHz have been computed for single element and 2X2 linear array. The results of linearly polarized coaxial probe single element are generated using IE3D software. Using single element as basic building block, an 2X2 linear array was designed. In this paper Aluminum sheet is used as material for ground plate and patch, air is used as dielectric substrate. IE3D software is used for the design and simulation of antenna array. The results obtained are presented succinctly. The inferences from the design of coaxial probe antenna are presented.

KEYWORDS: Wind profile, Microstrip, Antenna Array, Dielectric, Patch, probe feed, IE3D

1.INTRODUCTION

In the atmosphere, minor irregularities in the refractive index exist over a wide range of sizes in the troposphere and stratosphere. The refractive index depends primarily upon the temperature, pressure and humidity of the air. The radar depends on the scattering of EM wave energy of the air associated with clear air turbulence (CAT). The atmosphere minor irregularities in the index refraction exist over a wide range of refraction sizes.

The wind as it varies in direction or speed produce turbulent eddies (small whirling currents of air) .The turbulent eddies are created over a spectrum of sizes ranging from many tens of meters down to cm. Observations of wind velocity profiles are very important for studying meteorological phenomena, weather forecasting etc. Atmospheric radar (wind profiler) is one of the most suitable remote sensing instruments for observing height profiles of three components of wind velocity vector, including the vertical velocity, with high time and height resolutions without influence of weather conditions.

Propagation of radar signals through the atmosphere is strongly dependent on local meteorological conditions, especially in the atmospheric boundary layer. The wind profiling radar uses naturally occurring fluctuations in the radio refractive index and precipitation as targets. Due to their small aperture, UHF profilers are most suitable for measuring the winds in the boundary layer and lower troposphere regions. Unlike the VHF wind profiling radars, UHF radars are very sensitive for hydrometeors due to the

small wavelength. Therefore these profilers are very much useful in studying convection, precipitation etc.

UHF radar is a potential tool to carry out research studies such as ABL Dynamics (Winds, Turbulence structure), Seasonal and Inter-annual variations, Interaction between the ABL and the free troposphere, Precipitating systems, Bright band Characterization, Rain/Cloud drop size distribution etc. It is also useful in the operational Mountain meteorology and civil aviation and identification of Atmospheric ducts. It also acts as a supplementary tool to large VHF MST radars by providing the atmospheric data in 0-5 km height range.

Several UHF radars are being operated across the globe either as research tools or as a part of wind profiler networks for operational meteorology. Atmospheric radars originally developed in 1970s for the research of mesosphere and stratosphere have been extensively applied to operational use for observations of the troposphere wind fields since 1990s as demonstrated by the Wind Profiler Demonstration Network. In Japan, more than ten profilers including the MU (middle and upper atmosphere) radar of Kyoto University have been operated for research use. Through the research and evaluation of profiler's data on the numerical weather prediction (NWP) models, JMA (Japan Meteorological Agency) established the operational wind profiler network and data acquisition system (WINDAS) for the enhancement of capability to watch and predict severe weather in Japan.

Microstrip antenna is printed type of antenna consisting of a dielectric substrate sandwiched in between a ground plane and a patch [1]. The concept of Micro strip antenna was first proposed in 1953, twenty years before the practical antennas were produced. Since the first practical antennas were developed in early 1970's, interest in this kind of antennas was held in New Mexico[6]. The microstrip antenna is physically very simple and flat, these are two of the reasons for the great interest in this type of antenna.

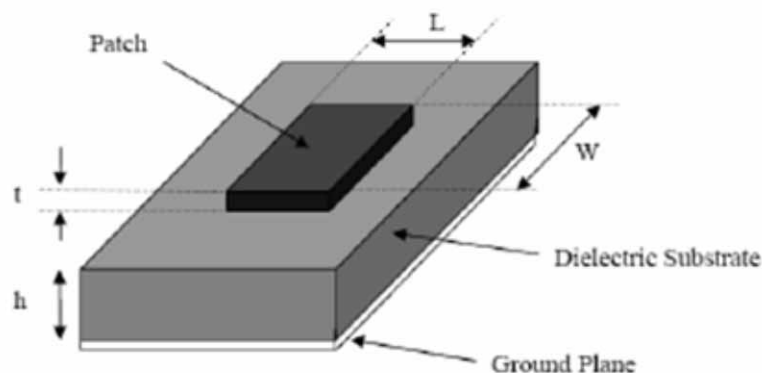
Microstrip antennas have several advantages compared to other bulky type of antennas. Some of the main advantages of the microstrip antennas are that it has low fabrication cost, its lightweight, low volume, and low profile configurations that it can be made conformal, it can be easily be mounted on rockets, missiles and satellites without major modifications and arrays of these antennas can simply be produced.

Observations of wind velocity profiles are very important for studying meteorological phenomena and weather forecasting. Atmospheric radar is one of the most suitable remote sensing instruments for observing height profiles of three components of wind velocity vector, including the vertical velocity with time and height resolutions without influence of weather conditions [1]. Propagation of radar signals through the atmosphere is strongly dependent on local meteorological conditions, especially in the atmospheric boundary layer [2] [3]. The wind profiling radar uses naturally occurring fluctuations in the radio refractive index and precipitation as targets. Due to their small apertures, UHF profilers operating around 900-1300 MHz [4][5] are most suitable for measuring the winds in the boundary layer and lower troposphere regions[6]. Unlike the VHF wind profiling radars, UHF radars are very sensitive for hydrometeors due to small wavelength [4]. Therefore these profilers are very much useful in studying convection, precipitation etc. UHF radar[4] is a potential tool to carry out research studies such as ABL Dynamics (Winds, Turbulence structure), seasonal and Inter-annual variations

Interaction between the ABL and the free troposphere, precipitating systems, Bright band characterization Rain/cloud drop size distribution etc. It is also useful in the operational Mountain meteorology and civil aviation and identification of atmospheric ducts. It also acts as a supplementary tool to large VHF MST radars by providing the atmospheric data in 0-5 Km height range [5]. Several UHF radars [4] are being operated across the globe either as research tools or as a part of wind profiler networks for operational meteorology.

2. DESIGN PROCEDURE

The designed antenna is an 1X8 linear array. The first step in the design is to specify the dimensions of a single microstrip patch antenna. The patch conductor can be assumed at any shape, but generally simple geometries are used, and this simplifies the analysis and performance prediction. Here, the half-wavelength rectangular patch element is chosen as the array element (as commonly used in microstrip antennas) [9]. Its characteristic parameters are the length L , the width w , and the thickness h , as shown in the following Figure:



To meet the initial design requirements (operating frequency = 430 MHz, and beam width = 90) various analytical approximate approaches may be used. Here, the calculations are based on the transmission line model [7]. Although not critical, the width w of the radiating edge is specified first. In practice, the length L is slightly less than a half wavelength (in the dielectric). The length may also be specified by calculating the half wavelength value and then subtracting a small length to take into account the fringing fields [7-9]

In this paper Aluminum sheet is used as material for ground plane and patch, air is used as dielectric substrate. IE3D software is used to design and simulation of antenna array.

3. SIMULATED RESULTS FOR 2X2 PATCH ANTENNA ARRAYS

3.1 RETURN LOSS MEASUREMENT:

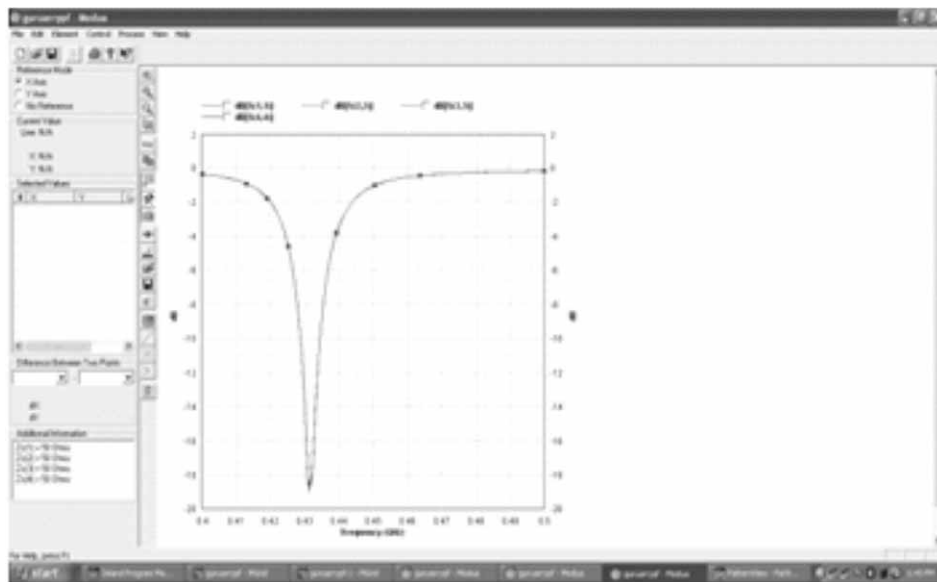


Figure: 1

From figure 1 The Return loss obtained at 430 MHZ is -19 dB and band width obtained at -10 dB is about 7 MHZ.

3.2 Dimensional Radiation Pattern:

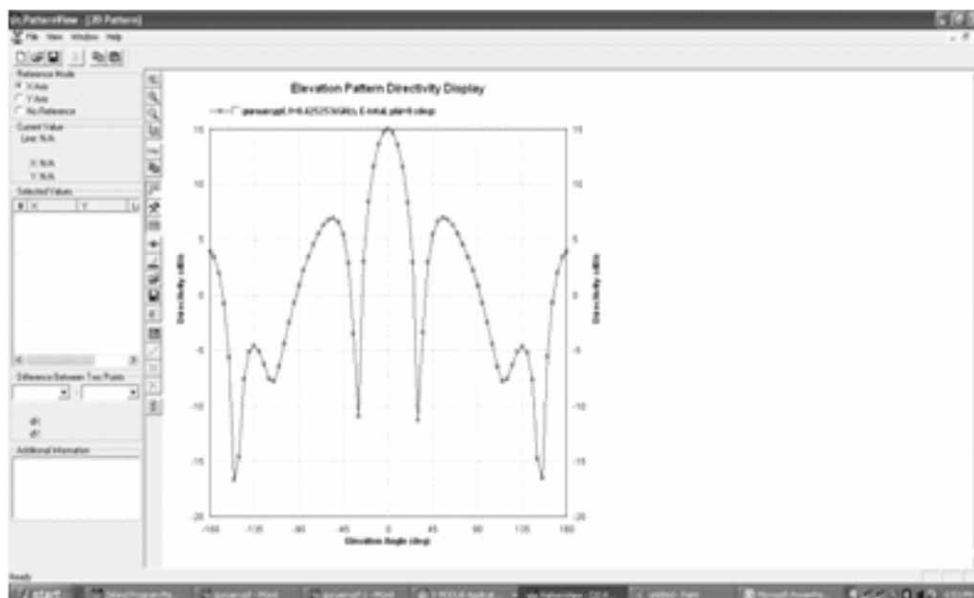


Figure 2

From figure 2, the 3 dB Beam Width obtained at $\phi=0$ is 1050 and at 900 is 950

4. VSWR MEASUREMENT

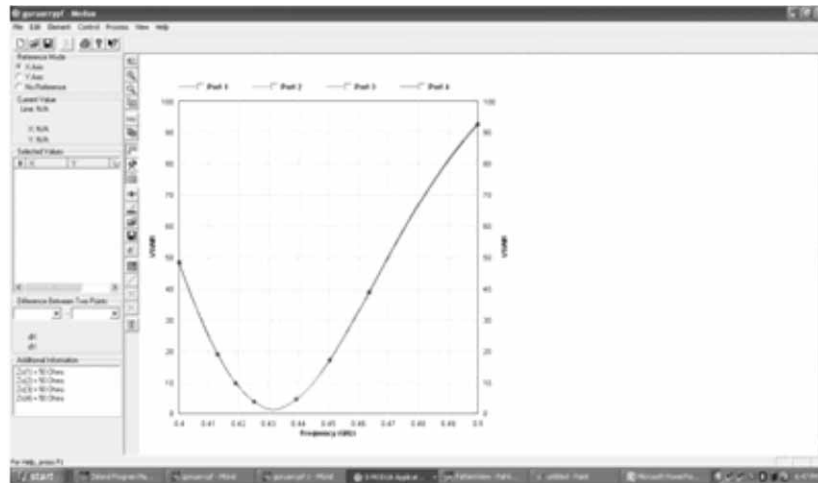


Figure 3
From the figure 3, the VSWR obtained at 430 MHz is 1.25

5. DIRECTIVITY VS. FREQUENCY

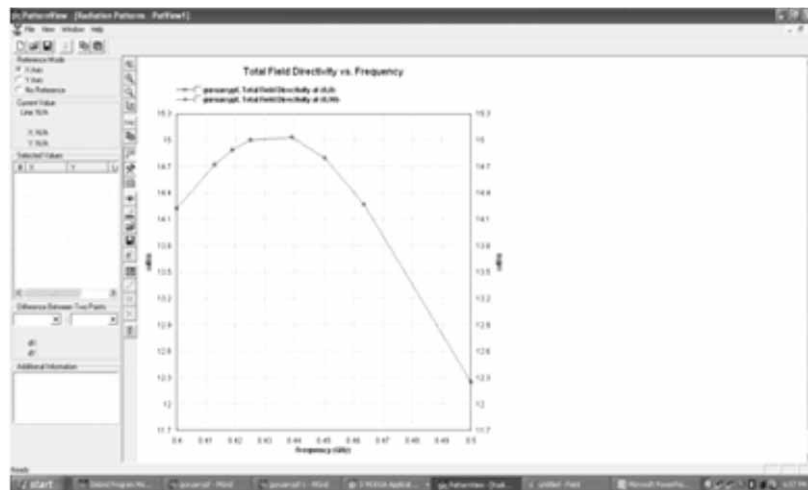


Figure 4
From the figure 4, gain obtained at 430 MHz is 15 dBi

6. ANTENNA EFFICIENCY VS. FREQUENCY

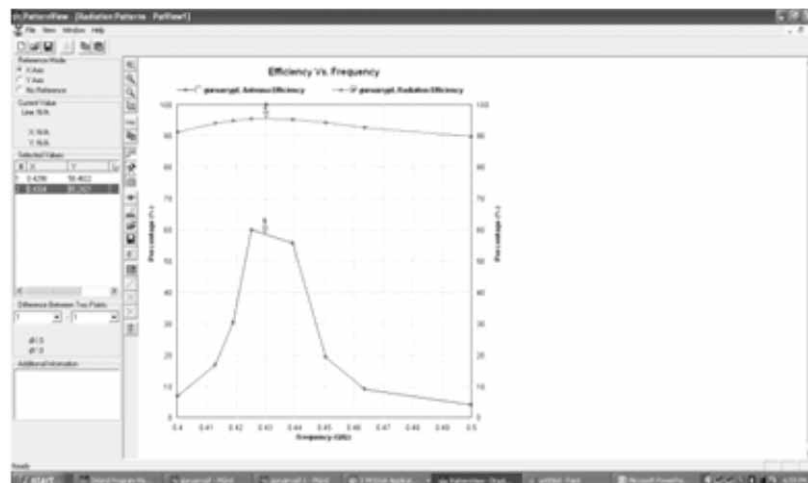


Figure 5
From the figure 5, the Antenna Efficiency is about 60% and radiation efficiency is about 90 %

7. GAIN VS FREQUENCY

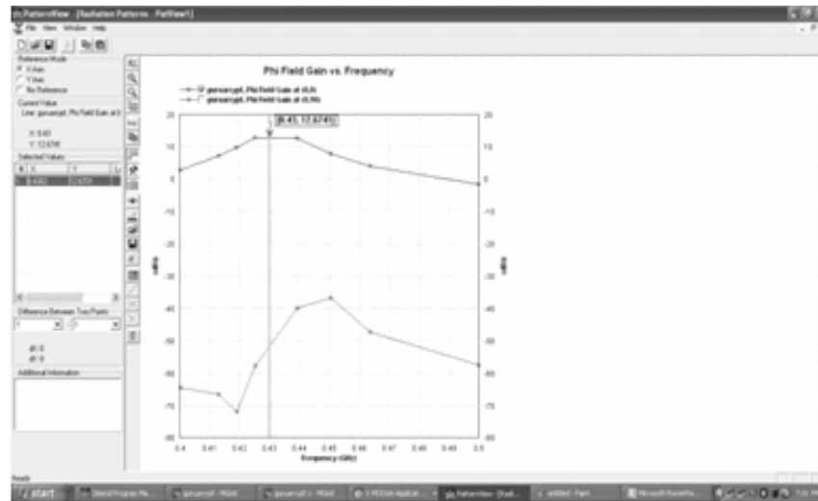


Figure 6
From the figure 6, Pi - field gain obtained at 430 MHz is 12.5 dBi

8. RADIATION PATTERN(3-D) FOR 2X2ARRAYS

E-THETA PATTERN:

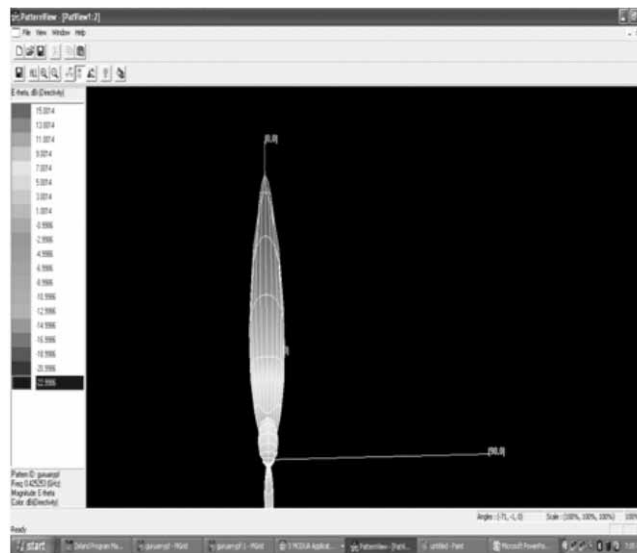


Figure 7
From figure 7, the Directivity of the 3-dimensional Radiation Pattern is 15 dBi

E- LEFT PATTERN:

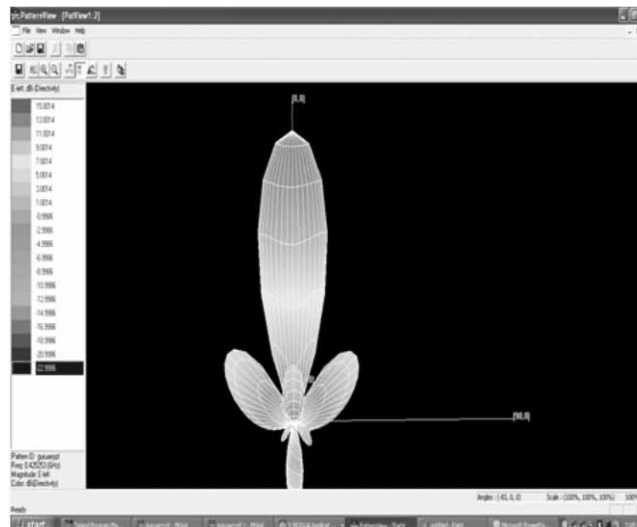


Figure 8

9. CONCLUSION

A 2X2 element array has been realized for wind profiling radars. Gain, Bandwidth and radiation patterns have been computed over a frequency at 430 MHz. From the data analysis, it has been pointed out that the side lobe level is the most critical factor, and thus determines the operating bandwidth. However, considering the impedance, gain and maximum side lobe at 430 MHz frequency, a 20 MHz bandwidth has been obtained. As demonstrated by the design 2x2 patch Antenna Array at 430 MHz has been successfully designed and simulated using IE3D. From the radiation pattern, it is observed that use of amplitude taper maintained the SLL within the maximum scan angle limit, which is an added advantage for Atmospheric Wind Profile Radar application. Using this 2x2 antenna array 15 dBi gain and 7 MHz bandwidth were obtained which is sufficient for data processing for the system. The future work of this Project is to extend the design to 1x8 Antenna Array and later 16x16 Antenna Array.

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FFT BASED ANALYSIS OF EEG SIGNALS FOR EPILEPTIC SEIZURE CHARACTERIZATION

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ABSTRACT

In this paper we have used Fast Fourier Transform (FFT) as a tool to analyze Electroencephalogram (EEG) signals recorded during epileptic seizures with various window functions. Through the analysis the dynamics of the seizures is examined by observing the frequency patterns and correlating it to the known neuro-physiological processes in the brain. We also investigated the functional importance of our choice of window functions. Important results are discussed in the context of possible advancements in Neurology and EEG based HMI.

Keywords: Epilepsy, FFT, EEG, Seizure, Spectral Analysis, Human – Machine Interaction (HMI)

1.INTRODUCTION

Electroencephalogram (EEG) was originally developed for carrying out investigations pertaining to mental processes. However its possible application in neurology was soon discovered and widely used as a tool to characterize epileptic seizures. Till date most of the neuro-physicians adopted and relied on visual inspection of EEG patterns which is mostly subjective and correct interpretation would largely depend on the experience and analysis power of the physician and thereby prone to error. So there is a need for developing a robust automatic computer based system/model which will analyse EEG signal parameters and characteristics. Many researchers are working in this area and have developed model for Epileptic Seizure Characterization using Gabor transform, Wavelet Analysis, Chaos etc. [1, 2, 3].

The first measurement of brain activity in humans was reported way back in 1929 [1] and eventually EEG patterns were correlated with various neuro-physiological processes of the central nervous system. Authors of research paper [2] analysed EEG signal and observed five main rhythms based on different oscillation frequency bands which depends on various normal and abnormal brain activities. Basar in his work [3] examined EEG Brain Dynamics using relation between EEG and brain evoked signals and came out with encouraging results. EEG activity is present in a spontaneous way or can be generated as a response to an internal or external stimulation. The alteration of ongoing EEG due to these stimuli is referred to as event related potential (ERP). Owing to the low amplitude of the ERPs in comparison with the ongoing EEG, it is a common practice to average several responses in order to visualize the evoked activity which is proved to be extremely helpful in clinical diagnosis and often is the basis of interpretation of EEG data with ERPs [3].

In research work [4], Independent Component Analysis was applied to the analysis of EEG signals by attempting to reverse the superposition and separate the EEG into mutually independent scalp maps. Gautama et al in their work [5] investigated the non-linear properties of the EEG signals using non-linear analysis methods and introduced delay vector variance method for better characterizing a time series. An interesting research was done in [6] for modelling of EEG signal sound frequency characteristic using time frequency analysis. They used FFT as their tool for analysis and combined it with moving average filters, simple artefact filters and reference EEG data for accurate characterization. In most diagnostic applications, it is desired to see and measure the change in EEG patterns due to active stimulation. In [7] Muchtadi et al used time frequency analysis of EEG signals to quantify the effects of simple acupuncture stimulation. Encouraging results were also obtained in [8], where a time-frequency deconvolution algorithm is used for biomedical signals like EEG and ECG (Electrocardiogram) for obtaining better resolution of the signals.

Analysis of the EEG signals through signal processing and correlation of data with neuro-physiological activity can be used in clinical diagnostics. Furthermore, applying powerful algorithms of signal processing to EEG signals helps extract more information than usually known and shed some light on the unknown realms of neurology and brain processes, thereby advancing the field in several important ways. It is with this motivation in mind that we have carried out this research work. Our research is based on the use of Fast Fourier Transform (FFT) algorithm with various window functions for analysis of EEG data. Use of window functions, significantly enhances our processing capability of EEG data using FFT and also ensures that we can characterize signals representing brain states and signals representing pulse or blink artefacts. FFT today has emerged as the most popular technique for EEG signal characterization as comparison to other techniques. The use of FFT based technique combined with various window functions for EEG signal analysis, which is used in this paper has several advantages over other more powerful techniques like it has well known algorithms with thorough understanding of their computational complexity, existence of many hardware architectures for efficient FFT computation in real-time, mathematically less complex to understand and hence can be explained to a large class of people (especially doctors and medical staff who are the target users of this technology) etc.

The objective of this paper is to find out how accurate the signal characterization process can be made for epileptic seizures with FFT and window functions and use the results obtained for applications in neurological diagnostics and human-machine interaction. Human-machine interaction is an emerging paradigm in which novel ways to interact with machines are discovered like through gestures, speech, thought etc. This is very helpful for people with disabilities too as they can also use technologies like others if they can learn to interact with the device through their functional faculties. In this work we focus on using brain as our interacting tool as there may be people with several forms of physical disability but almost everyone can still think! So using our thoughts to control devices can be extremely helpful in several ways for people. We will also show in this paper how our FFT based EEG signal analysis technique can be the first step towards developing such technologies.

2. EEG AND BRAIN ACTIVITY

EEG can be defined as the mean electrical activity of the brain at different sites of the head. More specifically, it is the sum of the extracellular current flows of a large group of neurons [2]. Any EEG pattern consists of a number of oscillations which are divided in frequency bands that have been related with different brain states, functions or pathologies [9] [10].

The five main rhythms observed in EEG patterns are as follows [2]:

Delta Rhythms: Their oscillation frequency band lies from 0.5 to 3.5 Hz. They are characteristic of deep sleep stages. However, delta oscillations with certain specific patterns and localizations are correlated with different pathologies.

Theta Rhythms: Their oscillation frequency band lies from 3.5 to 7.5 Hz. They are enhanced during sleep and they supposedly play an important role in infancy and childhood. In adults who are awake, high theta activity is considered abnormal and is related with different brain disorders.

Alpha Rhythms: Their oscillation frequency band lies from 7.5 to 12.5 Hz. They appear spontaneously in normal adults during wakefulness, under relaxation and mental inactivity conditions.

Beta Rhythms: Their oscillation frequency band lies from 12.5 to 30 Hz. They have less amplitude than alpha waves and they are enhanced upon expectancy states or tension.

Gamma Rhythms: Their oscillation frequency band lies from 30 to 60 Hz. These rhythms have been shown to have relation with linking of stimulus features into common perceptual information.

The analysis of these patterns and its correlation with our neuro-physiological activities has been very helpful in studying epileptic seizures. Epilepsy is a disorder of the normal brain function that is characterized by an excessive and uncontrolled activity of either a part or the whole central nervous system. Figure 1 shows normal global EEG pattern (combination of all the rhythms) of an adult and EEG pattern obtained during epileptic seizure.

EEG activity is present in a spontaneous way or can be generated as a response to an internal or external stimulation. The alteration of ongoing EEG due to these stimuli is referred to as event related potential (ERP) or sometimes evoked potential. Owing to the low amplitude of the ERPs in comparison with the ongoing EEG, it is a common practice to average several responses in order to visualize the evoked activity. The reason for averaging is that ERPs have definite latent period determined from the stimulation time and that they have a similar pattern of response which is predictable under similar conditions [3].

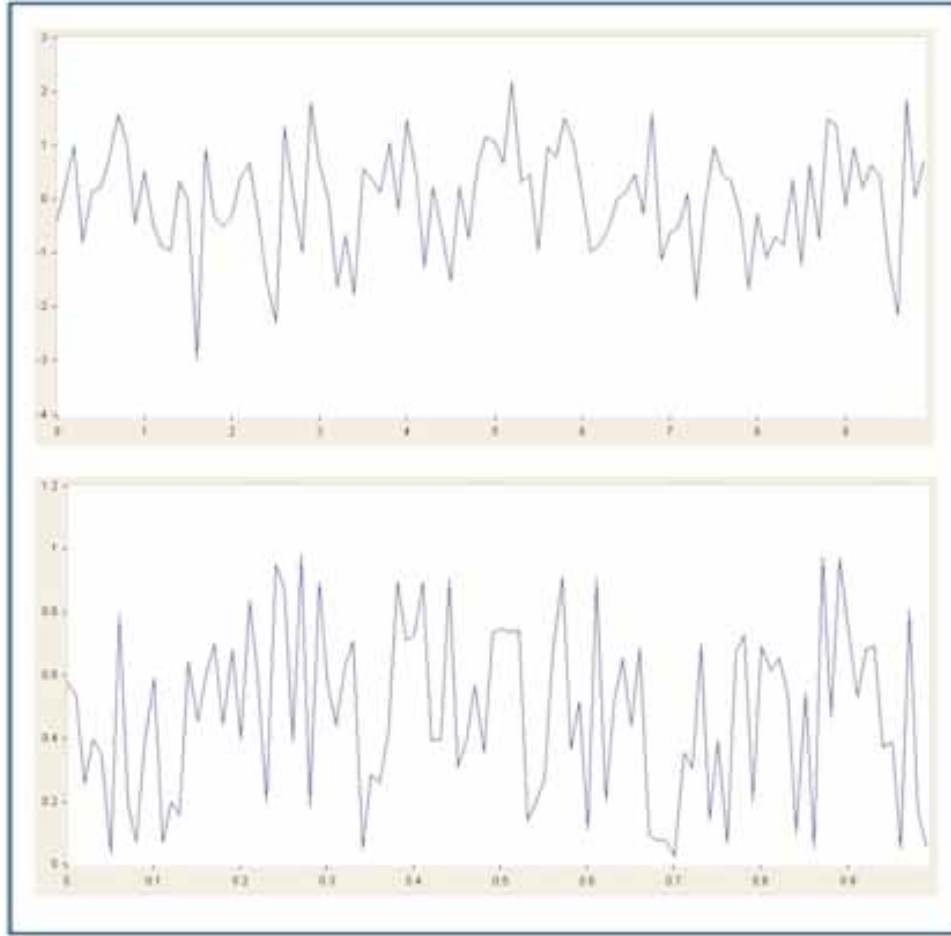


Fig. 1: The top EEG pattern is of normal adult in a relaxed state while the bottom EEG pattern is during seizure

3. FOURIER TRANSFORM FOR EEG SIGNAL ANALYSIS

The Fourier Transform of a continuous time signal $x(t)$ is given as:

$$x(t) = \int_{-\infty}^{\infty} X(f)e^{i2\pi ft} df \quad \dots (1)$$

Where $X(f)$ can be represented as:

$$X(f) = \int_{-\infty}^{\infty} x(t)e^{-i2\pi ft} dt \quad \dots (2)$$

Equation (2) gives the transform of the input signal $x(t)$. However, in today's age of computer based processing, our signals are not continuous time but rather discrete time digital signals. All the EEG recordings are passed through A/D converters before they are processed using computers and then appropriate analysis is carried out. For such signals we use Discrete Fourier Transform (DFT) which is defined as:

$$X(k) = \sum_{n=0}^{N-1} x(n)e^{\frac{-i2\pi kn}{N}} \quad \dots (3)$$

where k ranges from 0 to $N-1$.

The greatest advantage of using Fourier Transform based EEG signal analysis is that it allows the separation of different EEG oscillation components, which is very difficult to perform visually when several oscillations occur simultaneously.

4. FFT BASED EEG SIGNAL ANALYSIS

The Fast Fourier Transform is an algorithm to compute DFT on discrete signals proposed in 1965 [11]. This algorithm had a revolutionary effect on the field of Digital Signal Processing as it could compute Fourier coefficients using a number of operations proportional to $N \log N$ whereas earlier it required N^2 arithmetic operations to compute. Today the FFT remains the most widely used method of computing Fourier Transforms.

We begin our analysis with a global EEG pattern of an adult and passing it through symmetric Hamming window function represented by the equation:

$$w(n) = 0.54 - 0.46 \cos\left(\frac{2\pi(n-1)}{N-1}\right) \quad \dots (4)$$

Figure 2 shows the EEG pattern during seizure and its corresponding windowed version. The window was applied with RMS amplitude correction.

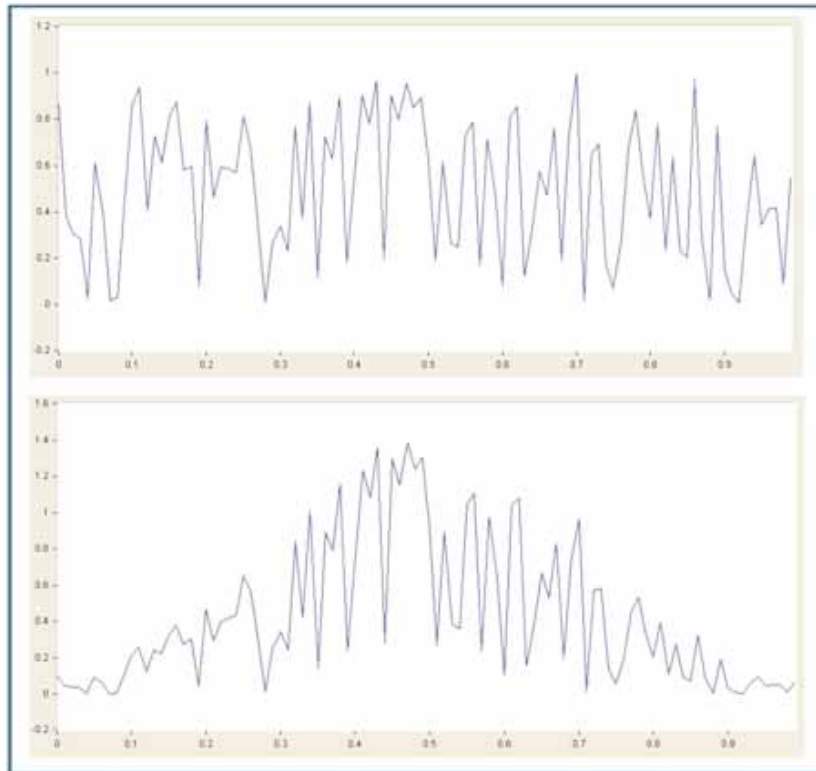


Fig. 2: The top EEG pattern is recorded during seizure and after passing it through symmetric Hamming window we get the signal represented in the bottom

The 1024 point FFT applied on the windowed EEG pattern gives the spectral information as shown in Fig. 3

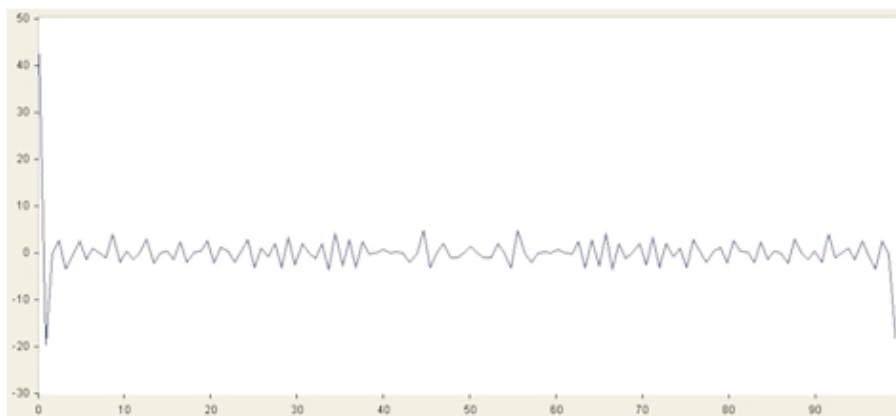


Fig. 3: 1024 FFT on Hamming windowed EEG pattern

Thus, we see that windowing operation on input EEG signals can drastically reduce the amplitude peaks such that measuring irregularities can be much easier than in the original EEG signal. Our next analysis is done using Hanning window function that is mathematically expressed as:

$$w(n) = 0.5 \left(1 - \cos \left(\frac{2\pi(n-1)}{N} \right) \right) \quad \dots (5)$$

In Figure 4, we have shown all the three EEG signal patterns and see that Hamming and Hanning windows give almost same performance. And hence their choice in any given application is largely implementation dependent. However, it is worth noting that the end points of the window function are smoother in case of Hanning than Hamming window and hence is better at preventing leakage problems.

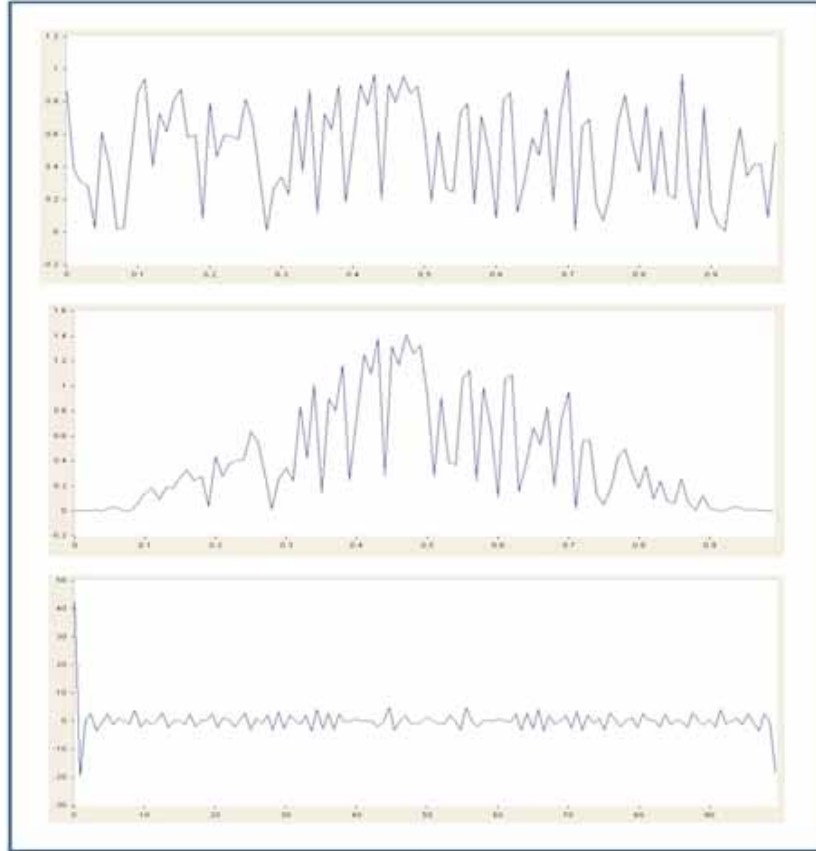


Fig. 4: Hanning window function applied to EEG pattern and its FFT spectrum

The next window function that we investigate is the Kaiser window function which is mathematically expressed as:

$$w(n) = \frac{I_0 \left(\beta \sqrt{1 - \left(\frac{2(n-1)}{N-1} - 1 \right)^2} \right)}{I_0 \beta} \quad \dots (6)$$

Where I_0 is the modified zeroth order Bessel function of the first kind and the value of β is 7.865. The analysis of EEG signal with Kaiser window is shown in Figure 5. As can be seen in the result, The Kaiser window is smoother at the end points and the consequent FFT spectrum shows better regularity.

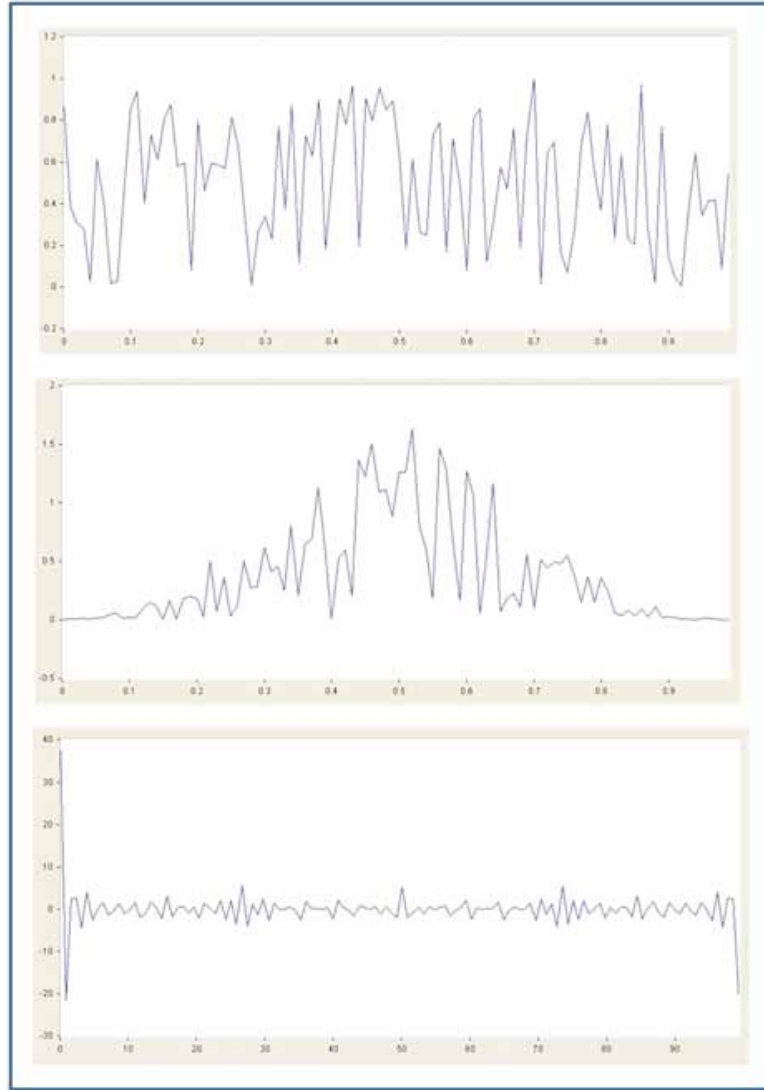


Fig. 5: Kaiser window function applied to EEG pattern and its FFT spectrum

The investigation of flat top window is presented in Figure 6. Flat top window function is stated mathematically as:

$$\begin{aligned}
 w(n) = & a_0 - a_1 \cos\left(\frac{2\pi(n-1)}{N-1}\right) \\
 & + a_2 \cos\left(\frac{4\pi(n-1)}{N-1}\right) \\
 & - a_3 \cos\left(\frac{6\pi(n-1)}{N-1}\right) \\
 & + a_4 \cos\left(\frac{8\pi(n-1)}{N-1}\right) \\
 & \dots (7)
 \end{aligned}$$

The value of these constants depends on the type and the number of points used for the window function. We have used symmetric type 2 alternate four point flat top window.

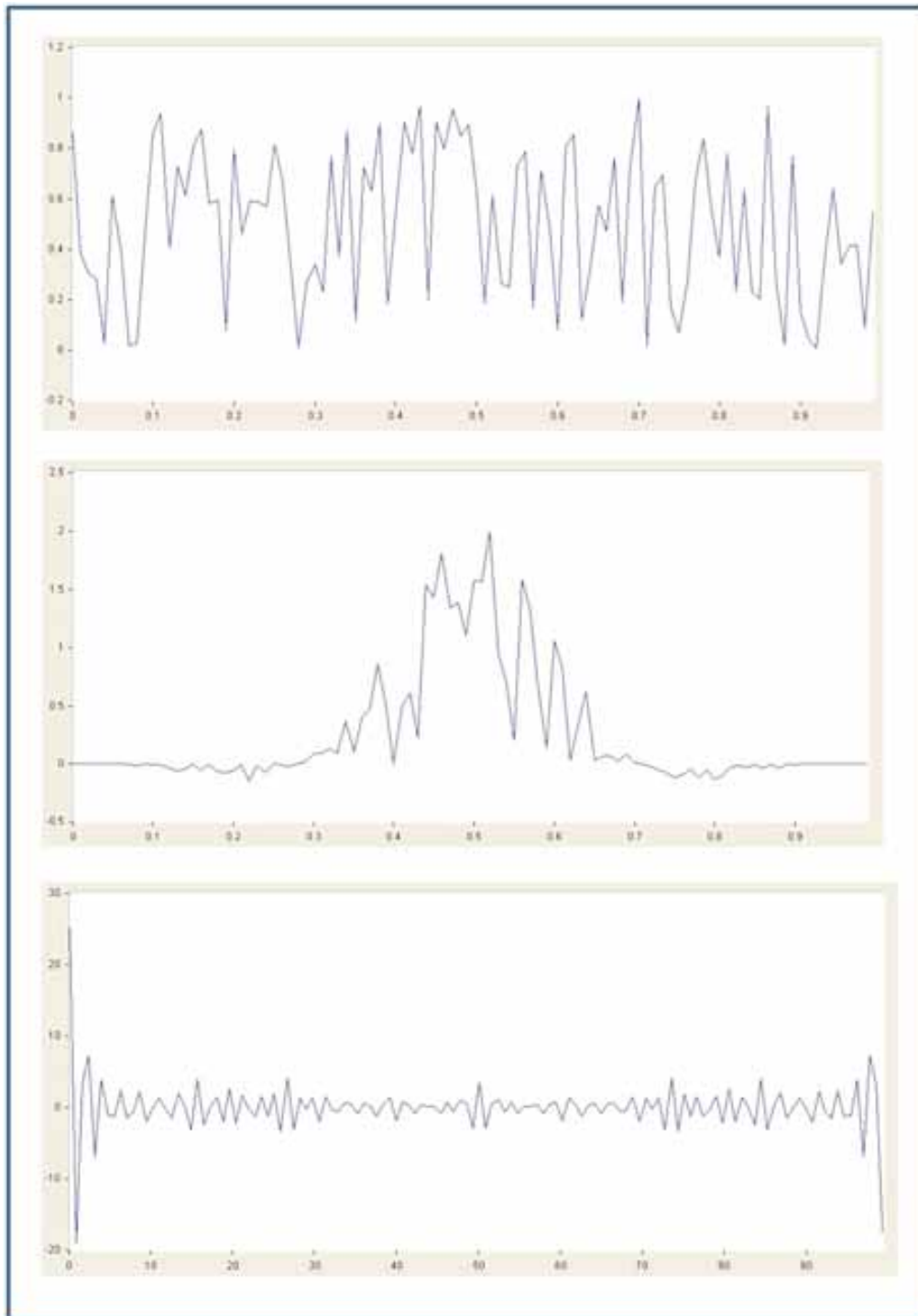


Fig. 6: Flat top window function applied to EEG pattern and its FFT spectrum

The last window function that we used in this work for EEG analysis is the Blackman window. The mathematical formula of Blackman window function is:

$$w(n) = 0.42 - 0.5\cos\left(\frac{2\pi(n-1)}{N-1}\right) + 0.08\cos\left(\frac{4\pi(n-1)}{N-1}\right) \quad \dots (8)$$

The results of our analysis are shown in Figure 7.

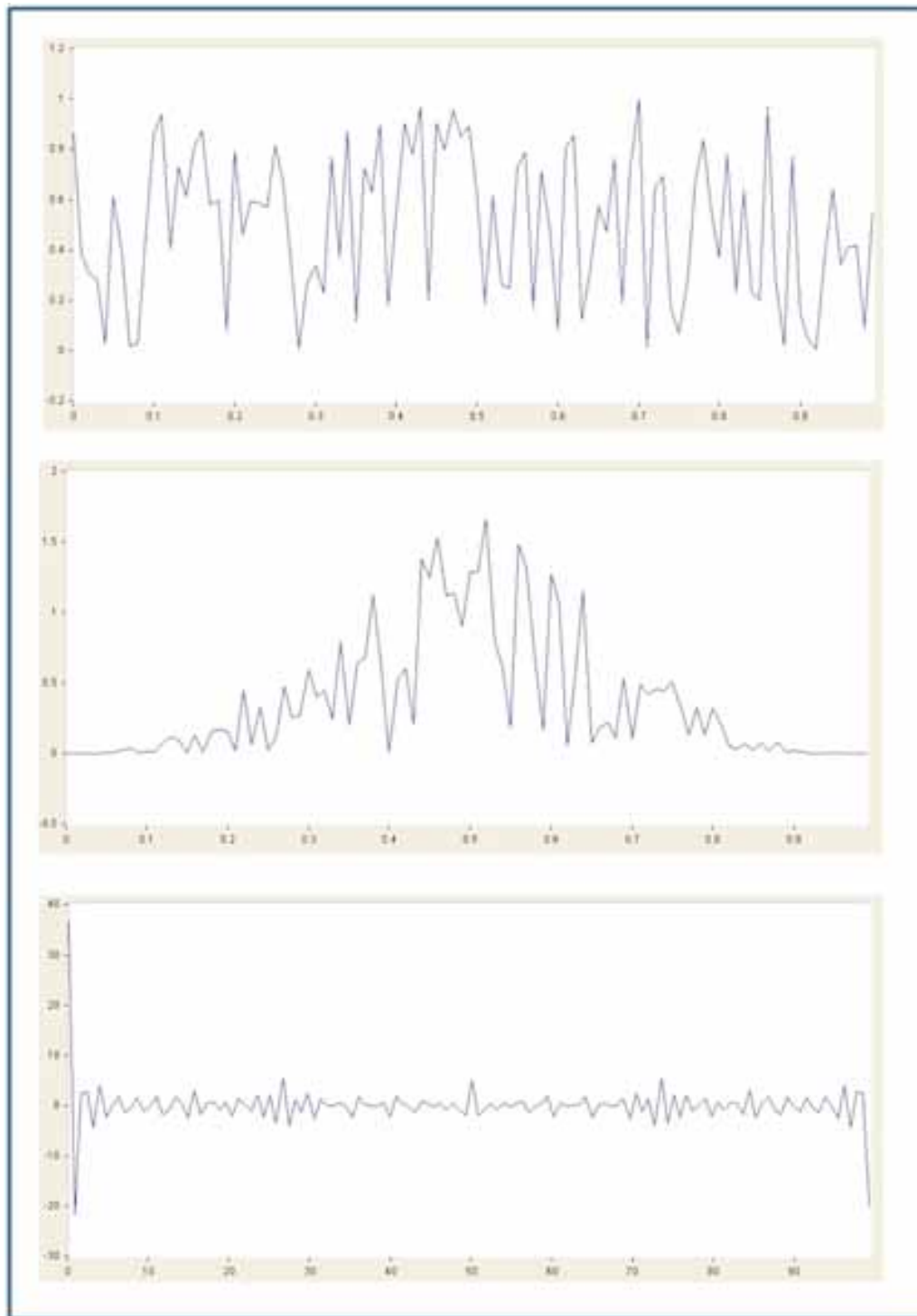


Fig. 7: Blackman window function applied to EEG pattern and its FFT spectrum

5. RESULTS OF ANALYSIS

From the detailed analysis that has been carried out, we see that all the window functions perform quite optimally as far as FFT computation is concerned. However, there are several interesting aspects that must be understood.

First of all, every window function has its advantages and limitations for resolving the EEG pattern for FFT computation. These resolution techniques are helpful across different frequency bands of the oscillations of the brain activity. While investigation shows Hamming and Hanning windows are quite optimal for delta, theta and alpha rhythms, Blackman and flat top windows are better for beta and gamma rhythms.

Secondly, The FFT spectrum obtained using different window functions are almost similar but on careful investigation of the individual peaks, flat top and Kaiser windows are better for correlation with neuro-physiological activity.

The third most interesting aspect that cannot be shown with stationary EEG data is the periodicity sometimes witnessed in spectral response of EEG signals during certain physiological activity executed by the subjects. These periodic peaks in spectral response can be further resolved and analysed by use of appropriate window functions (our analysis shows Blackman and flat top window function will work best in this case). These peaks can be suitably amplified and used for interaction with machines and devices and hence can be applicable for brain machine interaction.

6. CONCLUSION

In this research work we have analysed EEG signal patterns during epileptic seizures using FFT and window functions. This has helped us in determination of which window function is suitable for which application and can be a guide towards developing automated diagnostics. We have also shown the viability of this method for possible use in human machine interaction.

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PREDICTION OF FERRORESONANCE IN ELECTRICAL SYSTEMS USING MATLAB

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ABSTRACT

The ability to predict ferroresonance significantly relies on the accuracy of the transformer model and the power system's parameters. The accomplishment of a suitable simulation model allows the sensitivity studies to be performed to determine the degree of influence of various components and parameters of the ferroresonance phenomenon such as line length, point-on-wave switching and transformer core loss. The objective of this paper is to:

- (i) Review the systematic methodology to study Ferroresonance problems in various electrical systems, particularly, their existence, and stability. The theory of the incremental-input describing function is revisited. The analysis here tells whether or not ferroresonance would persist, once initiated, and at what parameters it would occur spontaneously in the given system.
- (ii) Offer the concepts for progress in the areas of transformer model development and evaluation, analysis and prediction of ferroresonance, and distribution system design and operation.

Keywords: Ferroresonance, Incremental Describing Function, MATLAB, Frequency Domain Analysis

1. INTRODUCTION

We can define the ferroresonance phenomena as it is a special case of jump resonance phenomena. Jump resonance refers to circuits containing a nonlinear inductor and a linear capacitor with or without some other elements present. For certain circuit parameters, if an incremental change in the amplitude or frequency of the input to the circuit causes a sudden jump in signal amplitude somewhere in the circuit, jump resonance is said to have occurred. Thus, the jump can be one of voltage, current, flux linkages, or all three. Ferroresonance is a term which describes the wide range of current and voltage distortions that can occur in circuits containing important factor in the initiation of ferroresonance capacitance and, typically, an iron-cored reactor [1]. In distribution networks the situation of a cable, transformer and overhead line operating under zero load conditions can provide the basic circuit for ferroresonance to occur.

Ferroresonance can produce damaging levels of overvoltage, leading to disastrous failures of cables, switchgear, transformers and surge arresters. Indeed, when ferroresonance occurs, all circuit components must be considered to be physically at risk. If the line is being worked on or re-energised by linesmen then these personnel must also be considered to be at risk.

2. REVIEW OF PREVIOUS WORK

The word ferroresonance was introduced in 1920 by Boucherot [2]. Due to practical interest, this phenomenon was investigated heavily in the 1930s when it was discovered that a series line capacitor and the nonlinear inductance of a transformer core can trigger ferroresonance under some conditions.

Research on the ferroresonance problem has been carried out using two different approaches. The first one uses experimental investigations, while the second concentrates on developing models and analytical tools to investigate the behavior of the ferroresonance phenomenon.

2.1 EXPERIMENTAL INVESTIGATION OF FERRORESONANCE The conditions for predicting ferroresonance are calculated through conducting experiments on actual system elements. In 1931, Weller noticed that opening a line conductor can result in an abnormal voltage in a lightly loaded power transformer bank [3]. Clarke conducted an experiment with a transformer bank made up of three single-phase transformers, a transmission circuit, fuses, and a three-phase power generator. Similarly, three-phase core type and shell type transformers were investigated [4]. Clarke noticed for the three-phase transformers if the power generator is grounded and the transformer is lightly loaded and grounded, there is no overvoltage across the transformer terminals. On the other hand, if the power generator is ungrounded and one or two conductors are opened, a high sustained voltage results which can damage the transformer bank. Furthermore, if the system is loaded, the ferroresonance overvoltage will be mitigated or eliminated totally.

2.2 THEORETICAL INVESTIGATION OF FERRORESONANCE: The general characteristics of ferroresonance in power system transformers have been known for some time. However, in order to determine specifically the behavior of such a phenomenon, an analytical treatment is necessary. With such an analysis it is possible to gain insight helpful for investigating the conditions under which the ferroresonance can occur and methods to remedy the problem. In the past 82 years, two approaches for analytical treatments for ferroresonance problem were explored; the time domain and the frequency

Ferroresonance is one of the most destructive and longest known power quality disturbances in the history of ac power systems. Moses [12] developed A newly developed and accurate time-domain transformer model capable of simulating dynamic and transient operating conditions is implemented in this study.

3. DOMAIN KNOWLEDGE

3.1 PRINCIPLE Odessey and Weber proposed the first analytical work for this problem in 1938[1]. This analysis used a graphical method. Odessey and Weber studied a series circuit consisting of a sinusoidal input voltage, a capacitor, a resistor, and a saturable-core reactor as shown in Fig 1.4. The steady-state voltage of the circuit can be denoted as

$$E = \sqrt{(IR)^2 + (E_L - \frac{I}{\omega C})^2} \quad (1)$$

where I is current of the series circuit, $E_L = f(I)$ is the voltage across the non linear inductor which is a function of the current, and ω is the angular frequency of the input voltage. Hence, E_L is the volt ampere characteristic of the non linear reactor.

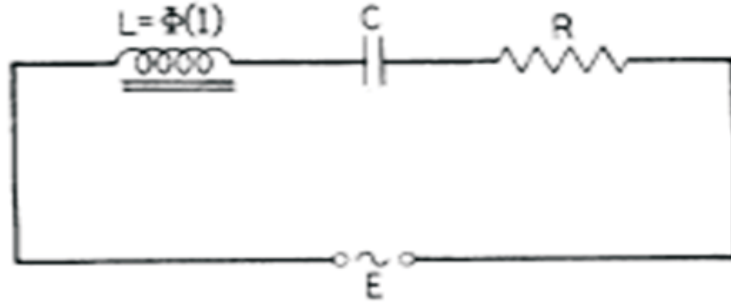


Fig.1

Under sinusoidal conditions the following condition holds,

$$E_L = \pm \sqrt{E^2 - (IR)^2} + \frac{I}{\omega C} \quad (2)$$

Odessey and Weber found the solution of the above equation by plotting the left and the right side of the equation.

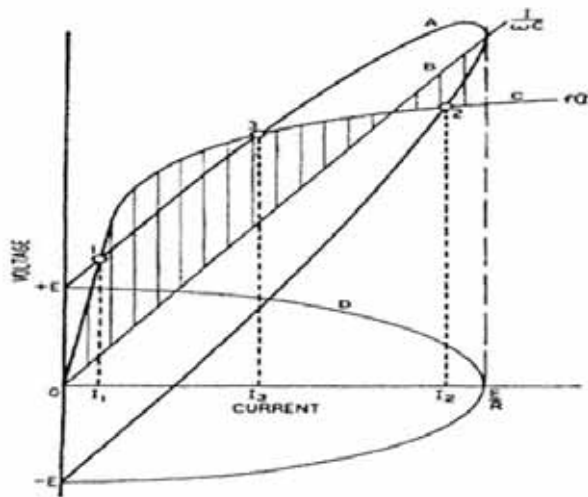


Fig.2

It is clear that the right side of (2) has two terms in the first term is an ellipse and the second term is a straight line. Therefore, for particular values of E, R, and C the circuit will have either three solutions or one solution, as depicted in Fig 2. In the figure, curve B is the voltage across the linear capacitor, curve C is the $E^2 - (IR)^2$, and curve A is the voltage across the non linear inductor, curve D is defined in the equation. Furthermore, for given in out magnitude E, C and R the circuit can have 3 solutions as shown in the figure between curves A and C at the locations 1, 2 and 3. Using physical insight, Odessey and Weber found that there are two

stable solutions at locations 1 and 2 and one unstable solution at the location 2.

3.2 SYMPTOMS OF FERRORESONANCE There are several modes of ferroresonance [7] with varying physical and electrical displays. Some have very high voltages and currents while others have voltages close to normal. There may or may not be failures or other evidence of ferroresonance in the electrical components. Therefore, it may be difficult to tell if ferroresonance has occurred in many cases unless there are witnesses or power quality recording instruments. Among notable symptoms of ferroresonance are audible noise and overheating.

A. Audible Noise

One thing common to all types of ferroresonance is that the steel core is driven into saturation, often deeply and randomly (otherwise, it is conventional resonance and not considered ferroresonance). As the core goes into a high flux density, it will make an audible noise due to the magnetostriction of the steel and to the actual movement of the core laminations. In any case, the sound is distinctively different and louder than the normal hum of a transformer.

B. Overheating

Another reported symptom of the high magnetic field is due to stray flux heating in parts of the transformer where magnetic flux is not expected. Since the core is saturated repeatedly, the magnetic flux will find its way into the tank wall and other metallic parts. One possible side effect is the charring or bubbling of paint on the top of the tank. This is not necessarily an indication that the unit is damaged, but damage can occur in this situation if the ferroresonance has persisted sufficiently long to cause overheating of some of the larger internal connections. This may in turn damage insulation structures beyond repair.

C. Arrestor and Surge Protector Failure

Lightning arrestors are designed to limit high voltages for a brief period during which they act as a short to the ground, thereby discharging the additional charges. A lightning arrestor failed in the distribution system of the local utility because it is ineffective in damping low-voltage ferroresonance conditions. Because of the limitation in the amount of energy it can absorb, the failure of the arrestor can be an indicator for the existence of the ferroresonance phenomena. In this case, ferroresonance persisted for several minutes, causing the arrestor failure. An instance of lightning arrestor failure on the distribution lines of the utility has been elaborated in [10]. This article and instances in [10] show that the failure of the lightning arrestors are effective indicator of the ferroresonance.

D. Flicker

Customers are frequently subjected to a wavering voltage magnitude. Light bulbs will flicker between very bright and dim. Some electronic appliances are reportedly very susceptible to the voltages that result from some types of ferroresonance, but we have no knowledge of the alleged failure mode. Perhaps, it is simply MOV failure in the power front end. These frequently fail catastrophically, going into thermal runaway and then burning open with considerable arcing display. This may do nothing more than pop a breaker, but surge protection is lost for any subsequent surge that might damage the appliance. Some have suggested that the high voltage is particularly hard on TV and microwave oven tubes.

E. Cable Switching

The transformers themselves can usually withstand the overvoltages without failing. Of course, they would not be expected to endure this stress repeatedly because the forces often shake things loose inside and abrade insulation structures. The cable is also in little danger unless its insulation stress had been reduced by aging or physical damage. Of course, operating a solid dielectric system above its normal stress level for an extended period can be expected to create some shortage of life.

4. METHODOLOGY

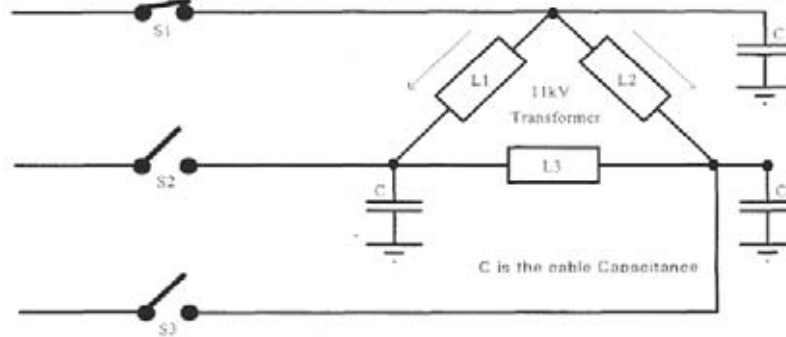
4.1 THE FERRORESONANT ELECTRIC CIRCUIT

Some power system circuits which can be the victim of ferroresonance phenomenon are given below.

- a. Single phase switching of delta and ungrounded wye windings
- b. Single Phase Switching of Grounded Wye Transformers with Ungrounded Capacitor Banks
- c. Mutual coupling onto de-energized line that has a connected transformer
- d. Breaker contact capacitance feeding a bus with a voltage transformer
- e. Capacitive voltage transformers
- f. Magnetically Coupled Phases in 3 Phase Transformers

One common condition for the occurrence of ferroresonance on the distribution network would be a 3-phase system including a length of cable and a delta-connected transformer (Fig.3). If one phase is switched on whilst the other two phases are open-circuited then ferroresonance can occur. The probability of ferroresonance increases if one phase is in service and one or two phases are switched on or off. The result will be the formation of significantly higher voltages on the open lines to earth compared

with the voltage across the transformer. The random overvoltage may be only a short transient of a few cycles or be continuous depending on the circuit parameters and the initial condition of the non-linear inductance of the transformer core. The frequency can be a stable, fundamental or harmonic oscillation, of even non-periodic and non-symmetric (continuous unstable transients).



Similarly, during voltage transformer ferroresonance an oscillation occurs between the nonlinear inductance of the VT [6] and the capacitance of any network remaining connected to the VT. In this case, energy is coupled to the nonlinear core of the voltage transformer via the open circuit breaker grading capacitance to sustain the resonance. The VT can be driven into saturation resulting in high currents at sub-harmonic or fundamental frequency. For the latter, very high voltage of up to 4 pu can theoretically arise in worst case conditions. Electromagnetic voltage transformers have a relatively low thermal capacity and overheating can result in insulation failure very quickly.

Fig.4 shows the single line diagram of the most commonly encountered system arrangement that can give rise to VT ferroresonance. Ferroresonance can occur upon opening of disconnector 3 with circuit breaker open and either disconnector 1 or 2 closed. Alternatively it can also occur upon closure of either disconnector 1 or 2 with circuit breaker or disconnector 3 open.

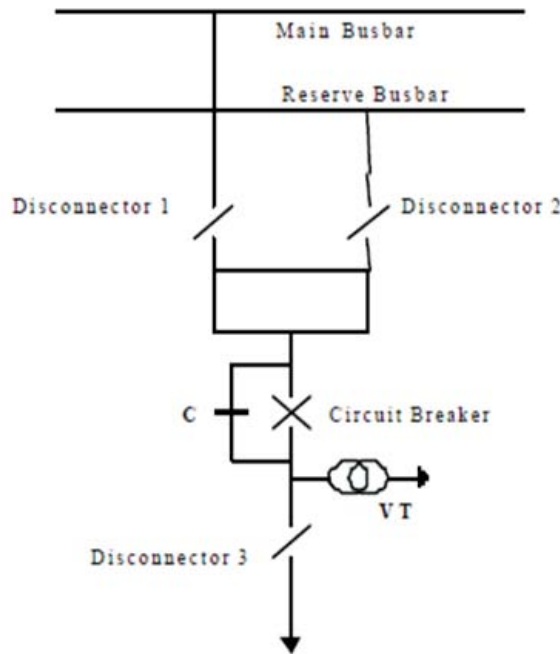


Fig. 4 System arrangement resulting in VT ferroresonance

The system arrangement shown in Fig.4 can effectively be reduced to an equivalent circuit as shown in Fig.5.

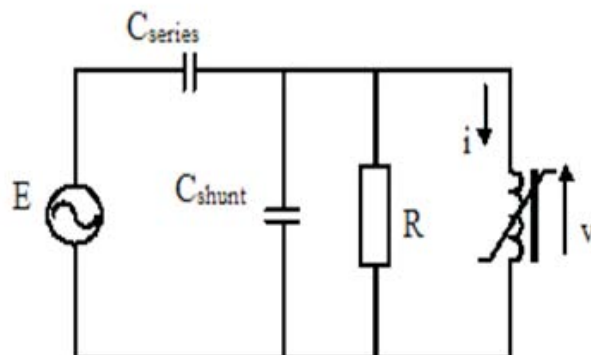


Fig.5 Reduced equivalent ferroresonance circuit

In Fig. 5, E is the rms supply phase voltage, C_{series} is the circuit breaker grading capacitance and C_{shunt} is the total phase-to-earth capacitance of the arrangement. The resistor R represents voltage transformer core loss that has been found to be an important factor in the initiation of ferroresonance.

4.2 FREQUENCY DOMAIN MODELING The method applies to any circuit configuration in which there is only one non-linearity and only one input voltage. Traditionally the circuit which is used for analysis is shown in fig.1. In order to dispel the notion that the circuit must be a simple RLnonlinearC series circuit, the circuit of Fig. 6 will be used as an example [11].

It represents one phase of an open-circuited transformer bank at the receiving end of a long transmission line. The equivalent circuit is justifiable since ferroresonance is basically a low-frequency phenomenon. It is of interest to note that the linear portion of any circuit with only one non-linearity could be replaced with its Thevenin's equivalent. Ultimately, though, the Thevenin's impedance would have to be expanded into a form similar to $G(s)$ in fig. 7.

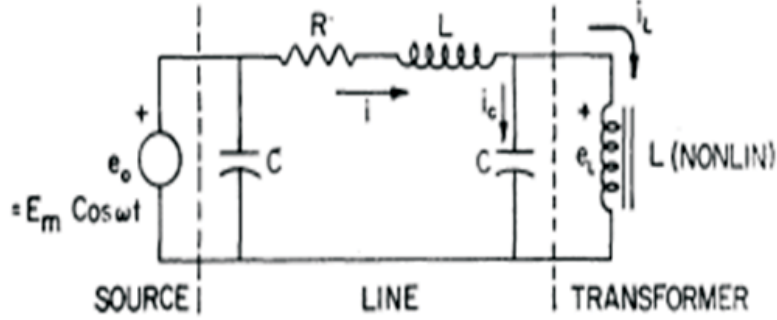


Fig.6.Circuit to be used in this study

The circuit equations are,

$$e_o = Ri + L \frac{di}{dt} + \frac{d\lambda}{dt} \quad (3)$$

$$\frac{1}{C} \int i dt = \frac{d\lambda}{dt} \quad (4)$$

$$i = i_L + i_C \quad (5)$$

$$i_L = f(\lambda) \quad (6)$$

where λ is the flux linkages of the transformer.

For analytical purposes it is desirable to have (6) in the form

$$i_L = c_1 \lambda + c_3 \lambda^3 + c_5 \lambda^5 + \dots \quad (7)$$

For an actual transformer it was found that

$$i_L = \lambda + 4\lambda^5 \quad (8)$$

was a close approximation. The constants c_1 and c_5 of (7) were determined for (8) by curve- fitting.

The Laplace-transformed equations are

$$E_0 = RI + sLI + s\Lambda \quad (9)$$

$$\frac{1}{sC} I_C = s\Lambda \quad (10)$$

$$I = I_L + I_C \quad (11)$$

$$I_L = \Lambda + 4 \Lambda^5 \quad (12)$$

$$\Lambda = G_0(s).E_o - G(s) .I_L \quad (13)$$

where,

$$G_0(s) = \frac{1}{s(s^2 LC + sRC + 1)} \quad (14)$$

and,

$$G(s) = \frac{R + sL}{s(s^2 LC + sRC + 1)} \quad (15)$$

Equation (13) can be represented by the standard block diagram of Fig.7. The nonlinear block, labeled N, represents (4.10).

In the frequency domain, the system is formulated in a feedback setting by quasi-linearizing the nonlinear elements in the system. This linearization depends on steady-state solutions of the system. Then, using this linearized model, we employ frequency domain techniques to analyze the stability of the steady-state solutions. In this section, we consider the nonlinear feedback system shown in Fig 7.

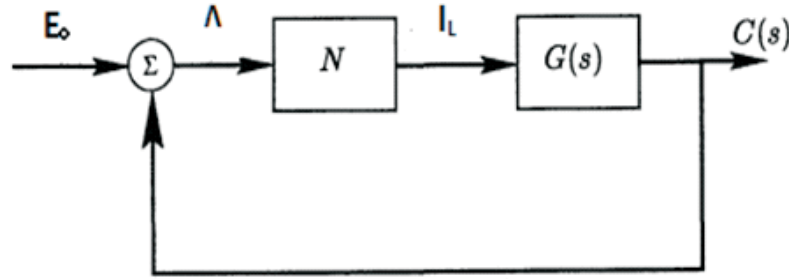


Fig 1: Observed infected instance number for the C – Worm and PRS Worm

The series ferroresonance circuit which comprises a resistor, capacitor and non linear inductor can be formulated in feedback setting as in fig.7

Λ - represents the flux of core.

E_0 - represents the input voltage of the transformer.

$G(s)$ - represents the frequency domain representation of the linear part if the system.

N - represents the non linearity.

I_L - represents the output of the non linear element.

C is the output of $G(s)$.

The objective of this scheme is to approximate N using the steady state value of the magnitude and the phase of the error signal, and then uses the frequency domain techniques such as Nyquist criterion to assess the stability of the feedback system. In this approach the steady-state solution of the system is compared using the describing function method.

Incremental Describing Function

The theory is based on the "incremental describing function" of West, Douce, and Livesley [5]. This theory is known as the incremental input describing function analysis. This method assesses the stability of the feedback system by adding the input signal to an incremental input with the same frequency but different phase and check the stability of the incremental system using Nyquist criterion. According to the theory, it is possible to define the gain of the non-linear element for a sinusoidal signal as

$$K(a) = \frac{\text{Amplitude of fundamental component of output}}{\text{Amplitude of the input}}$$

Swift [9] applied this theory to a single-phase transformer in 1969. He found by fixing the line capacitance and resistance of the transmission lines and varying the magnitude of the input voltage and the line inductance of the system, the system can have different solutions. Some of these solutions are stable while others are unstable.

Consider the system of Fig. 4 to be operating under steady state conditions. Suppose there is an incremental perturbation on $\lambda(t)$. The increment may have any phase relationship with respect to the phasor for $\lambda(t)$, that is,

$$\lambda(t) = \lambda_m \cos(\omega t + \Phi) + \mu \cos \omega t \quad (16)$$

where λ_m is the peak value of $\lambda(t)$, u the incremental perturbation ($\mu < \lambda_m$), and Φ the phase angle between the main signal and the perturbation.

If, as the magnitude of $\lambda(t)$ is increased, a Nyquist plot for the increment encloses the minus-one point, then the system is unstable and $\lambda(t)$ will increase spontaneously, i.e., jump. The amplitude to which it jumps is that value which results in the increment-Nyquist-plot returning to a state of non encirclement of the minus-one point.

As the increment "passes through" the nonlinearity N it is multiplied by a factor $K(\lambda_m, \Phi)$, i.e., a transfer function dependent on λ_m and Φ . It is then multiplied by a factor $G(j\omega)$, i.e., a transfer function dependent on ω . Thus the stability criterion is

$$K(\lambda_m, \phi).G(j\omega) = -1 \quad (17)$$

Or,

$$G(j\omega) = \frac{-1}{K(\lambda_m, \phi)} \quad (18)$$

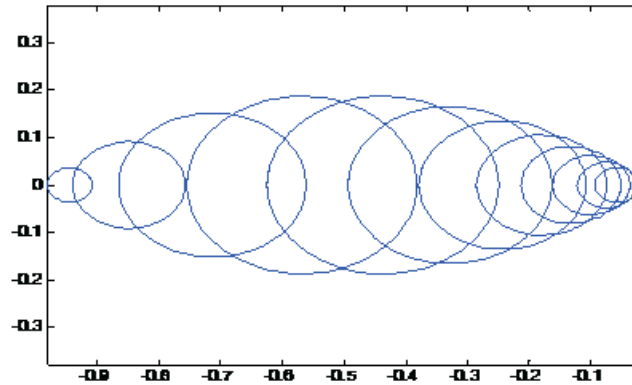


Fig. 8 Incremental describing function

Fig.8 shows the plot of incremental describing function by varying

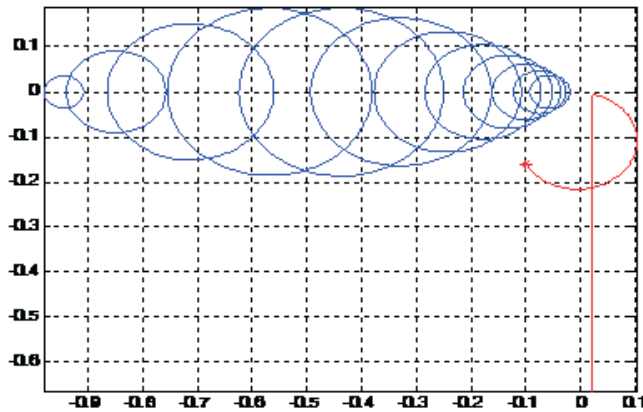


Fig.9 Loci of $G(j\omega)$ for $L=0.021$ pu

Fig. 9, shows the interaction incremental describing function with $G(j\omega)$. For $L = 0.021$ pu, $G(j\omega)$ falls outside the nonlinearity envelope, ferroresonance will not occur.

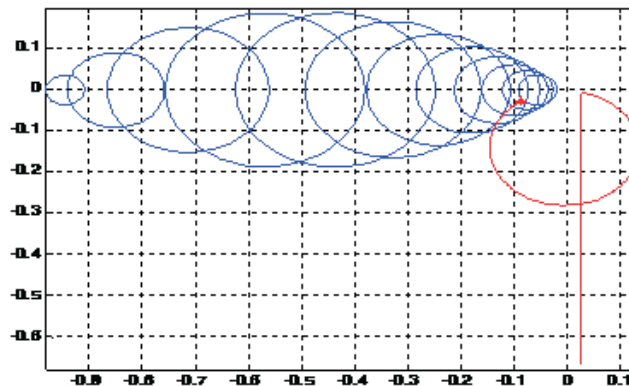


Fig.10. Loci of $G(j\omega)$ for $L=0.025$ pu

Fig.10, shows the interaction incremental describing function with $G(j\omega)$. For $L = 0.025$ pu, $G(j\omega)$ falls inside the nonlinearity envelope, ferro resonance will occur.

This shows that, for a particular system, of course, having particular fixed parameters, only one point need be plotted to determine whether or not ferro resonance will occur. This is shown in the figure.

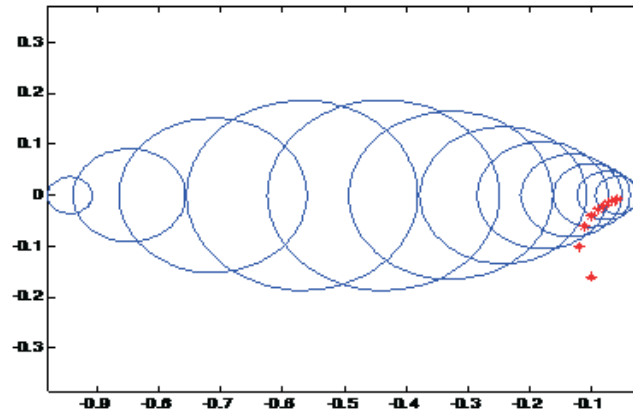


Fig.11 Ferroresonance condition for varying L

Fig.11 shows the interaction with different values of L. This plot gives the critical value of the inductance i.e. 0.023 pu. After this value the system goes into the ferroresonance.

Having established a value of λ_m of interest, e.g., λ_m at which the jump is about to occur (critical λ_m) or λ_m after jump has occurred, voltages and currents in the system are of interest. Since the system is in the steady state, normal phasor calculations can be used with the transformer magnetizing inductance taken from Fig. 12.

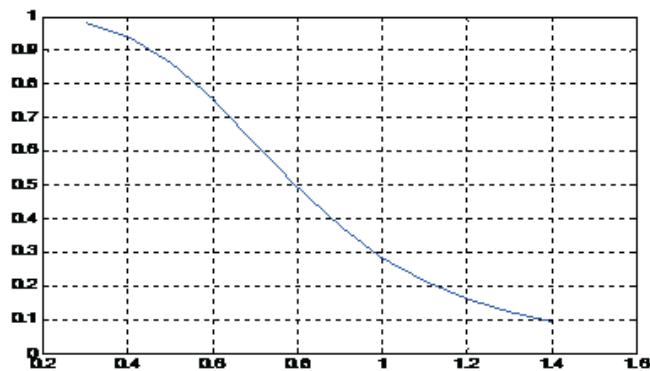


Fig. 12 Determination of equivalent inductance

5. CONCLUSION

The frequency-domain model developed here is capable of determining the stability and for a particular system; of course, having particular fixed parameters, only one point need be plotted to determine whether or not ferroresonance will occur.

The model is based on incremental describing function and considers dynamic hysteresis effects (major and minor loops) as well as core topology, asymmetry, and magnetic flux cross-coupling interactions of the core legs. Unbalanced switching with series and shunt capacitances, which is known to increase the risk of ferroresonance, is studied with the developed model. The validity of the model under ferroresonant conditions is confirmed by comparisons with extensive experimental data. Hence this method is useful to identify the crucial factor in Ferroresonance to the system designers well in advance.

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A NEW WINDING DESIGN FOR AUTOMOTIVE ALTERNATOR

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ABSTRACT

This paper introduces a new design for alternator system that provides dramatic increase in power output as compared to a conventional automotive alternator, along with substantial improvement in efficiency. Experimental results demonstrate these capability improvements. The paper highlights about the copper fill factor and its contribution to increase the efficiency. A high slot fill stator design is provided, which allows and enables higher generator efficiency and output for a given package size. This new technology preserves the simplicity of conventional alternator designs and can be implemented in existing manufacturing infrastructure.

Keywords- copper fill factor, split phase winding, pole pitch, slot angle, coil pitch, efficiency.

1. INTRODUCTION

Nowadays, almost all generating systems installed on combustion engine driven vehicles, are based on the alternator. The constantly rising electrical power requirements will be soon beyond the limits of the conventional alternator. A suitable machine replacement is still under investigation. However, due to the relatively high cost of the other machines and large investments in manufacturing infrastructure for alternators, improvements on present-day alternator could represent an interesting alternative for the short term future. The electrical power requirements in automobiles have been rising rapidly and expected to continue to rise (Fig. 1). This trend is driven by the replacement of engine-driven loads with electrically powered versions, and by the introduction of a wide range of new functionality in vehicles. The continuous increase in power requirements is pushing the limits of conventional automotive power generation and control technology, and is motivating the development of high efficient alternators.

Here we introduce a new design for automotive alternators that utilizes the conventional alternator but incorporates a new winding. Most of the alternators today have a wave winding in the stator. It was found out that stator fill factor with wave winding was low and had scope for improvement. Therefore this new design allows much higher levels of output power and efficiency to be achieved as compared to conventional designs while retaining simplicity of structure and control.

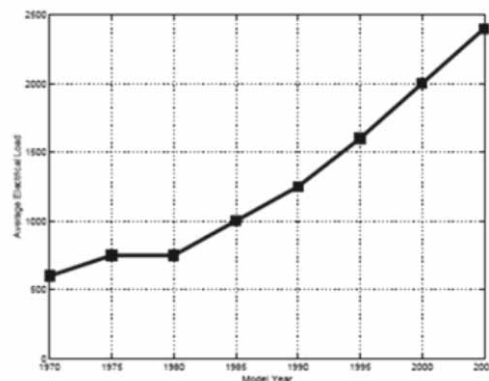


Fig. 1 Power requirement in automotive alternator

2. AUTOMOTIVE ALTERNATOR

A conventional automotive generator is a wound-field synchronous machine with a claw pole rotor and often named “Lundell” alternator. The excitation coil is wound axially on the rotor. This coil is surrounded by two solid iron pole pieces, or claw poles, and is fed from the stator via a pair of slip rings. The stator is composed by a slotted laminated iron core and a three-phase winding, star or delta connected. Usually six diodes in a full-bridge configuration are used to rectify the output current. The output power is controlled by regulating the field current. Generally, Lundell alternators are characterized by low efficiency and low manufacturing cost. Fig.2 shows the typical output curves of an alternator as given by the manufacturer. The output current curve is characterized essentially by two points: the generation starting speed (Ω_{GS}) and the maximum output current at the highest speed, which corresponds approximately to the DC short-circuit current of the alternator (ISC). However, during the design process, a special attention is paid to the output power requirement at idle speed (IIDLE). No output power is required below the idle speed.

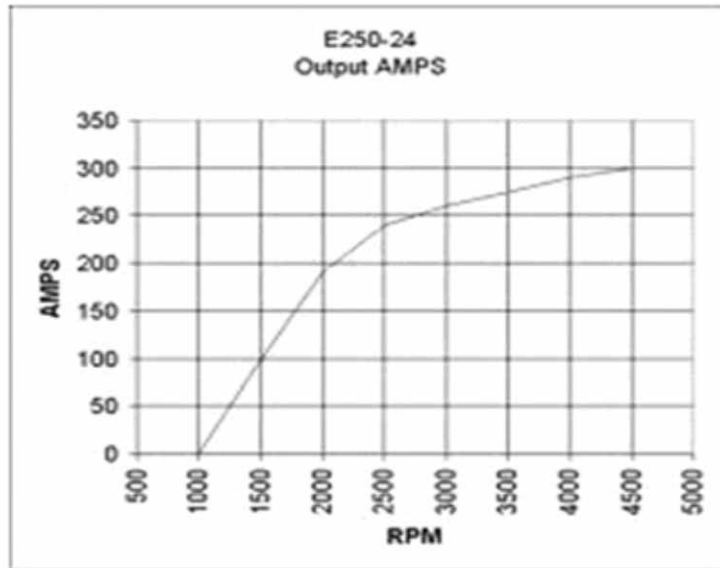


Fig. 2 Graph of output current versus speed

Fig. 3 shows the typical claw pole rotor and stator core of an automotive alternator.



Fig. 3 Claw pole rotor and Stator core

3. ARMATURE WINDINGS

Armature winding of a machine is defined as an arrangement of conductors designed to produce emf by relative motion. The action of rotating electromagnetic machines is dependent upon the conversion of power that takes place through the medium of magnetic field; an emf being induced in the winding that experiences a change of flux linkages. The winding through which a current is passed to produce the main flux is called the field winding. The winding in which voltage is induced is called the armature winding.

Some of the commonly used terms associated with windings are explained below:

Conductor: The active length of wire in the slot, i.e. length of wire responsible for electromagnetic energy conversion.

Turns: A turn consists of two conductors separated from each other by a pole pitch. The conductors forming a turn are kept a pole pitch apart in order that the emf in two are additive to produce maximum resultant emf.

Coil: A coil is formed by connecting several turns in series.

The beginning of the turn, or coil, is identified by the symbol S (start) and end of the turn or coil by the symbol F (finish).

The concept of electrical degrees is very useful in the study of machine.

Theta (mech): Mechanical degrees or angular measure in space

Theta (elect): Electrical degrees or angular measure in cycles

For a pole machine, an electrical degree is defined as follows:

$$\text{Theta (elect)} = (p/2) * \text{theta (mech)} \quad (1)$$

Pole pitch: The angular distance between the centres of two adjacent poles on a machine.

$$\text{One pole pitch} = 180\text{degree (elect)} = (360\text{degree (mech)})/p \quad (2)$$

Coil pitch: The two sides of a coil are placed in two slots on the stator surface. The distance between the two sides of a coil is called the coil pitch. If the coil pitch is pole pitch, the coil is called the full pitch coil.

3.1 WAVE WINDING DIAGRAM

There are 36 slots in the stator of the alternator. Two parallel Copper wire of diameter 1.32 is wound in the slots with the number of turns being 7. So the existing specification is 1.32 2*7 wave winding.

1.32: diameter of the wire

2: number of wires wound in parallel

7: number of turns

Fig.4 below shows the existing type of armature winding.

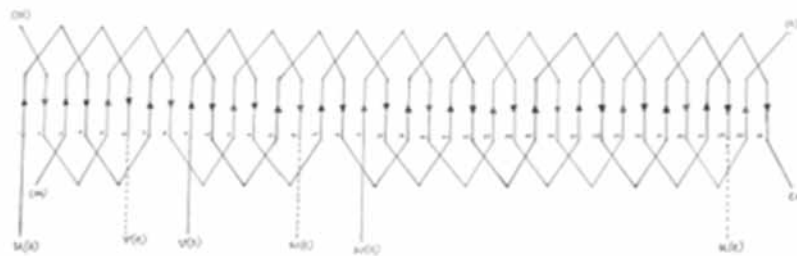


Fig. 4 Wave Winding

3.2 SPLIT PHASE WINDING This is a new type of winding. In this type of connection winding travels ahead and then takes a return path in the opposite direction through the same slots overlapping the winding. It travels both like a progressive and retrogressive wave winding. The connection of conductors in the stator slots is the winding diagram. To draw the winding diagram, we need to develop the winding table. Some of the formulas required for developing the winding table are

$$\text{Pole pitch} = \text{number of slots per pole} \quad (3)$$

$$\text{Slot angle} = 180\text{degree} / \text{pole pitch} \quad (4)$$

$$\text{Coil span} = 180\text{degree} / \text{slot angle} \quad (5)$$

3.2.1 PROCEDURE TO DRAW THE WINDING TABLE

No of slots = 36

No of poles = 12

Pole pitch = no of slots / pole = $36/12 = 3$

No of slots/pole/phase = $12/3 = 4$

Slot angle = $180/3 = 60$

Coil span = $180/60 = 3$

There are 12 poles in the machine. Slot number 1 to 3 under 1st pole, 4 to 6 under 2nd pole and so on and slot number 34 to 36 under the last pole (12th pole).

Let us consider the 1st phase. If one side of the coil side of the 1st phase is placed in slot number 1, the other side of the coil should be placed in slot number $(1 + \text{slots per pole} = 1 + 3 = 4)$. The finishing end of the coil side at slot number 4 is connected to the starting end of the coil side at slot no. $(4 + 3 = 7)$. Now the other side of the coil side at slot number 7 is placed at slot number $(7 + 3 = 10)$. This type of connection is followed till the 34th slot. The winding progresses like a wave winding. The starting end of the 1st phase is in slot 1 and it ends in slot 34. In this winding we connect the coil in the 34th slot back again in retrogressive way in the

same slots. i.e. from the 34th slot, the other side of the coil is placed in ($34 - \text{slots/pole} = 31$). The other side of the coil is placed in ($31 - \text{slots/pole} = 28$), it goes on till the 1st slot and from the 1st slot to the 34th slot .so the connection ends in the 34th slot. The winding travels progressively and retrogressively in the same slots. In every slot the windings are split into 2 directions but the current direction in the conductors remains same.

3.2.2 WINDING TABLE

Table 1. Winding table for the 1st phase

Back	Front	Back	Front
(start)1+3=4	4+3=7	34-3=31	31-3=28
7+3=10	10+3=13	28-3=25	25-3=22
13+3=16	16+3=19	22-3=19	19-3=16
19+3=22	22+3=25	16-3=13	13-3=10
25+3=28	28+3=31	10-3=7	7-3=4
31+3=34		4-3=1	1-3=34(end)

Table 2. Winding table for the 2nd phase

Back	Front	Back	Front
(start)9+3=12	12+3=15	6-3=3	3-3=0(36)
15+3=18	18+3=21	36-3=33	33-3=30
21+3=24	24+3=27	30-3=27	27-3=24
27+3=30	30+3=33	24-3=21	21-3=18
33+3=36	36+3=39(3)	18-3=15	15-3=12
3+3=6		12-3=9	9-3=6(end)

Table 3. Winding table for the 3rd phase

Back	Front	Back	Front
(start)17+3=20	20+3=23	14-3=11	11-3=8
23+3=26	26+3=29	8-3=5	5-3=2
29+3=32	32+3=35	2-3=35	35-3=32
35+3=38(2)	2+3=5	32-3=29	29-3=26
5+3=8	8+3=11	26-3=23	23-3=20
11+3=14		20-3=17	17-3=14(end)

It is to be noted that the mechanical slot angle = $360\text{degree}/36=10$ degree.

3.2.3 SPLIT PHASE WINDING DIAGRAM

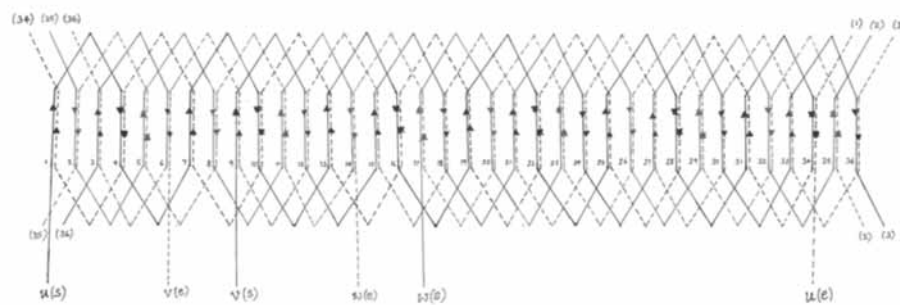


Fig.5 Split phase winding

The existing specification of the winding is 1.32 2 *7 wave winding. In split phase winding the winding is branched into two direction which helps in accommodating more number of conductors in the slot. This increases the copper fill factor.

3.3 COPPER FILL FACTOR Fill factor= (A_{cu} (in mm sq))/(A_{slot}(in mm sq)) The area of copper is determined by the no of wires per slot and the wire diameter. The area of slot is determined by slot geometry.

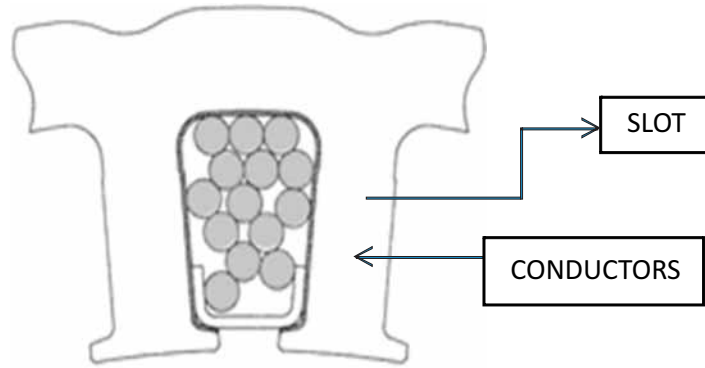


Fig.6 Stator slot

Increasing the fill factor enhances the output performances of the machine. This helps in increasing the efficiency of the alternator.

3.3.1 EFFECT OF COPPER FILL FACTOR An increase of the wires/slot lifts the characteristic curve in low speed area and lowers it in high speed area. The graph in fig.7 shows the effect of copper fill factor on the performance of the alternator.

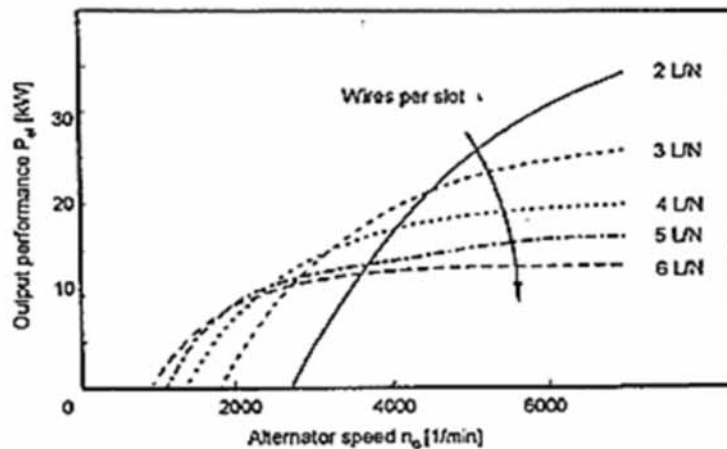


Fig. 7 Graph of output performance versus speed

3.3.2 FILL FACTOR CALCULATION

The number of wires per slot and the wire diameter create as a resulting feature the fill factor. For its calculation the area of copper has to be divided through the area of slot.

Fill factor = A_{cu}/A_{slot}

The area of the copper is determined by the number of wires per slot and the wire diameter. The area of the slot is determined by the slot geometry.

Fill factor can be calculated by using the above formula.

Area of copper wire = $(N \cdot \pi \cdot (d/2)^2)/4$ where N is the number of turns, d is the diameter of the wire.

Area of the slot = total slot area (A_a) - area of slot insulation (A_s).

Let us consider one example for the calculation of fill factor.

F.R = Filling Rate

Wave winding with number of turns = 14, diameter of the wire = 1.32mm, area of the slot = 48.78 sq.mm, area of slot insulation = 0.35sq.mm.

$$F.R = (14 \cdot \pi \cdot 1.32 \cdot 1.32) / (48.78 - 0.35)$$

$$F.R = 39.56\%$$

Similarly fill factor is calculated for the new split phase winding.

1) Split phase winding with number of turns = 12, diameter of the wire = 1.45 mm, area of the slot = 48.78 sq.mm, area of slot insulation = 0.35 sq.mm.

$$F.R = (12 \cdot \pi \cdot 1.45 \cdot 1.45) / (48.78 - 0.35)$$

$$F.R = 41.23\%$$

2) Split phase winding with number of turns = 16, diameter of the wire = 1.32mm, area of the slot = 48.78 sq.mm, area of slot insulation = 0.35 sq.mm.

$$F.R = (16 \cdot \pi \cdot 1.32 \cdot 1.2) / (48.78 - 0.35)$$

$$F.R = 45.38 \%$$

Table 4. Fill factor calculation

Type of winding	N	D	Aw	As	Ai	F.R
Wave	14	1.32	19.16	48.78	0.35	39.56
Split phase	12	1.45	19.97	48.78	0.35	41.23
Split phase	16	1.32	21.98	48.78	0.35	45.38

N=no of turns, AW= area of the copper wire, AS=area of slot, Ai=area of slot insulation

Fill factor calculation proves that the fill factor of split phase winding is increased. This increased fill factor helps in improving the output performance of the alternator. The split phase winding is wound in a stator and test is conducted on the alternator.

4. RESULTS



Fig. 8. Stator with Wave Winding



Fig. 8. Stator with Wave Winding

Table 5. 1.32(2*7) Wave winding

Speed	Torque	voltage	Current	Input	Output	%?
1800	4.58	13.4	35.6	868.10	477.04	54.95
2000	4.73	13.4	40.8	995.61	546.72	54.91
2500	5.12	13.4	53	1351.13	710.20	52.56
3000	4.88	13.4	58.7	1543.32	786.58	50.98
4000	4.28	13.4	65.5	1801.76	877.7	48.71
5000	4.75	13.4	82.7	2506.99	1108.18	44.20
6000	3.30	13.4	70.80	2087.27	948.72	45.45

Table 6. 1.45 2*6 Split phase winding

Speed	Torque	Voltage	Current	Input	Output	%?
1800	4.11	13.48	32.17	778.62	433.65	55
2000	4.68	13.47	41.49	986.23	558.57	56.67
2200	5.00	13.46	48.88	1159.92	657.92	56.72
2500	5.21	13.46	57.19	1373.35	769.77	56.05
3000	5.14	13.45	65.85	1624.68	885.68	54.51
4000	4.58	13.44	76.82	1929.57	1032.46	53.51
5000	4.65	13.42	88.56	2452.28	1188.47	48.46

The efficiency column of both the table shows that there is an increase in efficiency in the split phase winding alternator. A graph of efficiency versus speed is plotted for wave winding and split phase winding alternator.

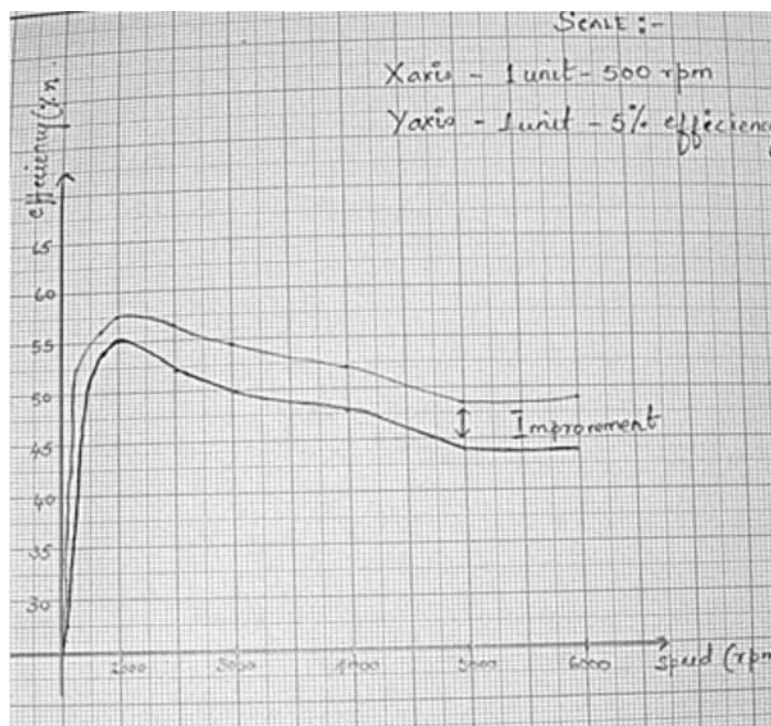


Fig. 10. Graph of output efficiency versus speed

5. CONCLUSION

Alternator is a prime equipment for the working of automobiles. It is used for powering the electrical loads like ignition, fuel injection, side and tail lights, dashboard lights, audio systems and air conditioners etc. It is a 3 phase ac machine. The operating efficiency of this machine is 52 %. This efficiency can be improved to a higher value by copper fill factor. This proposed method involves replacing the existing wave winding by split phase winding. It is seen that by this method the copper fill factor improves. A 4% improvement of efficiency is seen compared to a conventional one. Indirectly, an increase in the efficiency of the alternator considerably reduces the fuel consumption. The future work of the project is the split phase winding increased the net copper in the stator. This also increases the copper losses which has not been considered. A study should be carried out to analyse the increased losses. The performance test indicated that with the increase in the output current there was a corresponding increase in the input torque. A study can be carried out to reduce the torque which enhances the efficiency further more. Cost benefit analysis should be carried out for the feasibility of the proposed split phase winding.

ACKNOWLEDGEMENT

The authors thank Prof. A G Suresh, Head of the department, EEE, NHCE & Mrs. Suryaprabha asst prof for their input and support. The authors also thank Mr. Ashwin G Reddy design engineer for helping with experimental validation of this new technology. Finally, authors thank the member companies of the Bosch Limited for providing support for the work.

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ELECTRIC POWER QUALITY MONITORING AND ANALYSIS USING WAVELET TRANSFORM

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ABSTRACT

Power quality issues have been a matter of concern in recent years due to the extensive use of power electronics devices and non-linear loads in electric power system. The sensitive detection and accurate classification of power disturbance attract more attention from both utilities and industrial customers. The poor electric power quality is normally caused by power line disturbances such as impulses, notches, glitches, momentary interruptions, wave-faults, over-voltages, under-voltages, and harmonic distortion. This results into many problems for the affected loads, such as malfunctions, instabilities, short life time etc. A wavelet-transform-based approach for monitoring and analysis of power quality is proposed in this paper.

Keywords: Power Quality Monitoring, Discrete Wavelet Transform (DWT), Continuous Wavelet Transform (CWT), Multi-resolution Signal Decomposition (MSD) etc.

1. INTRODUCTION

Electric Power quality has become an alarming issue over the recent several decades because, with the introduction and wide spread use of non-linear loads and sensitive electronic equipment, such as variable-speed drives or robots, automated production lines or machine tools, programmable logic controllers or power supplies in computers, customers have become much more aware and sensitive to transient and other power quality problems [1]. Poor electric power quality is normally caused by power line disturbances such as impulses, notches, glitches, flicker, voltage imbalance, transients, momentary interruptions, wavefaults, overvoltages, undervoltages, sub-harmonics, interharmonics, harmonic distortion etc. that leads to catastrophic consequences such as mal-operation of devices and machines, fast ageing of equipment, unreliable functioning of devices, computer data error/loss, heating etc. In order to improve electric power quality, the sources and causes of such disturbances must be known before appropriate mitigating control action can be taken [2]. Assessment of power quality require the following stages: Firstly, real time estimation of the instantaneous magnitudes and frequencies of components embedded in disturbance signals, i.e. monitoring, and locating the disturbance; secondly classifying these disturbances by pattern matching with pre-defined categories and finally, to determine the corresponding origins and causes [3]. Thus a power quality monitoring system must be developed that is able to detect, localize, estimate and classify disturbances on the supply lines. Here, Wavelet Transform (WT) is used as a powerful tool that translates the time-domain signal into a representation localized not only in the frequency but also in the time.

The wavelet transform approach prepares a window that automatically adjusts to give proper resolutions of both the time and the frequency. In this approach, a larger resolution of time is provided to high-frequency components of a signal, and a larger resolution of frequency to low-frequency components [4-6]. Multi-resolution signal decomposition has been applied to detect and localize different power quality problems. The squared wavelet coefficients are used to find a unique feature for different power quality problems of noisy signals. The wavelet analysis technique is used to reconstruct transient signals with only small number of wavelet coefficients. Wavelet transform is applied to model short-term power system disturbances and to determine the accuracy with whether wavelets can be used for the calculation of transients in the system and to reconstruct different power system disturbances [7-11]. The multi-resolution analysis technique is used to detect and localize different power quality problems. Wavelet Toolbox which helps in implementing the theoretical aspects wavelet transform and its applications into practical work is used [12-18].

In this paper, the multi-resolution analysis technique is used to detect and localize different power quality problems. Furthermore, the standard deviation curve at different resolution levels as a new feature to classify different power quality problems is introduced.

2. WAVELET APPROACH TO POWER QUALITY MONITORING

Transformations are applied to signals to obtain further information from that signal which is not readily available in the raw signal. Unlike Fourier Transform, Wavelet Transform expands functions not in terms of trigonometric polynomials but in terms of wavelets, which are generated in the form of dilations (scaling) and translations (time-shift) of a fixed function called the mother wavelet. The continuous wavelet transform (CWT) is developed as an alternative approach to the short time Fourier transforms to overcome the resolution problem. However, there are two main differences between the STFT and the CWT: Firstly, the Fourier transforms of the windowed signals are not taken, and therefore single peak will be seen corresponding to a sinusoid, i.e., negative frequencies are not computed. Secondly, the width of the window is changed as the transform is computed for every single spectral component, which is probably the most significant characteristic of the wavelet transform [19].

2.1 ENERGY CONTAINED AND DEVIATION IN SIGNAL ENERGY Energy contained in a signal can be computed by Parseval's Theorem: Parseval's Theorem states that “the energy computed in either domain equals the energy in the other”. If the used scaling function and the wavelets form an orthonormal basis, then Parseval's theorem relates the energy of the distorted signal to the energy in each of the expansion components and their wavelet coefficients. This means that the norm or the energy of the signal can be partitioned in terms of the expansion coefficients [14]. Thus, in the case of wavelet analysis of a signal, “the energy that a time domain signal contains is equal to the sum of all energy concentrated in the different resolution levels of the corresponding wavelet transformed signal”. This can be mathematically expressed as

$$E_f(n) = \sum_{n=1}^N |x(n)|^2 = \sum_{n=1}^N |a_j(n)|^2 + \sum_{j=1}^J \sum_{n=1}^N |d_j(n)|^2 \quad (1)$$

where

$x(n)$ = signal in time domain

$E_f(n)$ = energy concentrated in signal $f(n)$

n = sample number

N = total sample numbers

j = wavelet transform level

J = total wavelet transform levels

$$\underbrace{x(t)}_{W_j} = \sum_k d_j(k) \cdot 2^{j/2} \psi(2^j t - k) = \text{energy concentrated in approximated version of signal } f(n) \text{ at level } J$$

$$\sum_{j=1}^J \sum_{n=1}^N |d_j(n)|^2 = \text{energy concentrated in detailed version of signal } f(n) \text{ from level } 1 \text{ to } J$$

2.2 RATIONALIZED DEVIATION IN SIGNAL ENERGY The two total signal energies (found by Parseval's Theorem) of the distorted signal and of the pure signal version are compared. The result of this comparison is a deviation. This deviation is then rationalized by dividing it by the energy present in the reference signal at the maximum multi-resolution signal decomposition (MSD) level. The rationalized deviation in signal energy can thus be evaluated by

$$devE(j) = \left[\frac{E_{dist}(j) - E_{ref}(j)}{E_{ref}(j_{maxE})} \right] * 100\% \quad (2)$$

where, j = wavelet transform level

$devE(j)\%$ = deviation in energies at j th level of distorted signal and pure signal

$E_{dist}(j)$ = energy distribution concentrated in j th level of distorted signal

$E_{ref}(j)$ = energy distribution concentrated in j th level of reference signal

$E_{ref}(j_{maxE})$ = energy distribution at the level which concentrates max. energy in the reference signal

3. PROPOSED SCHEME

In power quality disturbance signals, many disturbances contain sharp edges, transitions, and jumps. By using the multi-resolution signal decomposition (MSD) technique, the power quality (PQ) disturbance signal is decomposed into two other signals; one is the approximated (smoothed) version of the PQ disturbance signal, and the other is the detailed version of the PQ disturbance signal that contains the sharp edges, transitions, and jumps. Therefore, the MSD technique discriminates disturbances from the original signal, and then analyses them separately. An important industrial application of the MSD is for monitoring power quality problems due to dynamic performance of the industrial plants. MSD can detect and diagnose defects, and provide early warning of impending power quality problems. Using the properties of the wavelet transform and the features in the

decomposed waveform, one will have the ability to extract important information from the distorted signal. This information can be used to detect any distortion in the electric power and to classify the type of this power quality problem.

3.1 DETECTING AND LOCALIZING A DISTURBANCE In the proposed work, disturbance detection and localization is performed in the wavelet domain rather than the time or frequency domain. Using the multi-resolution signal decomposition (MSD) technique one can decompose the distorted signal into different resolution levels. Any changes in the smoothness of the signal can be detected and localized at the finer resolution levels.

As for as detection and localization is concerned, the first finer decomposition levels of the distorted signal,

$$\underbrace{x(t)}_{w_j} = \sum_k d_j(k) \cdot 2^{j/2} \psi(2^j t - k) \quad (3)$$

are normally adequate to detect and localize this disturbance. However, the other coarser resolution levels are used to extract more features that can help in the classification process. A Power Quality (PQ) monitoring system is often obligated to precisely capture the occurrence of the voltage sag and swell disturbances in order to find possible solutions to remedy the causes. Figure 1 shows the single line diagram of the sample power system used to simulate the power quality disturbance. A 20% voltage-sag signal is simulated caused by switching the load of (80+j60) kVA to a heavier one of (115+j85) kVA for two-cycle duration and then switching it back. The base of 220 V is used for the voltages (in per unit) given in the testing results.

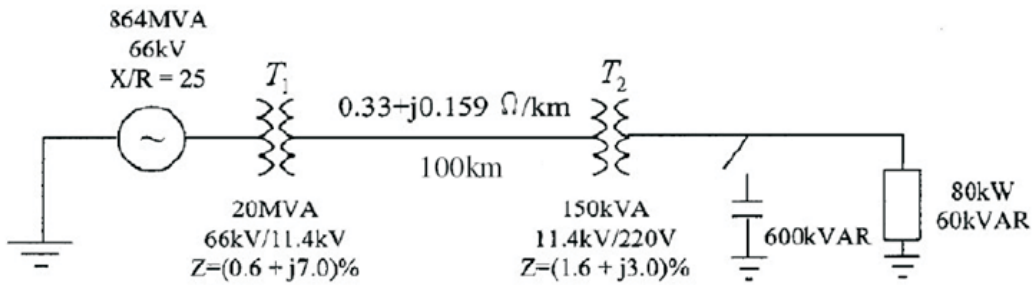


Figure 1. Single line diagram of the sample power system used

4. RESULTS & DISCUSSIONS

The analyzing wavelet adopted in this study is the “Db 4” as it is the most localized, i.e. compactly supported, in time. For the signal analysis discrete wavelet transform (DWT) multi-resolution signal decomposition (MSD) technique is used, which decomposes the signal into its detailed and approximated versions at each wavelet decomposition level. Simulated results are obtained using MATLAB R2009b software.

4.1. IDENTIFYING THE DISTURBANCE In this step, through Eq. (1), the energy concentrated in 10 wavelet coefficient levels is calculated and plotted. The results are shown in Figure 2 (a). The 10th level holds the biggest part of the signal energy. The 4th level also keeps also an important parcel of it. The remaining levels practically do not add so much important parcel to the signal energy. In order to spot these differences, the Eq. (2) is used. This equation allows the calculation of the deviation between the energy distributions of the signal in study at each wavelet transform level. The result of this, the deviation curve, is illustrated in Figure 2 (b). This curve “magnifies” the deviations of the signal with disturbance from the corresponding pure sinusoidal one. The curve of Figure 2 (c) is within the “family of patterns” for voltage-sags. This will be shown in the ongoing sections.

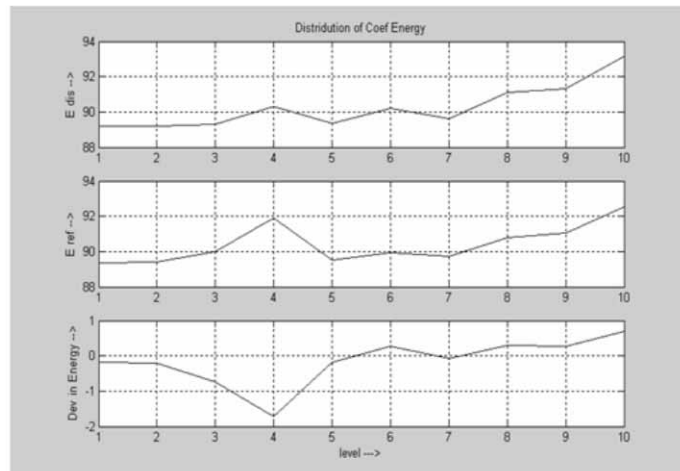
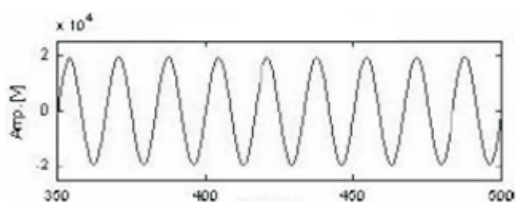
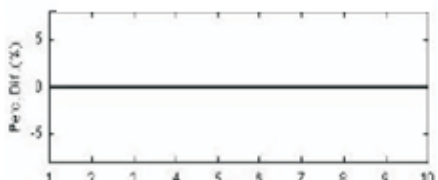
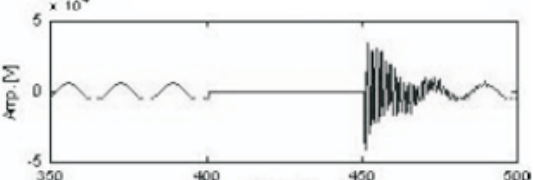
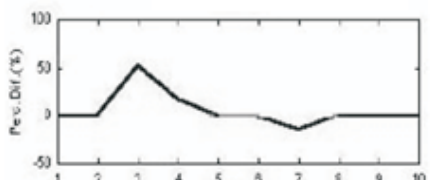
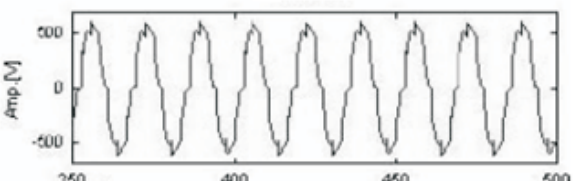
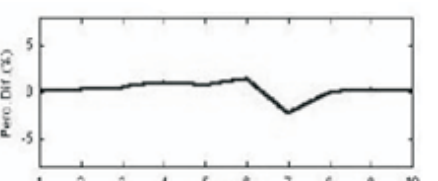
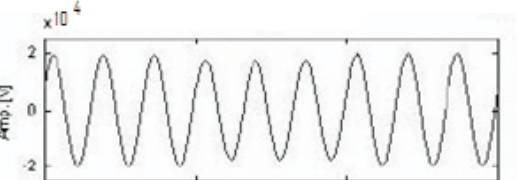
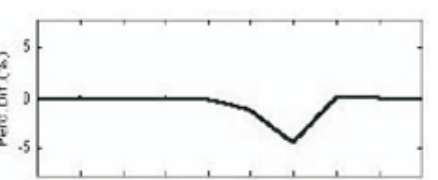
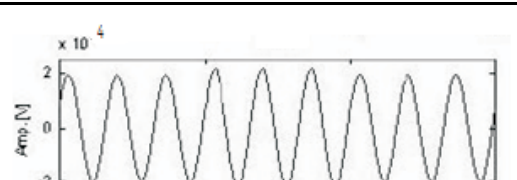
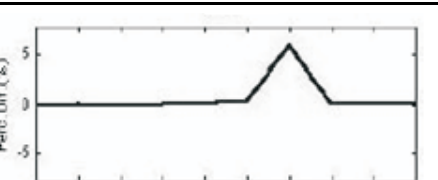
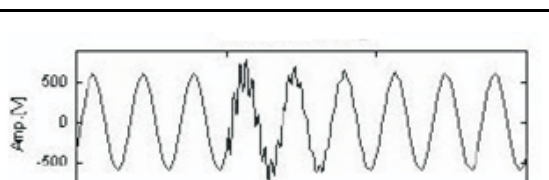
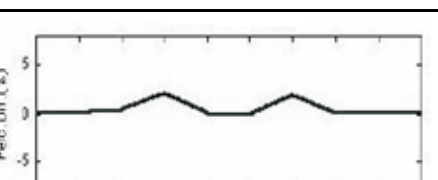
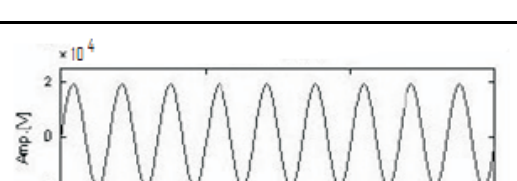



Figure 2. Distribution of the energy in 10 wavelet coefficient levels : (a) energy distribution for distorted signal; (b) energy distribution for pure sinusoidal signal; (c) deviation between the two energy distribution patterns

Using the same steps for simulation, patterns for other power quality problems are obtained which are summarised here.

Table 1. Some voltage signals with a power quality disturbance and corresponding deviation in energy distributions: (a) study reference: pure sinusoidal wave; (b) a short-circuit event; (c) a harmonic distortion; (d) a voltage sag; (e) a voltage swell; (f) a capacitor bank switching transient; (g) an inductive- resistive load switching transient

No.	Power Quality DisturbanceSignal	Distribution of Energy Deviation
(a)		
(b)		
(c)		
(d)		
(e)		
(f)		
(g)		

5. CONCLUSION

The paper presents the use of some wavelet transform features and multi-resolution signal decomposition and reconstruction techniques as powerful analysis tools which is able to detect and to locate in time, as well as to classify the power quality disturbances on the basis of generated pattern or signature. The property of multi-resolution signal analysis shows the ability of the technique to extract important information from the analyzed distorted signal. The main advantage of the proposed method comes from its ability to separate power quality problems that overlap in both time and frequency. Using the localization property gained from the liner resolution levels and the curves of energy deviation, a time-frequency picture of the distorted signal is constructed. It has been shown that the power quality disturbances have unique deviations in their curves of energy from their corresponding pure sinusoidal waveform curve of energy. The shape of the curves of energy deviation is changed with time to represent the energy distribution of the distortion at different frequency bands at certain time. This feature is adopted to provide a classification of the type of disturbance. The proposed deviation in energy distribution feature vector presents a simple classification role for the operator to detect, localize, and classify different power quality problems. This feature vector is characterized into different shapes where each shape can be used to monitor and classify power quality phenomena. Furthermore, using the proposed scheme one can distinguish among similar power quality problems. It can also help in finding the source of disturbance as particular a disturbance is occurred due to certain happenings (sources) in the power system, not due to the all.

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OPTIMIZATION OF YTTERBIUM FIBER LASER PARAMETERS BASED ON RESPONSE SURFACE METHODOLOGY, DURING MACHINING OF 5MM THICK EN353 STEEL

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ABSTRACT

This paper presents the investigated results on machining of 5mm thick EN353 steel by Ytterbium fiber laser. The effects of the different parameters on the Material Removal Rate (MRR) are explained through various graphs. A mathematical model for correlating the interactive and higher-order influence of various machining parameters such as laser power, modulation frequency, gas pressure, cutting speed, pulse width on the metal removal rate has been developed for achieving control over fiber laser machining process. The Response Surface Methodology (RSM) is adopted for optimization the machining parameters for maximum Material Removal Rate.

Key words: Fiber laser machining, RSM, metal removal rate, ANOVA, MRR

1. INTRODUCTION

Various non-traditional machining processes such as AWJM, ECM, EDM, WEDM, AFF etc. have shown their scope of applications towards the machining of 5mm thick EN353 steel but these processes have also their own limitations and still remain machining problems like low material removal rate, high surface roughness and poor dimensional accuracy etc. Flemming Ove Olsen, Klaus Schuett Hansen, and Jakob Skov Nielsen have explained in their paper that the first results of proof-of-principle studies applying a new approach for laser cutting with high brightness and short wavelength lasers will be presented. In the approach, multi beam patterns are applied to control the melt flow out of the cut kerf resulting in improved cut quality in metal cutting. The beam patterns in this study are created by splitting up beams from two single mode fiber lasers and combining these beams into a pattern in the cut kerf. The results are obtained with a total of 550 W of single mode fiber laser power. Burr free cuts in 1 mm steel and aluminum and in 1 and 2 mm AISI 304 stainless steel is demonstrated over a wide range of cutting rates. The industrial realization of this approach is foreseen to be performed by either beam patterning by diffractive optical elements or multi beam fiber laser arrangements. [1]. Tsai and Chen [2] proposed an explanation for why the focused Nd:YAG laser is used to scribe a groove-crack on the surface of substrate and the defocused CO₂ laser is used to introduce thermal stress. An excimer laser was used to study the basic mechanism roughening the surface of silicon carbide by Tonshoff and Kappel [3]. Tsai and Li [4] stated that the under water laser drilling quality of LCD glass and alumina substrates is much better than that from laser drilling in air. A three dimensional thermal model was developed for a laser assisted machining process and validated the developed model by comparing predicted surface temperature histories with measurements made using a focused laser pyrometer by Rozzi et al [5]. Laser beam machining can be applied to a wide range of materials such as metals and non metals, soft and difficult to machine materials, and response surface methodology (RSM) is the best method for parameters optimization with reduced number of experiments without affecting the accuracy of results but qualitative variables can not be optimized [6]. Quality problems in fiber-laser cutting have until now limited its application to metal cutting. Laser machining is a thermal process, the effectiveness of this process depends on thermal and optical properties of the material and hence laser machining is suitable for materials that exhibit a high degree of brittleness, hardness and have favorable thermal properties as explained by Kacar et al [7].

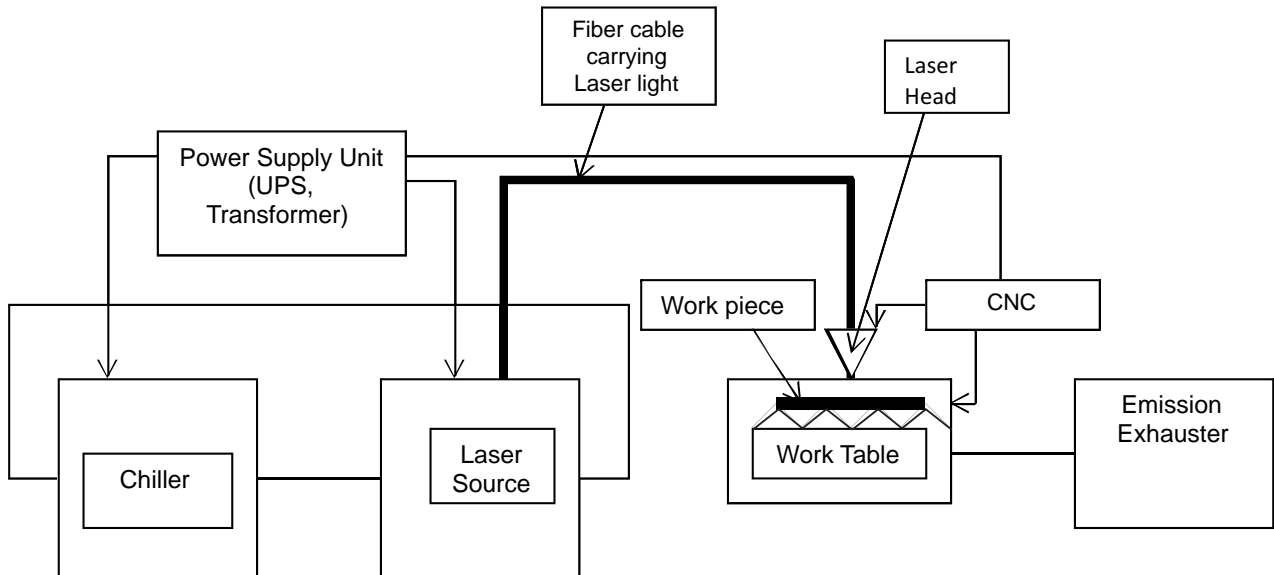


Figure 1 Schematic representation of the Ytterbium Fiber Laser machining system

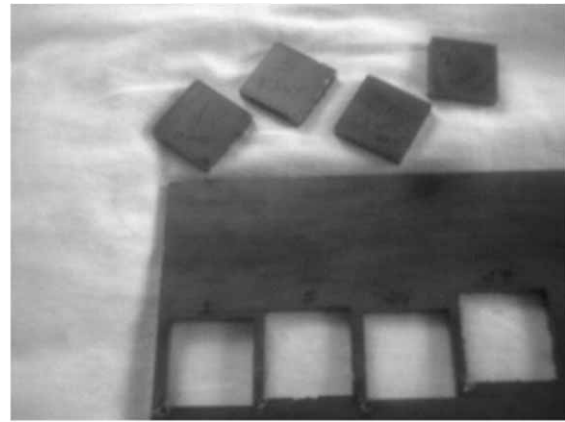


Figure-2 ytterbium laser machining is done on 5 mm thick EN353 steel.

An Ytterbium laser machine YLR 1000 with CNC system RP 3015 was used for experiments.

Table 1 represents the detail specification of Ytterbium laser machine YLR 1000.

Table-1 Specification of Ytterbium Fiber Laser Machine

	YTTERBIUM FIBER LASER (ULTRA RED, 1 μ WAVE LENGTH)(YLR 1000)		
	parameter	YLR1000	unit
cw power	nominal output power	1	kw
beam	a. emission wave length	1070-1080	nm
	b. beam parameter prpodct	6	mm*rad
	c. output fiber core dia. Of feeding fiber	150	μ m
	d. fiber length	10	m
	e. polarization	random	
gas	no laser gas used		
electrical	a. operating voltage(3 phase)	400-460	volt ac
	b. power frequency	50/60	Hz
	c. power consumption	8	kw
cooling	a. Laser cooling water temperature range	22-24	degree C
	b. Laser cooling water flow rate	5	Lt/min
environment	a. operating ambient air temp. range	10-50	degree C
	b. humidity with built in conditioner	95	%
	c. storage temp.	-40	degree C
Dimensions	W x D x H	856 x 806 x 1186	mm
weight	weight	330	kg

2. EXPERIMENTAL PLANNING

Table 2 represents the chemical composition of EN353 steel. Table 3 represents the chemical composition of stir cast 5mm thick EN353 steel sample used for experiments. Table 4 represents the physical and mechanical properties of EN353 steel used for experimental investigations.

Table 2 Chemical composition of EN353 steel

EN353 steel	C	Si	Mn	S	P	Ni	Cr	Mo
	0.18	0.26	0.93	0.008	0.016	1.34	1.11	0.11

Table 3 Composition of 5mm thick EN353 steel used for experiment

EN353 steel	C	Si	Mn	S	P	Ni	Cr	Mo
	0.18	0.26	0.93	0.008	0.016	1.34	1.11	0.11

Table 4 Properties of 5mm thick EN353 steel used for experiment

Properties	Density(g/cc)	Ultimate tensile strength (MPa)	Grain size (ASTM)	group
	7.8	760	7	Case hardened steel

Table 5 Machining parameters, actual setting values and their coded levels

Sr.No.	Machining Parameters	Symbol	Units	Level				
				-2	-1	0	1	2
1	Laser power (W)	x_1	Watt	400	500	700	900	1000
2	Modulation frequency(Hz)	x_2	Hz	600	700	800	900	1000
3	Gas pressure (bar)	x_3	bar	1	2	3	4	5
4	Cutting speed (m/min)	x_4	m/min	0.5	0.7	0.9	1.1	1.3
5	Pulse width (%)	x_5	%	75	80	90	95	100

Table 6 shows the components of the central composite second-order rotatable design

Table 6 Components of central composite second-order rotatable design

No.of Variables (k)	Repli-cation	Factorial Block(s) : FB					Axial Block(s):AB			Total no. of points in FB & AB	Value of
		Factorial points (n_f)	No. of Block	No. point in each Block	No of centre points (n_{cf})	Total no. of points	Axial points (n_a)	Cent-ral point (n_{ca})	Total no. of points		
5	$\frac{1}{2}$ Replication	16	1	16	6	22	10	1	11	33	2.00

3. EXPERIMENTAL RESULTS

Table 7 also represents the experimentally obtained results for response 1 i.e. MRR

Table 7 Plan for CCD; different controlling parameters and results

Run	x_1	x_2	x_3	x_4	x_5	MRR, g/s (Response 1)
1	-1	-1	-1	-1	1	1.228
2	1	-1	-1	-1	-1	1.229
3	-1	1	-1	-1	-1	1.230
4	1	1	-1	-1	1	1.638
5	-1	-1	1	-1	1	1.638
6	1	-1	1	-1	1	2.047
7	-1	1	-1	-1	1	2.048
8	1	1	1	-1	-1	2.049
9	-1	-1	-1	1	-1	2.047
10	1	-1	-1	1	1	2.047
11	-1	1	-1	1	1	2.048
12	1	1	-1	1	-1	2.047
13	-1	-1	1	1	1	1.229
14	1	-1	1	1	1	1.228
15	-1	1	1	1	-1	1.230
16	1	1	1	1	1	1.638
17	-2	0	0	0	0	1.638
18	2	0	0	0	0	1.638
19	0	-2	0	0	0	1.639
20	0	2	0	0	0	1.640
21	0	0	-2	0	0	1.641
22	0	0	2	0	0	2.047
23	0	0	0	-2	0	2.048
24	0	0	0	2	0	2.049
25	0	0	0	0	-2	1.228
26	0	0	0	0	2	1.229
27	0	0	0	0	0	1.230
28	0	0	0	0	0	1.229
29	0	0	0	0	0	1.365
30	0	0	0	0	0	1.445
31	0	0	0	0	0	1.228

5. MATHEMATICAL MODELING AND PROCESS OPTIMIZATION

5.1 MATHEMATICAL MODELS FOR MRR The developed mathematical model based on RSM for correlating the MRR with various predominant laser machining process parameters as considered in the experimental design as follows,

$$YMRR = 0.1.3404 + 0.0719.x_1 - 0.0250.x_2 + 0.1702.x_3 + 0.0893.x_4 - 0.0548.x_5 - 0.0609.x_1.x_2 + 0.0279.x_1.x_3 + 0.3528.x_1.x_4 - 0.1855.x_1.x_5 - 0.0171.x_2.x_3 - 0.4905.x_2.x_4 + 0.6821.x_2.x_5 - 1.1908.x_3.x_4 - 0.3218.x_3.x_5 - 0.2510.x_4.x_5 + 0.2621.x_1^2 + 0.2848.x_2^2 + 0.4895.x_3^2 + 0.6942.x_4^2 - 0.1512.x_5^2 \dots\dots\dots(1)$$

5.2 ANALYSIS OF VARIANCE AND MODEL FITMENT TEST Table 8 represents the results of ANOVA for checking the adequacy of developed mathematical models.

Table 8 Results of analysis of variance for MRR

Source of variation	d.o. f.	Sum of squares	Mean square	F-value	P-value
		MRR (Eqn. 5)	MRR (Eqn. 5)	MRR (Eqn. 5)	MRR (Eqn. 5)
Second -order terms	20	3.1550	0.1577	6.1847	0.0026
Lack of fit	6	0.2144	0.0357	-	-
Experimental errors	4	0.0406	0.0101	-	-
Total	30	3.4101	-	-	-

From Table 8, it is concluded that the laser power, modulation frequency, gas pressure, cutting speed, pulse width are significantly influencing for controlling MRR as the P-value for both the responses are less than 0.05. The F-test values for both the responses at 95% confidence level are 6.1847. The value of $R^2(\text{adj})$ for MRR are 0.78. These values are above the average value and developed second order models fits the data, therefore, the data for both the response are well fitted in the developed second order models.

5.3 PARAMETRIC ANALYSIS ON MACHINING CHARACTERISTICS OF YTTERBIUM FIBER LASER

5.3.1 PARAMETRIC INFLUENCES ON MRR

Figure 3 shows the combined effects of assist gas pressure and laser power on MRR. From figure 3, it is clear that the MRR increases with moderate laser power and maximum MRR observe at laser power in between 700 to 775 Watts. MRR also increase with increase in gas pressure. Based on RSM analysis, it is found that optimal MRR is achieved at 2.5 bar gas pressure. The experimental results reveals that comparatively high gas pressure and moderate laser power are found to be favorable for higher MRR [8].

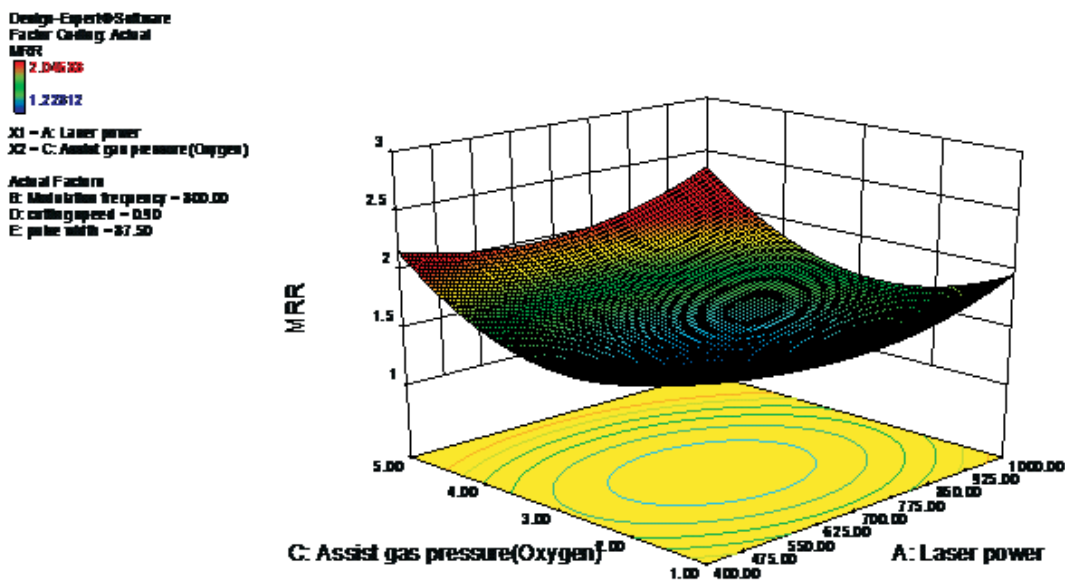


Figure 3 Response surface plot of MRR with gas pressure and laser power

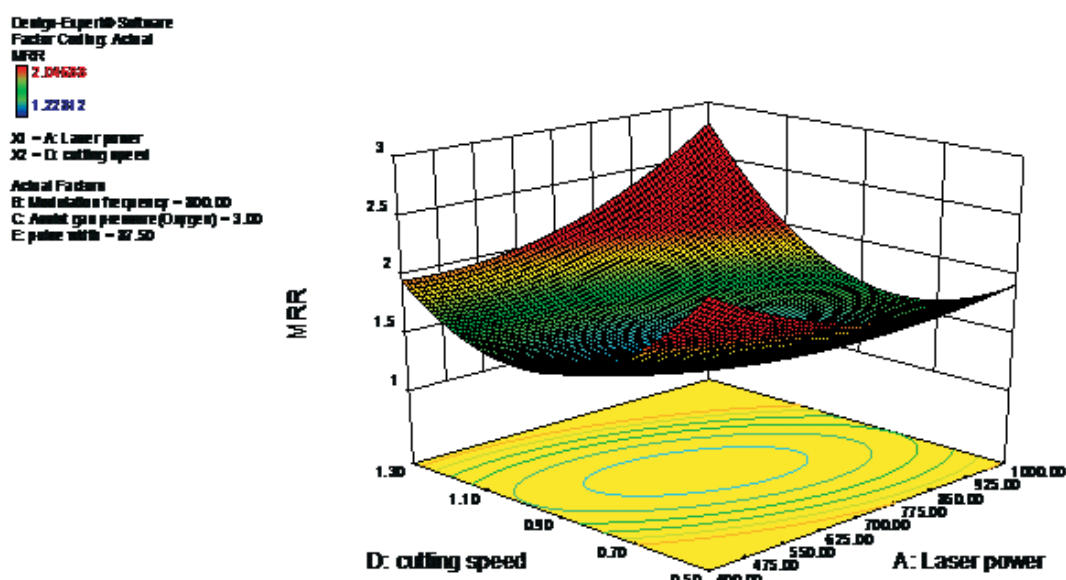


Figure 4 Response surface plot of MRR with cutting speed and laser power

Fig. 4 shows the combined effects of wait cutting speed and laser power on MRR. From Fig. 4, it is clear that the MRR increases with decrease of cutting speed and decrease of laser power. The experimental results reveals that the comparatively moderate laser power with moderate cutting speed are found to be favorable for higher MRR.

Table 9 Optimal values of process parameters for maximized MRR

Experimental validity search on MRR				
Process parameters	Actual values of parame-tric combination	Value obtain-ed from Eqn.5	Value obtain-ned from experi-ment	Error
Laser power (W)	526	3.7964	3.8014	0.005
Modulation frequency (Hz)	863			
Gas pressure (bar)	4.99			
wait time (s)	0.54			
pulse width (%)	80.13			

6. CONCLUSION

The Ytterbium fiber laser has a capability to perform successful quality to cut 5 mm thick EN353 steel. The Ytterbium fiber laser process parameter can be possibly controlled for effective cutting of 5 mm thick EN353 steel. Based on the machining of 5mm thick EN353 steel by Ytterbium fiber laser the following outcome can be concluded on the basis of the developed mathematical relations as follows:

- The material removal rate increases with moderate laser power and maximum material removal rate observed with in the range of 775 to 850 Watt laser power.
- MRR increases with moderate laser power and maximum MRR observe at laser power in between 700 to 775 Watts. MRR also increase with increase in gas pressure. Based on RSM analysis, it is found that optimal MRR is achieved at 2.5 bar gas pressure.

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DEFECT MINIMIZATION BY USING PROBLEM SOLVING TOOLS: A CASE STUDY

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ABSTRACT

Defect minimization is crucial during manufacturing and assembly stages of various products, as it affects quality as well as productivity. In this study a case of Apex Automotives, located in NCR India, is taken up for identifying the defects that arise during manufacturing, assembly of the product known as “Wire Crimping”. The company supplies a wide range of automobile components to leading automobile manufacturers in India. During the crimping of wire, a large number of defects take place. During the study, overall 27 defects have been identified. Out of these, 5 have been identified as major ones and taken up for further analysis. These defects are Side Deform Defect-163 (36.03%), Strands Out-64(14.25%), Conductor Out-49 (11.35%), Terminal Bend-37(8.24%), No Bell Mouth-22 (4.89%). After using quality control tools the root causes of these defects have been identified and the remedy proposed.

Key words: Wire Crimping, Crimping Defects, Quality Improvement, Manufacturing Defects Minimization.

1. INTRODUCTION

The need for quality control and quality assurance in all areas of industrial production as well as in the service industry is greater today than ever. It is not possible to produce a desired quality and maintain it consistently over a length of period unless adequate control is exercised at every stage. Quality management should be taken as continuous phenomenon, implying that there is no end to improvement; it is unending process. As the technologies used in the production become more advanced, quality control techniques also have to keep pace [1]. It is not sufficient any more, to just inspect the end product and control the quality from the observations of the inspector. Quality control has to be systematically introduced from the very beginning of production, or rather at the design stage and followed up till the finished product has been put into performance. Quality control thus deals with the system to establish and achieve the desired standard of quality and performance. Such a system of quality control is commonly termed as total quality control. [2].

Many organizations in automobile sector are facing the problem of high rejection rate of their components. This high rejection rate is due to substandard/poor quality of the component. The poor quality not only affects the performance of the specified product but is also harmful for various business issues. Due to this the point of contact between people and product become the point of friction between them and it leads to customer dissatisfaction. There is always a need for continuous improvement in the quality of the product, so that to enhance the customer satisfaction level. In this study an effort is made to reduce the rejection rate of the component/product by systematically using the quality control tools.

2. DATA COLLECTION AND DEFECT IDENTIFICATION

Apex Automotives Pvt. Ltd, located in NCR, India. The company supplies a wide range of automobile components to leading manufacturers in India. We took one of the widely used components that are used in automobiles. The process for manufacturing this product is 'wire crimping'. During the crimping of wire large number of defects takes place. Before moving to the description it is necessary to understand the meaning of crimping. Crimping is joining two pieces of metal or other malleable material by deforming one or both of them to hold the other. The bend or deformity is called the crimp. Crimping is most extensively used in metalworking. Crimping is commonly used to join bullets to their cartridge cases, and for rapid but lasting electrical connectors. As it can be a cold-working technique, crimping can also be used to form a strong bond between the work piece and a non-metallic component. Sometimes, a similar deformity created for reasons other than forming a join may also be called a crimp. Crimping can be done by manually as well as by crimping machine. This component is used in automobiles to provide the electrical connection between different parts and power source so that the proper power can be flow in the whole system. Figure no.1 shows the process of manual wire crimping. The process flow chart of the wire crimping process is shown in Figure no.2

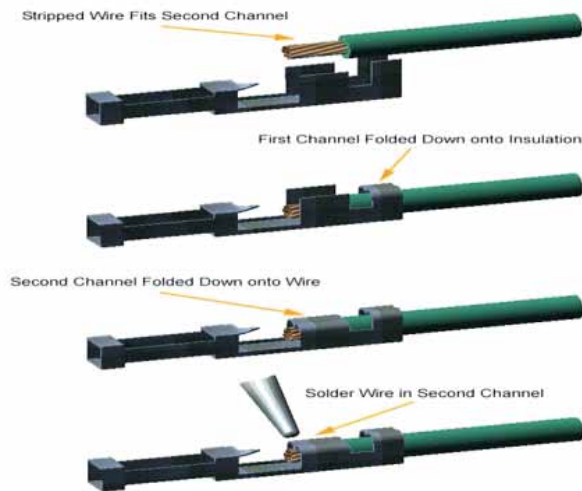


Figure1: Manual Wire Crimping Process

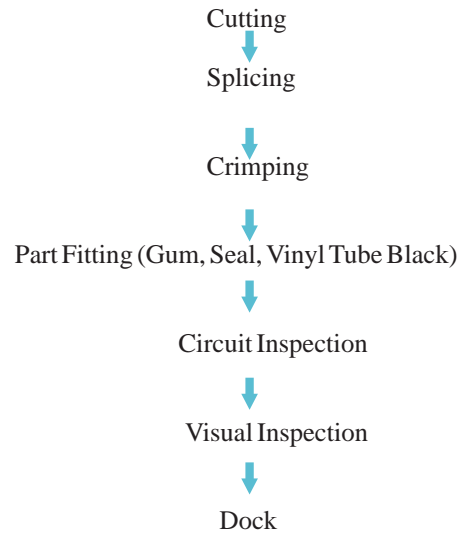


Figure2: Flow chart for wire crimping process

Data was collected in the form of two reports one is self inspection and other is middle inspection report for the month of January 2011 to find out various crimping defects. After in- depth analysis of both the reports we were able to summarize the data in terms of total number of each defects and their respective percentage contribution in over all defects. The following table shows the summarized data.

Table 1: Various Crimping Defects

S. No.	Defect	No. of Defects	%	Cumulative Defect %
1.	side deform	163	36.3	36.3
2.	strands out	64	14.25	50.55
3.	conductor out	51	11.35	61.9
4.	terminal bend	37	8.24	70.14
5.	no bell mouth	22	4.89	75.03
6.	wire length excess	15	3.34	78.37
7.	wire size wrong	15	3.34	81.71
8.	low core	14	3.11	84.82
9.	PVC cut	14	3.11	87.93
10.	vinyl barrel damage	9	2	89.93
11.	mouth press	7	1.55	91.48
12.	low insulation	6	1.33	92.81
13.	twisting	4	0.89	93.70
14.	wastage bend	4	0.89	94.59
15.	seal missing	4	0.89	95.48
16.	down bend	3	0.66	96.14
17.	deform	3	0.66	96.80
18.	bell mouth excess	3	0.66	97.46
19.	terminal damage	2	0.445	97.90
20.	seal cut	2	0.445	98.35
21.	high insulation	2	0.445	98.79
22.	conductor marking	1	0.22	99.015
23.	joint problem	1	0.22	99.23
24.	terminal missing	1	0.22	99.45
25.	pressing problem	1	0.22	99.67
26.	terminal without	1	0.22	99.99
27.	high core	0	0	100 app.

From the above table, it is observed that basically there are 27 different types of crimping defects like strands out, side deform, conductor out, bell mouth press, length variation, twisting, terminal bend, PVC cut, low core, high insulation etc. Out of these 27 defects the prominent defects that affect the quality of the final product to a great extent are represented below-

- 1) Side deform defect-163(36.03%)
- 2) Strands out-64(14.25%)
- 3) Conductor out-51(11.35%)
- 4) Terminal bend-37(8.24%)
- 5) No bell mouth-22(4.89%)

Therefore our study is focused on analysis and reduction of these defects by using various quality control tools. For the purpose of this study three main defects Side deform, Strands out and Conductor out are taken up for analysis by using only Quality control tools like Fishbone or cause and effect diagram and control charts, flow diagram.

3. DATA ANALYSIS

3.1 SIDE DEFORM DEFECT In side deform defect the terminal is deformed either from right or left side. For proper adjustment with the opposite mating part shape of the terminal should not be changed. The contribution of this particular defect among all the defects is 36.03%.

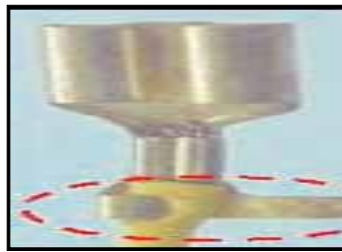


Figure3: Side Deform Defect

3.2 STRANDS OUT DEFECT As shown in table no.1 it can be seen that the strands out is second most prominent defect. In case of Strands out defect few of the conductors coming out from any side of conductors barrels and remaining are inside the barrel. This causes the strength problem while fitting with opposite terminal.



Figure 4: Strands out

3.3 CONDUCTORS OUT DEFECT The conductor out defect is shown in figure no.3 as seen from the figure the conductor is coming out from the conductor barrel, so it is called as conductor out defect.



3.1.2 CAUSE AND EFFECT DIAGRAM The various causes and their effects that lead to side deform defect are identified and are represented in the form of cause and effect diagram [3].

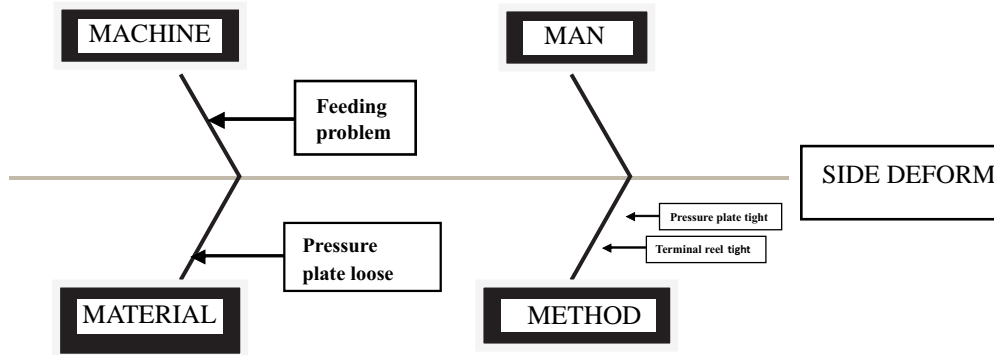
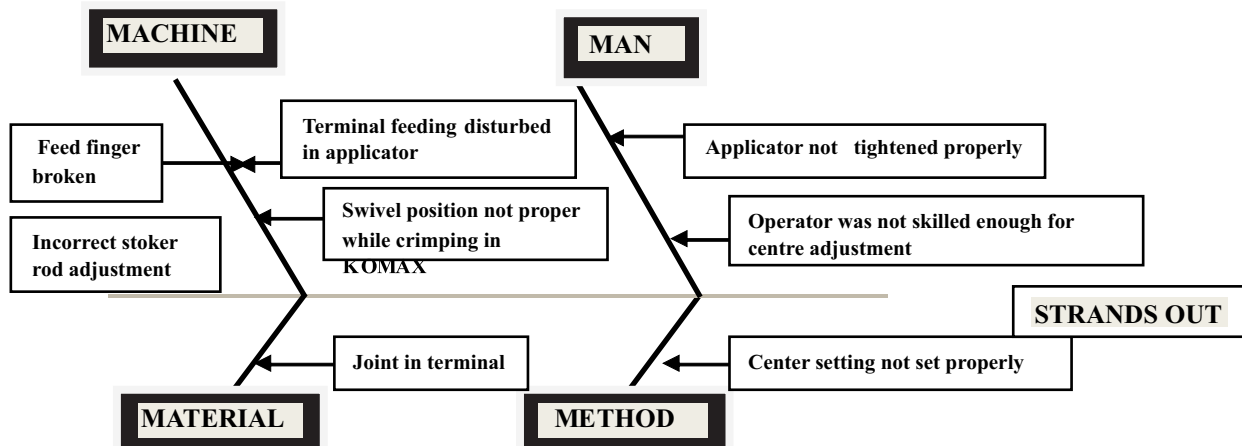


Figure 6: Cause and effect Diagram for Side Deform Defect

On analyzing the cause and effect diagram, the causes responsible are validated to determine the main root cause of the problem. In this case, for side deform defect, the root cause for these defects is mainly machine. On analyzing the data of self & middle inspection report we identify that main problem is feeding problem for side deform defect. After overall analysis we calculate that 63% problems of side deform defects are generated due to feeding problem.

3.2.2 CAUSE AND EFFECT DIAGRAM FOR STRANDS OUT DEFECT

Root cause for can be easily understood by cause & effect diagram or fishbone diagram



3.3.2 CAUSE AND EFFECT DIAGRAM FOR CONDUCTOR OUT DEFECT

The various causes that leads to side deform defect are identified and are represented in the form of cause and effect diagram.

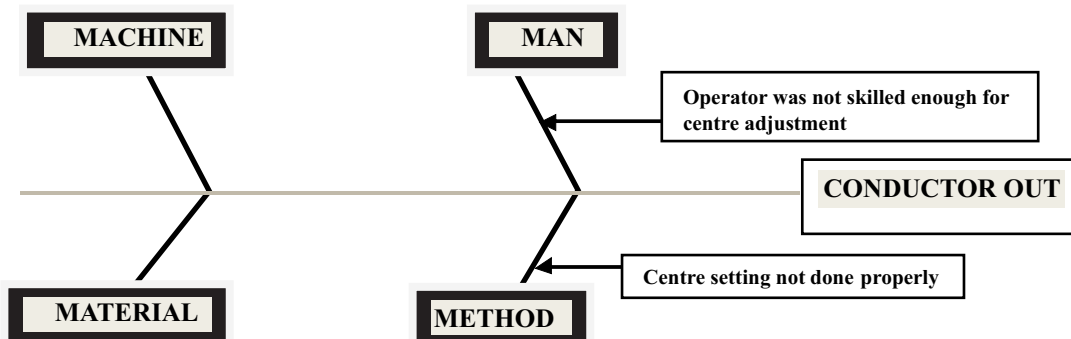


Figure 8: Cause and Effect Diagram for Conductor out Defect

From above cause & defect diagram we find out mainly two reasons for conductor out defect:

1. Centre setting not done properly and
2. Operator problem.
3. These above-mentioned reasons contribute 50-50% for generation of conductor out defect

The results obtained from the cause and effect diagram are further analyzed and thorough discussion was carried out with engineers in QC department. All the methods are recommended on the basis of group discussion and a number of brainstorming sessions between us and engineers / operators working on various machines. The following methods were suggested and implemented on a trial basis.

4. PROBLEM SOLUTION

4.1.1 SIDE DEFORM

After identifying the causes of damages through cause and effect diagram, it was found that following are the main reasons for side deform defect:

1. Feeding problem
2. Pressure plate loose/tight problem
3. Terminal reel tight

The factors responsible for feeding problem are:

- Low feed rate,
- Feeding of wire is not properly,
- Tightening of cam,
- Pressure distribution is not standard.

Method recommended

The solution of this problem is feed rate and pressure distribution should be standardized.

4.1.2 STRANDS OUT

After analyzing the whole procedure and data collection, we find out the following causes for Strands out defect:

1. Feed finger broken
2. Incorrect rod adjustment
3. Terminal feeding disturbed in applicator
4. Swivel position is not proper while crimping in KOMAX
5. Applicator not tightened properly
6. Operator was not skilled
7. Joint in terminal
8. Center setting not properly
9. Wrong wire die combination

During investigation it was found that the self inspection was not done by operator properly. Hence we can say that for all above causes operator is responsible either directly or indirectly.

Method recommended

Strands out defect can be minimized by providing proper training to all the associates.

4.1.3 CONDUCTOR OUT

Based on cause and effect diagram & validation of causes, “centre adjustment is not proper” was found to be the root causes for conductor out defect.

Method recommended

1. Procedure for the centre adjustment must be standardized
2. Module will be made in HINDI for centre adjustment
3. Retraining should be given to all associates

4.2 WHY-WHY ANALYSIS

Curiosity is a marvelous part of the human mind. Our curiosity causes us to analyze and isolate critical root-causes and corrective actions via the Why-Why approach as follows.

This basic procedure is meant to effectively and efficiently utilize time, funds, and human resources to eliminate problems (e.g., problems in terms of quality, price, delivery, safety, or environment protection) in any operation, ensure customer satisfaction, and maintain employee participation. Numerous recurrent problems have been observed in various forms of processing, not only in production sectors but also in clerical offices; and most of the time, the responses to those processing problems are merely remedial type patchwork. Some of those recurring problems occur many times an hour and waste much money. [4].

4.2.1 Fact-finding relationships flowchart and the why approach for “Side deform defect”

These summarization charts are eventually formed as failure mechanism flowcharts for identification and isolation of problem causes and establishment of corrective action. Doing this (Answering why) five times to find probable causes to root cause is the 5 why approach. In this approach 5 types of question asked to find out root cause (facts). These 5 facts are as follows:

1. What happened
2. Where
3. When
4. Who observed it
5. How it happened (4)

The following diagram shows the fact- finding relationship for side deform defect..

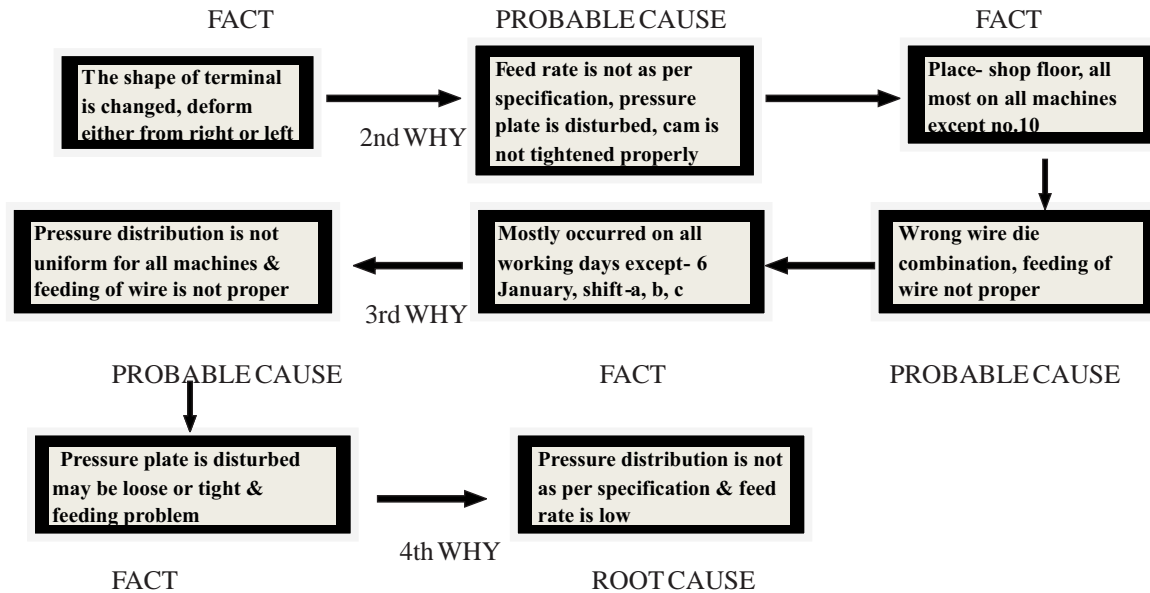


Figure 9: Flow diagram for finding root cause for Side deform defect by WHY-WHY approach

From the above chart it has been seen that the probable causes for side deform defects are feed rate problem, centre adjustment problem, pressure plate disturbed etc. But after implementation we find that the major root cause feed rate of wire is low & pressure distribution is not as per specification.

Both of these causes can be eliminate by providing the proper feed rate to the wire and uniform distribution of pressure to all machine as per specification. By using these methods we are able to minimize the defects up to 14%.

4.2.2 Probable Causes to Root Causes by 5 why approach for Strands out defect

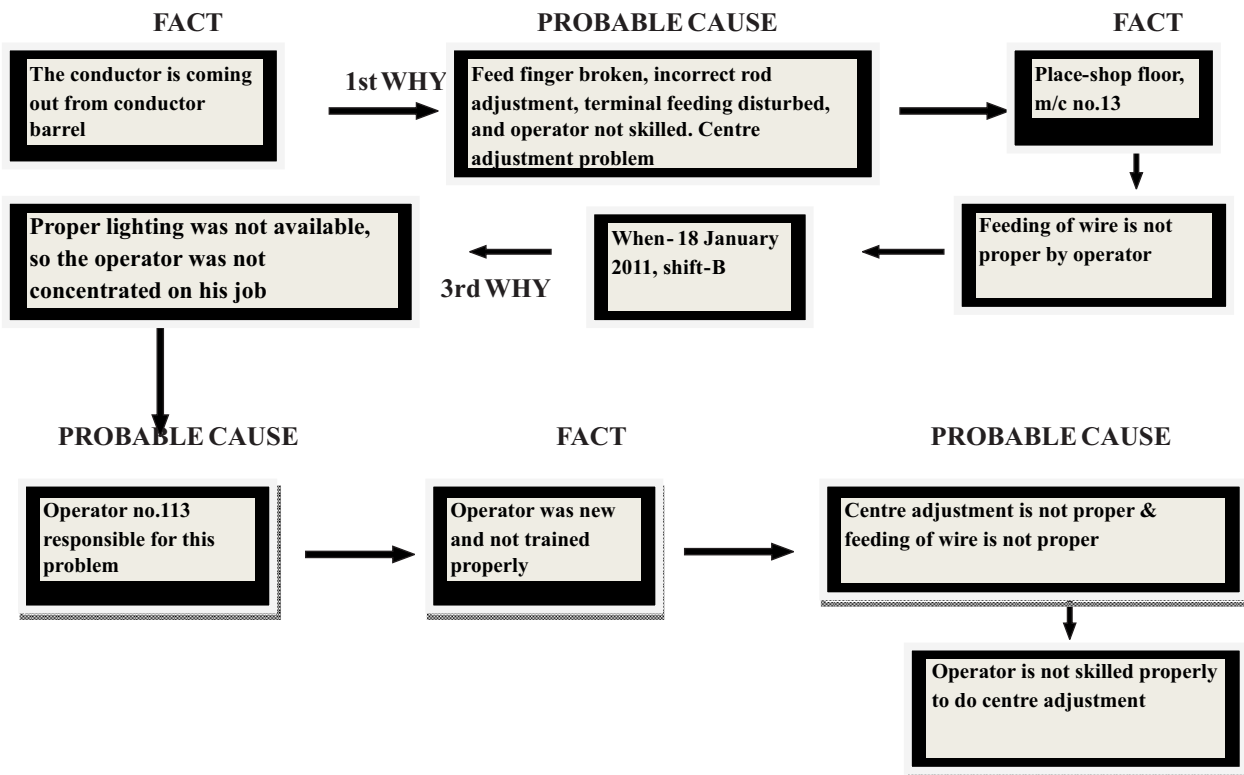


Figure 10: Flow diagram for finding root cause for strands out defect by WHY-WHY approach

From the above flow chart we find out the root cause for stands out defect which is that the operator is not skilled to do proper center adjustment & to provide proper feed rate to the wire. The only remedy to minimize this defect is by providing the training to all the operators. By implementing the recommended methods we were able to minimize the defects from 14.25 % to 3.3%.

4.2.3 Probable Causes to Root Causes by 5 why approach for conductor out defect

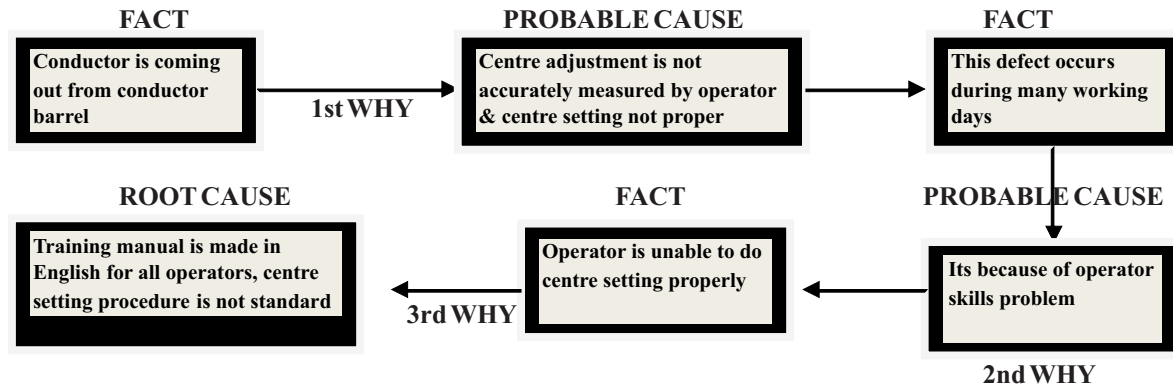


Figure 11: Flow diagram for finding root cause for conductor out defect by WHY-WHY approach

By implementing only 3-why approach we were able to find out the root causes. Conductor out defect mainly occurs due to the operator problem. In the data collected from the company we observed that this defect arises 51 times in January 2011 month and out of which 46 times it is due to operator problem. So we can say that the process can be controlled by providing the proper training to all the operators. Similarly the technique can be applied for terminal bend defect & No bell mouth defect to find out the root cause and elimination of these causes to improve the quality of product.

5. RESULTS AND RECOMMENDATIONS

With this paper it is understood that problem solving tools play a vital role in minimizing defects and improving overall performance of a product. The study has helped us to identify major defects that arise during wire crimping process. These major defects are further analyzed by using Cause and Effect diagrams, and why-why analysis. The root cause for the defects is fixed and corrective methods have been suggested.

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OPTIMUM INSULATION THICKNESS OF BUILDING WALLS FOR ENERGY SAVING

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ABSTRACT

In the paper, we discuss about the Energy saving in building walls by using the optimum insulation thickness. Heat loads are used as input to an economic model for the determination of optimum insulation thickness. The Optimum insulation thickness, Energy savings and Payback periods are calculated by using life-cycle cost analysis over life time of 10 years of the building. Glass wool and Extruded Polystyrene (XPS) are selected as an insulation material. Generalized charts for selecting the optimum insulation thickness as a function of Degree-Days and wall thermal resistance are prepared. In this study, the optimum insulation thickness of external walls for various wall materials (Stone, Brick and Concrete) and different fuel types (Coal, LPG, Electricity, Natural Gas and Fuel-oil) have been calculated. Heating loads were calculated by Degree-Day method. It was found that as the optimum insulation thickness varies between 3.14 cm and 8.47 cm, energy saving in the term of money varies between Rs. 216.96/m² and Rs.1986.26/m² and Pay-back period varies between 1.43 and 5.64 years depending on the climate, the type of wall, the insulation material and the cost of fuel.

Key words: Optimum insulation thickness; Degree-Days; Life cycle cost method; Energy saving

1. INTRODUCTION

Energy strategy of any country is energy saving. Due to limited energy sources, high cost of energy sources and Environment pollution coming from using the fuels, Energy saving has become compulsory. Thermal insulation is one of the best methods to achieving Energy conservation in building. Rate of Energy consumption is increasing rapidly due to population growth and urbanization. Population growth means constructing more buildings which gives rise to energy expenditure. Energy loss in building elements arises due to building envelope which contains walls and roofs. The external walls of building are the interface between its interior and the outdoor environment. Therefore, using insulation is an option for minimizing the energy loss. Energy efficiency of external wall depends on position of insulation. The most suitable fuels for India are LPG and Electricity is the highest energy sources and in rural areas, LPG is the highest energy sources. The concept of Life Cycle Cost is used to determine the optimum insulation thickness. Numerous studies have been conducted to optimize the thermal insulation thickness based on Degree-Days.

The purpose of the present paper is to show the optimum insulation thickness for the different wall type; Stone, Brick and Concrete, which are usually used in building construction in India. The optimization is based on a life-cycle cost analysis. The life cycle cost analysis is used in this study. Life cycle cost analysis (LCCA) is used to calculate the optimum insulation-thickness. The heat losses in building occur through external walls, windows, ceiling, floor and air infiltration. We considered heat loss from external wall only.

To fulfill the outline of the present paper, a literature review followed with scope of paper is given as follows. Arici et. al. [1] determined the optimum air layer thickness of double glazed windows considering the both heating and investment cost. The effect of five different fuels types (Natural gas, Coal, Fuel oil, Electricity and LPG) is considered to determine the optimum air layer thickness. Bolatturk.A. [2] have calculated the optimum insulation thickness on external walls of buildings based on both annual heating and cooling loads. Annual cooling and heating loads were calculated using the degree-hours method by considering solar radiation. Chen et. al. [3] investigated the energy consumption in china by statistical method. The statistical

method is applied to measure residential energy consumption by case studies, in order to validate the feasibility of method.

The statistical index system of residential energy consumption is constituted with refers to housing unit characteristics, household characteristics, possession, utilization of energy consuming equipment and residential energy consumption quantities. Daouas, N.[4] calculated the Optimum insulation thickness, Energy saving and Payback period in Tunisian for a typical wall structure based on both cooling and heating loads. In this the complex finite Fourier transform (CFFT) method is adopted for the insulation of the transient heat transfer through a typical external wall. Numerical calculations are performed using a Mat Lab computer program. Daoual et al. [5] determined the optimum insulation thickness under steady periodic conditions. Estimated loads are used as inputs to a life-cycle cost analysis in order to determine the optimum thickness of insulation layer.

As a result, the East and West orientation, which provide nearly equal cooling loads, are less favorable compared with South and North orientations. Ekice et al. [6] investigated the effects of wall type and degree-days value on optimum insulation thickness for different insulation materials. Energy savings are directly proportional to the climatic conditions of the region. Heating load is calculated by degree-days concept. Gurel et al.[7] analysed the environmental and economical effects of insulation applications in insulation material. The effect of insulation thickness on energy saving for different fuels is observed. During the use of different fuels, the amount of CO₂ and SO₂ emissions were calculated for different insulation materials. Jinghuna et al.[8] calculated the optimum thickness of five insulation material for a typical residential wall using solar-air cooling and heating degree-days analysis and P1-P2 economic model. Solar-air cooling and heating degree-days are calculated by considering the effects of solar radiation on wall orientation are surface colour during cooling and heating seasons. Kaynakli,O.[9] investigated these parameters(Inflation rate, discount rate, life time, energy costs, heating/cooling loads of the building, the wall structure and properties of the insulation material) on the optimum thermal insulation thickness for building walls.

In this study, the effect of solar radiation was considered in the calculations. The effects of these parameters on the total life-cycle cost, payback periods and energy savings were also investigated. Kaynakli,O.[10] determined the optimum insulation thickness for different fuel types based on life cycle cost analysis (LCCA). The author described the degree-time method for estimating the energy requirements for heating purposes in a building over a specified period. The degree-time method assumes that the energy needs for a building are proportional to the difference between the outdoor temperature and the base temperature. Mahlia et al.[11] investigated potential cost saving and emission reductions achieved by installing different insulation materials of optimum thickness in building wall. The author has showed that introducing selected insulation materials of optimum thickness and introducing air gaps in composite walls reduce fuels consumption and emission of air-conditioned buildings. Ozbalta et.al [12] examined the efficiency of insulation location and thermo physical properties of various external wall materials. The role of thermal inertia of external wall is investigated. The effect of insulation position of the wall on decrement factor and time lag are investigated in view of energy saving and thermal comfort for inhabitants. Ozel.M.[13] determined the optimum insulation thickness for different wall orientations under dynamic thermal conditions. Yearly heating and cooling transmission loads according to wall orientations are calculated by using implicit finite-difference method under steady periodic conditions. A dynamic method that considers the thermal inertia of the walls is used for determination of yearly heating and cooling transmission loads. Ozel,M.[14] calculated the yearly cooling and heating transmission load according to increasing insulation thickness for each structure and insulation materials. The investigation is carried out by using an implicit finite different method for multilayer walls in the climatic condition of Elazig, Turkey. In this analysis, Optimization is done by considering only the transmission part of the air conditioning load since other load do not influence the optimum thickness of insulation. Ozkan et al [15] determined the effects of the alternation of glazing and exterior wall area on the optimum insulation thickness. The optimum insulation thickness of the external wall, energy saving over a lifetime of 10years and payback periods in the terms of the two different insulation materials are calculated for the four different climate regions in turkey. Papakustas et al.[16] calculated the total annual values of the heating and cooling degree-days for the two main cities in Greece. During the summer period, a higher percentage of variation of degree-days is observed compared to the winter period, which means that the temperatures increased more during the summers than during the winters. Ucar.A[17] study the optimum thickness of insulation considering condensed vapour in external walls for four different cities in Turkey by using Exergo economic analysis . The Exergo economic optimization is based on the cost of insulation and fuel. Simulations are performed for four different climatically location of turkey. Ucar et al.[18] determined the optimum insulation thickness of the external wall, energy savings over a lifetime of 10 years and payback periods for the five different materials and the various cities in Turkey.

The concept of life-cycle cost is used to determine the optimum insulation thickness in order to take effects of the change in interest and inflation rate that directly affect both the cost of insulation materials and fuels. Yildiz et al[19] calculated the heating loads by degree-day method and for the economical analysis, the optimum insulation thickness values were calculated by life cycle method. The Coal, Natural gas, Fuel oil and LPG, exhaled like CO₂ and SO₂ emission amount were calculated. Yu et al.[20] observed the effects of energy saving strategies on AC electric consumption of different orientations rooms in hot summer and cold winter zone in China. The simulations results indicate that there is a large potential to decrease the energy consumption of the extant strip residential building by reconstructing envelope. Based on the forgoing literature review the present paper aim is to calculate the optimum insulation thickness of external walls, the energy savings over a lifetime of 10 years and the payback periods for three different wall types, four different energy sources and two different insulation materials.

2. BUILDING MATERIALS AND DIFFERENT EXTERNAL WALL STRUCTURE

In India, the external wall insulation applications are generally made by the sandwiches wall type. The structure of external wall is made by 2 cm internal plaster, different wall materials (Stone, Brick or Concrete), 8.5 cm insulation material and 2 cm external plaster. In this analysis, the calculations were carried out for a three different types of walls, which have been constructed with stone (50 cm), brick (29 cm) and concrete (25 cm). The surfaces of the walls are insulated on the external side and plastered on

both sides as shown in fig.1

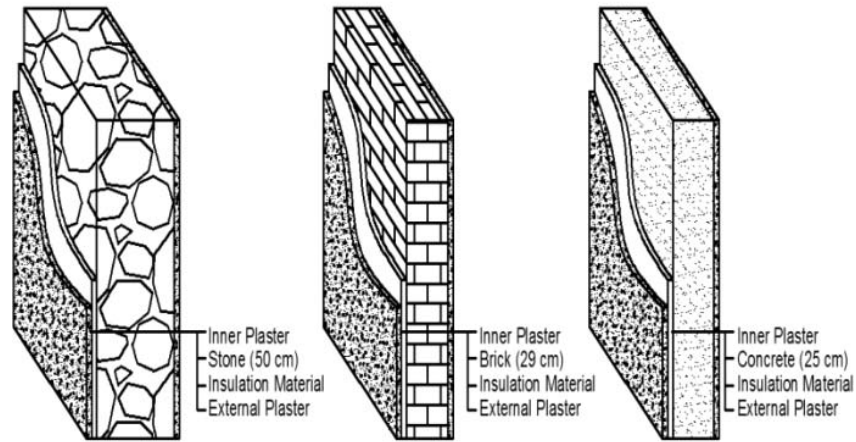


Fig.1. Different external walls structure

2.1 MATHEMATICAL MODELS FOR ANNUAL FUEL CONSUMPTIONS Heat loss from buildings occurs through surface of external wall, window, ceiling and air infiltration. In this analysis, heating loss is observed only on the external wall surface.

The heat loss per unit area of external wall is

$$Q = U(T_b - T_a) \quad (1)$$

Where U is the overall heat transfer coefficient. T_b is the base temperature and T_a is mean air temperature.

Annual heating loss can be calculated according to value of the Degree-Days.

$$QA = 86400 DD U \quad (2)$$

Where DD is the Degree- Days. The annual energy requirement is

$$EA = 86400 DD / (R_{tw} + x/k) \eta_s \quad (3)$$

Where η_s is the efficiency of space heating system.

And the annual fuel consumptions is

$$M_{fa} = 86400 DD / (R_{tw} + x/k) LHV. \eta_s \quad (4)$$

where LHV is lower heating value of fuel.

2.2 OPTIMIZATION OF INSULATION THICKNESS AND ENERGY SAVING The life-cycle cost analysis (LCCA) is used in this analysis. It determines the cost analysis of a system. The total cost of heating over the life time of the insulation material which was taken as 10 years. Total heating cost is indicated together with life cycle (N) and presents worth factor (PWF). PWF can be calculated by using inflation rate g and interest rate i. Inflation and the interest rate are taken as 10 % and 8 % respectively. The total heating cost of the insulated building is

$$C_t = CA PWF + C_i x \quad (5)$$

The optimum insulation thickness is obtained by minimizing total heating cost of insulation building (C_t). So the derivative of C_t with respect to x is taken and equal to zero from which the optimum insulation thickness X_{opt} obtained.

$$X_{opt} = 293.94(DD C_t PWF K / HU. C_i \eta_s)^{0.5} - K R_{tw} \quad (6)$$

Pay-Back Period(PP) is calculated by solving the equation(7)

$$C_{ins}/A_s = (1+r)^{PP} - 1 / r(1+r)^{PP} \quad (7)$$

Where C_{ins}/A_s is the simple Pay-Back Period. Energy saving obtained during the lifetime of insulation material can be calculated as follow:

$$E_s = C_{to} - C_{ins} \quad (8)$$

where C_{to} and C_{ins} are the total heating costs of the building without insulation and with insulation is applied respectively.

3. RESULTS

The optimum thickness of two insulation materials (Rock wool and Extruded Polystyrene) are calculated with a sandwiches wall types building. The heat losses in building occur through external walls, windows, ceiling, floor and air infiltration. We considered heat loss from external wall only. Table 1 presents the optimum insulation thickness for various wall structures.

Table 1: Optimum insulation thickness for various wall structures

Wall Type	Resistance	Insulation Thickness(m)	
		XPS	Glass Wool
Wall 1 (stone)	0.558	0.0314	0.0790
Wall 2 (Brick)	0.8875	0.0205	0.0665
Wall 3 (Concrete)	0.4075	0.0363	0.08477

Payback period (in year) and Energy saving for different type of wall construction, different types of fuel and different types of insulating material are shown in Table 2

Table 2: Payback period and Energy saving for different type of wall construction

Wall type	Payback periods (years)		Energy saving (Rs/m ²)	
	XPS	Glass Wool	XPS	Glass Wool
Wall 1 (stone)	3.498	1.966	1222.536	1261.45
Wall 2 (Brick)	5.64	3.16	216.695	561.8
Wall 3(Concrete)	2.52	1.43	1480.825	1986.26

Table 3 present the parameters used in calculation of Optimum insulation thickness, Payback periods and Energy savings for the insulated buildings.

Table 3: Parameters used in calculation of Optimum insulation thickness

Parameter	Value
Degree-Days	1500
Fuel	LPG
Cost of fuel	40 Rs/m ³
Lower heat value of fuel	46.046 10 ⁶ j/m ³
Efficiency of fuel	90%
Cost of Glass wool	4279 Rs/m ³
Thermal Conductivity of Glass wool	0.038 w/m-k
Cost of Extruded Polystyrene	15050 Rs/m ³
Thermal Conductivity of Extruded Polystyrene	0.033 w/m-k
Interior plaster conductivity	0.698 w/m-k
External plaster conductivity	0.872 w/m-k
Stone thermal conductivity	1.7 w/m-k
Brick thermal conductivity	0.465 w/m-k
Concrete thermal conductivity	1.74 w/m-k
PWF	9.05 Years
Interest rate(i)	8%
Inflation rate(g)	10%

Figs 2. (a & b) shows variation of cost with insulation thickness for Glass wool (GW) and extruded Polystyrene (XPS) insulation materials. The insulation cost increases linearly with insulation thickness, but Energy cost decreases with increasing insulation thickness. Total cost is sum of insulation and energy cost. The insulation thickness at which the total cost is minimum is called optimum insulation thickness. The results show that optimum insulation thickness is 0.0314 m for XPS while it is 0.079 m for glass wool in the case of wall type 1 (Stone)

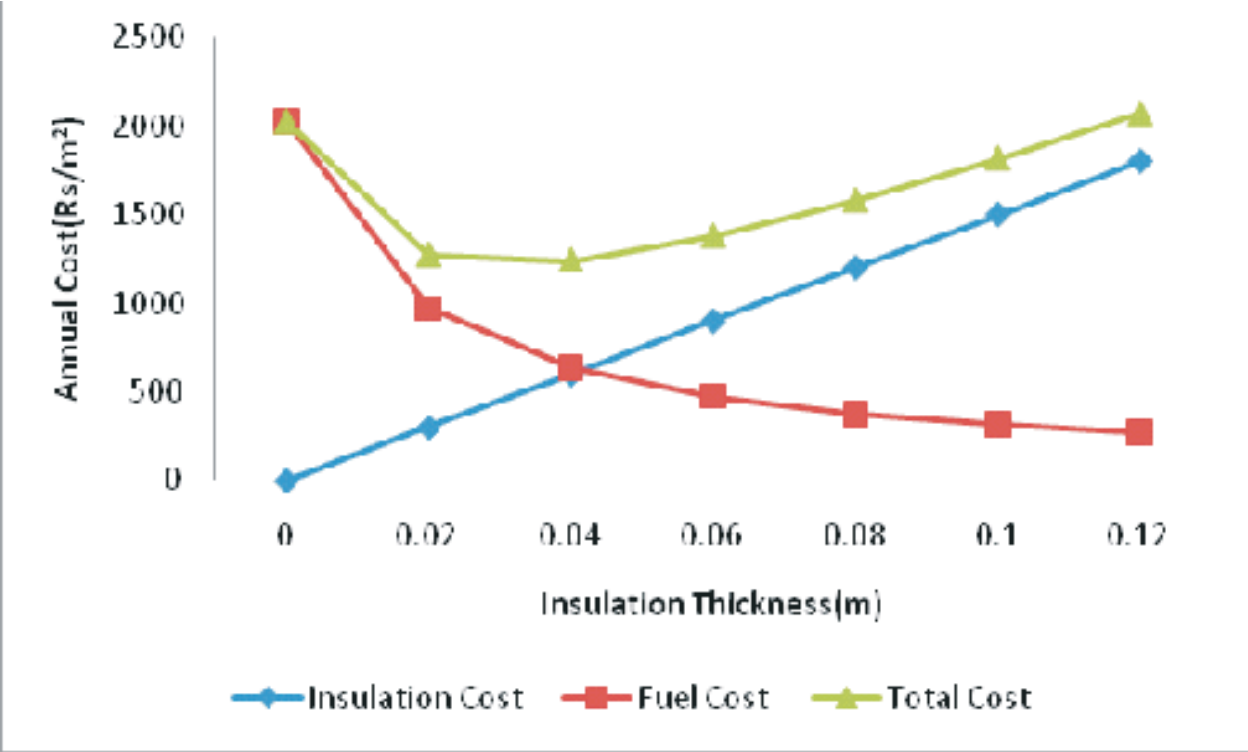


Fig. 2 (a) variation of total cost with insulation thickness for XPS insulation for wall constructed of Stone.

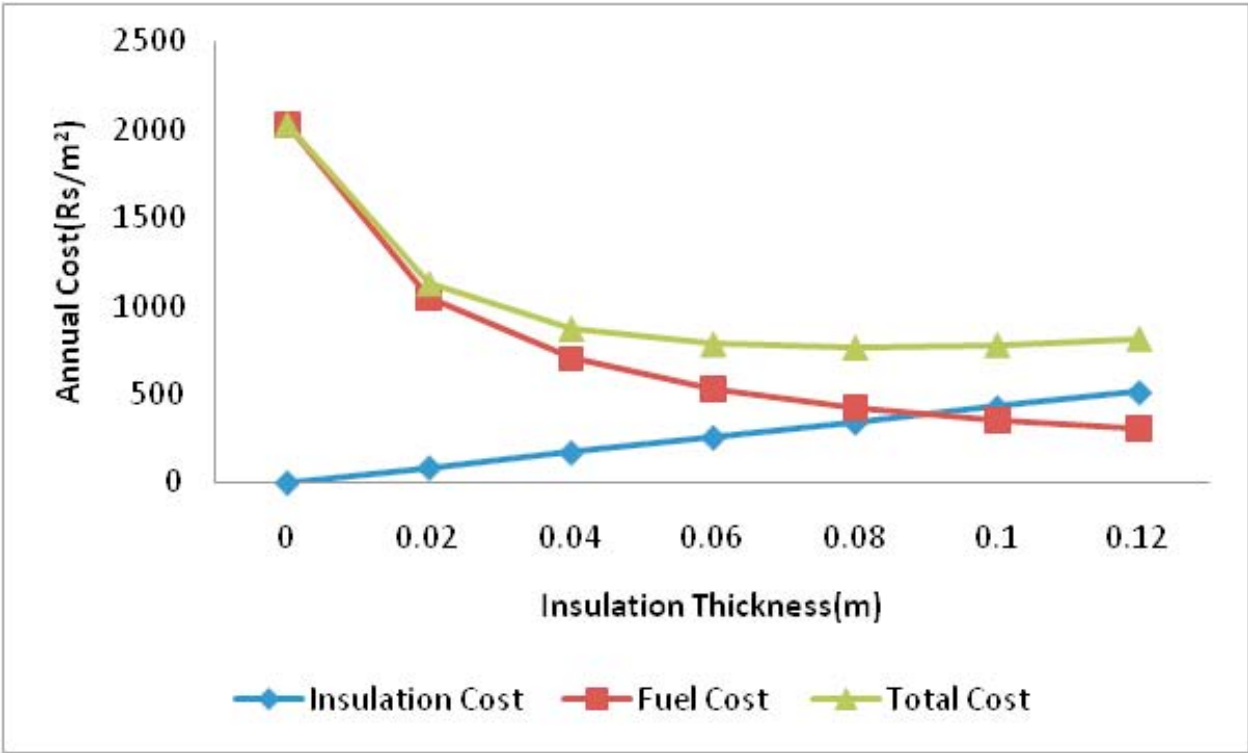


Fig. 2 (b) variation of total cost with insulation thickness for Glass Wool (GW) insulation for wall constructed of Stone.

Figs. 3 (a & b) shows effect of insulation thickness on Energy savings for two different insulation materials (XPS and Glass wool) for different wall types. As insulation thickness increases, energy saving gradually increases reaches to its maximum value and after that the energy saving decreases with increasing thickness of insulation. At optimum insulation thickness, the Energy saving is maximum. From fig. 3 (a), it can be concluded that lowest value of Energy saving is obtained for wall type 2 (Brick) and highest energy saving is obtained for wall type 3 (Concrete). In the case of type 2 (Brick), the energy saving is almost zero after increasing the insulation thickness above 0.04m.

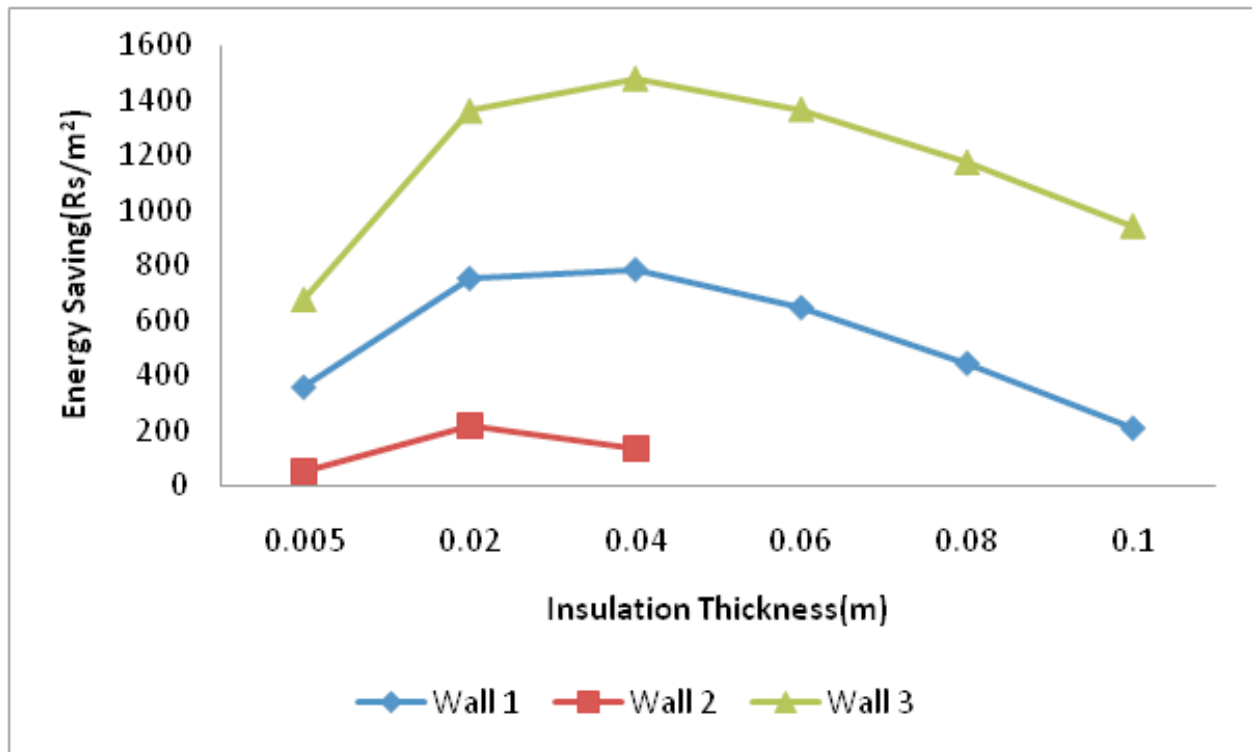


Fig. 3 (a) Variation of Energy saving versus insulation thickness for different types of wall and XPS is selected as a insulating material

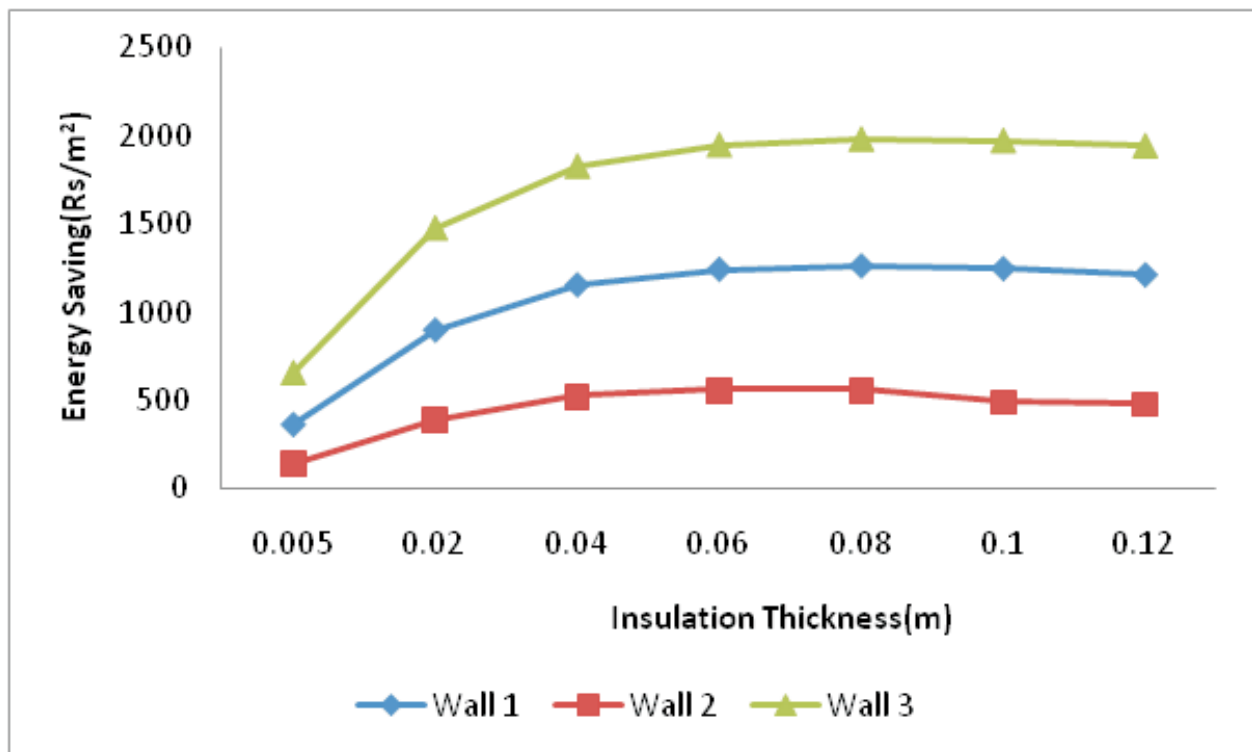


Fig. 3(b) Energy saving versus insulation thickness for three different wall types and Glass wool is selected as insulating materials.

Fig 3 (b) show the variation of Energy saving with respect to insulation thickness for three different wall types while Glass wool is selected as the insulation materials. On the basis of parametric analysis for fig. 3 (b), wall type 3 (Concrete) is more effective as compared to other type of wall, according to Energy saving point of view.

Fig. 4 Represent the variation of optimum insulation thickness with respect to present worth factor (PWF) for two types of insulation (Glass wool and XPS). When PWF value is gradually increases, then insulation thickness is also increases. From fig 4, it can be concluded that, for a given value of PWF, building will be insulated with XPS require less insulation thickness. Glass wool insulation requires more insulation thickness as compare to XPS insulation for a given value of PWF. Therefore it can be concluded that XPS insulation is more effective as compare to glass wool insulation.

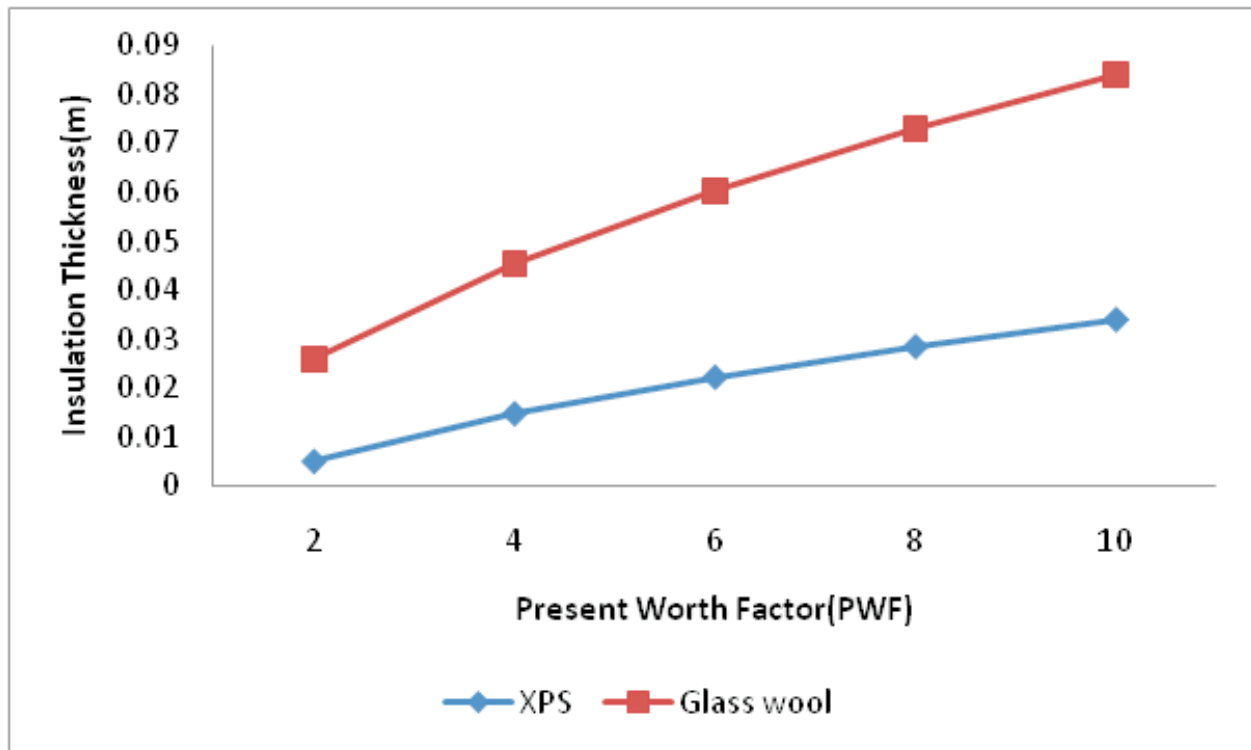


Fig. 4 Optimum insulation thickness versus Present worth factor.

Fig .5 shows the effect of Degree -Days on optimum insulation thickness for different wall types. At a given number of degree days, walls having higher thermal resistance require less insulation. Wall 2 (brick) has higher thermal resistance, so it requires less insulation. From fig. 5, it is observed that when the degree-days value increases, the thickness of the insulation is also increases. Applying insulation in climatic conditions having higher degree-days (DD) for heating would be more advantageous.

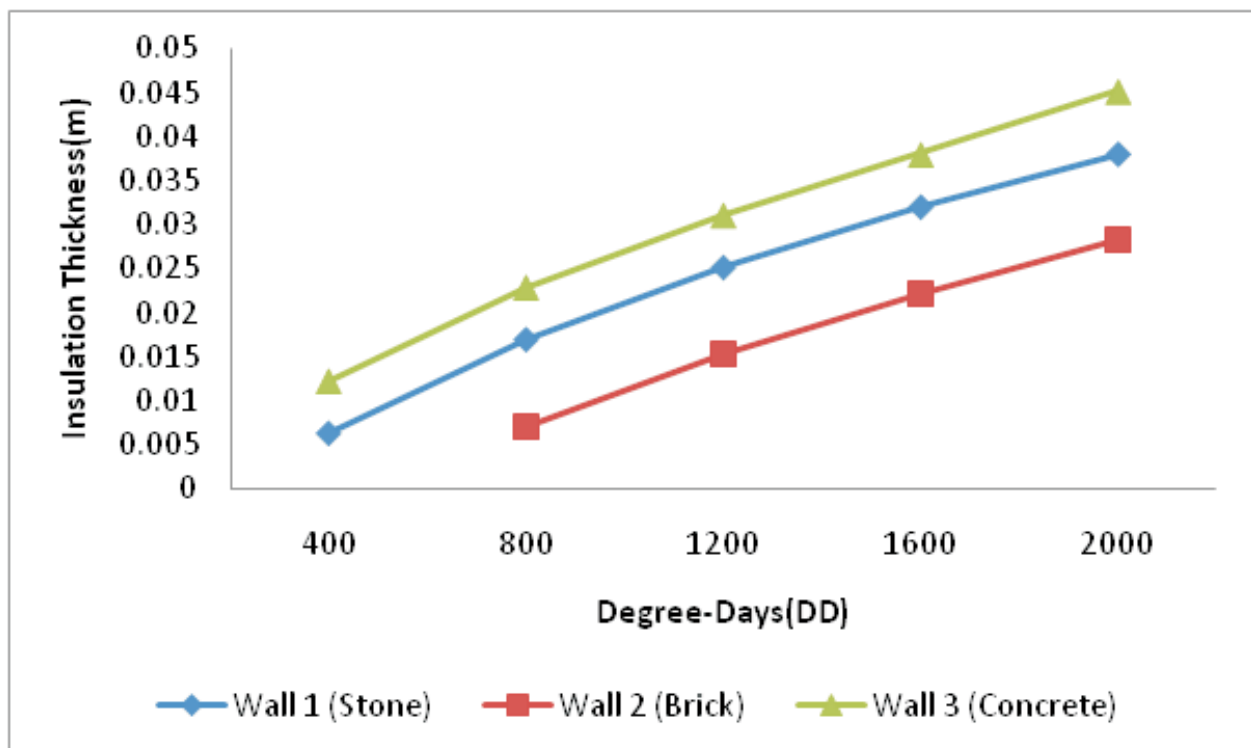


Fig. 5 Effect of degree days (DD) on optimum insulation thickness for different types of wall- (XPS insulation)

4. CONCLUSIONS

The optimum insulation thickness of different types of walls, Energy saving over a lifetime of 10 years and payback periods were computed for two different insulation material and fuel types. Generalized charts for obtaining the optimum insulation thickness were prepared for different types of walls. As seen from Figure, choosing a thickness value apart from optimum thickness will increase the total cost. Therefore, optimum insulation thickness must be applied to Building. It is seen that Extruded Polystyrene(XPS) has the lowest value of optimum insulation thickness of 2.05 cm, while Glass Wool has the highest value of optimum insulation thickness of 8.47 cm. Insulation become more necessary if more expensive heating system is used.

Results show that optimum insulation thickness varies between 3.14 cm and 8.47 cm, Energy saving in the term of money vary between 216.96 Rs/m² and 1986.26 Rs/m² and Pay-back period vary between 1.43 and 5.64 years depending on the climate, the type of wall, the insulation material and the cost of fuel.

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A STUDY OF THE CONSUMER PREFERENCES FOR PURCHASES FROM ORGANIZED AND UNORGANIZED RETAILERS AT BHOPAL

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ABSTRACT

Year 2011 witnessed big hue and cry over the issue of FDI in retail in India and the matter was temporarily put at the back burner due to the coming elections. The retailers all over the country started agitations against the decision of FDI in retail without most of them understanding the level and phases of reforms that the government had suggested. This study was conducted to find the consumer perception of the fears raised by political parties and retailers against the FDI in retail in Bhopal, India. It was conducted to find out the consumer preferences for purchases from organized and unorganized retailers at Bhopal. Majority of the respondents buy their Grocery and FMCG requirements from unorganized retailers. The main findings of the study are that the majority of the respondents prefer bulk buying from organized sector due to reasonable prices and quality, 57% respondents enjoy the ambience and facilities which are being provided by the big retail outlets and that the price, parking, quality products influence the buying habits of about 68% of the respondents. The customer relationship management of both the sectors was equally preferred by the respondents. Finally, the respondents are switching more to organized retail sector during weekends and festive season.

Key Words: FDI in retail, Organized Retail, Unorganized Retail, Consumer Preferences, Ease of purchase, Time of Purchase

1. INTRODUCTION

The retailers all over the country started agitations against the decision of FDI in retail without most of them understanding the level and phases of the reforms that the government had suggested. The Economic Survey has sought a 'phased opening of FDI' in the debatable multi brand retail sector. The opposition to FDI in multi-brand retail forced the government to suspend its decision. The debate was not over and is expected to be hot again once any political party comes at the center with clear majority. The survey recommended the rollout in stages. "Allowing FDI in multi-brand retail is one of the major issues in this (services) sector. This could begin in a phased manner in the metros, with the cap at a lower level." Further the survey said that the existing 'mom and pop' stores (Kirana shops) should be incentivized to modernize and compete effectively with the retail shops, foreign or domestic. According to the Inter-Ministerial Group (IMG) on inflation, FDI in multi-brand retail would help in developing a 'farm-to fork' retail supply system, and addressing the investment gaps in post harvest infrastructure for agricultural produce. This study was conducted at Bhopal, the capital of Madhya Pradesh to find out consumer preferences for purchases from organized and unorganized retailers at Bhopal.

Literature Review

Hotelling's (1929) paper originated the principle of minimum differentiation which suggests that a given number of stores operating within the same market sector will achieve superior performance if they are clustered together. Dabholkar (1996) developed Retail Service Quality Model (RSQS). It lays emphasis on 5 aspects which are (1) Physical aspects- Retail store appearance and store layout (2) Reliability – Retailers keep their promises and do the right things (3) Personal interaction –Retail store personal are courteous, helpful and inspire confidence in customers (4) Problem solving-Retail store personal are capable to handle returns and exchanges, customers problems and complaints (5) Policy- Retail stores policy on merchandise quality, parking, operation hours and credit cards. John B. Clark, Hojong Hwang (2000) conducted a study to compare customer

satisfaction between American and Korean discount store. Binta Abubakar, Val Clulow (2002) the result suggested that since retail format had become very standardized, corporate reputation was rated high and might be a source of sustainable competitive advantage. Kerrie Bridson, Melissa Hichman (2003) the study found that both hard and soft attributes were significant predictors of satisfaction with the merchandise, trading format, and customer service and customer communication of the store. Subhashini Kaul (2005) concluded that service quality is being increasingly perceived as a tool to increase value for the consumer. Dr. Burcu Ilter (2006) in this study had focused on the expectations, experiences, and perceptions of high school girls to see what attracts them to the malls. Vaishali Aggarwal (2008) concluded that among the factors important for customer satisfaction, 'quality' 'convenient location' and 'availability' got the highest rating in term of their importance to the customer on a 5- point scale. Alisa Nilawan (2008) the finding of the study revealed that modern decoration, location of mall, word of mouth, discount coupons, prompt and attentive services were the main factors that influenced customers for visiting malls. KPMG (2010) the discussion paper on “Foreign Direct Investment (FDI) In Multi-Brand Retail Trading” emphasized that the opening up of the multibrand retail sector to foreign players will be a step in the right direction as this could bring about a number of benefits in terms of improved infrastructure, efficient processes, employment generation opportunities and better experience for Indian consumers in the long-run. It may also urge the Indian players both in organized and un-organized formats to re-think their business plans to become more efficient and remain competitive. Amol Sharma and Prasanta Sahu (2012) in the “Business” reported that the Indian government issued a formal order fully opening the country's single-brand retail sector to foreign investment, a move that will give greater access to companies like Nike Inc. but doesn't lift barriers to foreign investment for multibrand retailers, such as Wal-Mart Stores Inc.

2. JUSTIFICATION OF THE STUDY

The study was conducted to find the consumer perception of the fears raised by political parties and retailers against the FDI in retail in India. Some of the apprehensions are as follows:

- FDI in retail will ruin unorganized retailer. Some fears that the entry of global retail giants like Wal-Mart, Carrefour and Tesco would throw the neighborhood mom 'n' pop stores out of market.
- FDI in retail may induce unfair trade practices like predatory pricing. The ability of foreign players to leverage on limited resources and operate at lesser cost makes them more prices competitive.
- The retail revolution may be limited to cities and that the rural India may be deprived of it.
- The entry of global players may bring an artificial increase in the real estate prices.

3. OBJECTIVES OF THE STUDY

- (I) To evaluate the effects of growing organized retail on the unorganized retail.
(ii) To evaluate the consumer preferences.

Limitations

1. Limited Sample Size.
2. Inhibitions of Respondents.

4. RESEARCH METHODOLOGY

The research is descriptive in nature. Consumers from different age groups, gender, locations, income levels and educational backgrounds are taken as sampling unit and the sample size is 200. The method of sampling taken is convenience. Both primary and secondary data were collected from respondents and journals respectively. The data was collected through structured questionnaire. Statistical tools like mean, standard deviation, coefficient of variation, correlation, pie charts and chi-square test were used.

Table 1: Demographic details of the respondents

Sr. no	Factor	Category	No. of Respondents	Percentage
1	Gender	Male	118	59
		Female	82	41
		Total	200	100
2	Age	Below 30 years	64	32
		31-40 years	52	26
		Above 40 years	84	42
		Total	200	100
3	Education	Up to metric	20	10
		Graduate	60	30
		Post graduate	120	60
		Total	200	100
4	Occupation	Business	54	27
		Profession	30	15
		Service	50	25
		Household	38	19
		Student	28	14
		Total	200	100

5. ANALYSIS

Chart I Source of the purchases of Grocery and FMCG by the respondents

69% of the respondents buy their Grocery and FMCG requirements from unorganized retailers.

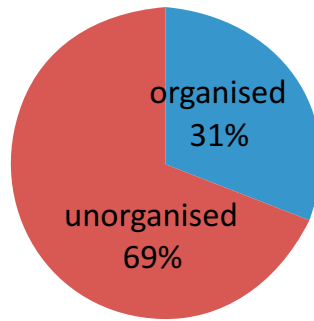
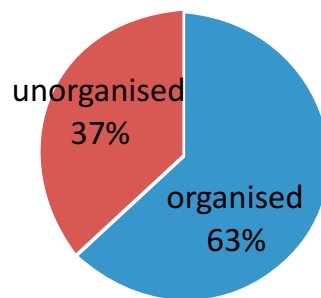
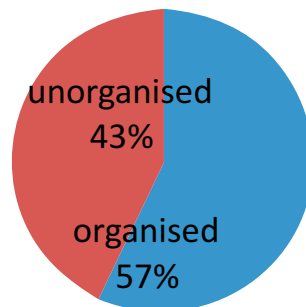


Chart II Respondents' preferences for bulk buying due to reasonable prices and quality



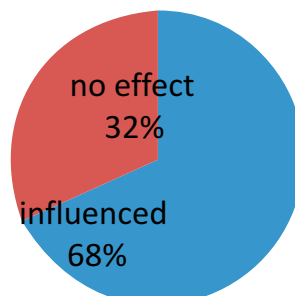
63% of respondents prefer Bulk Buying from organized sector due to reasonable prices and quality.

Chart III Ease of purchase



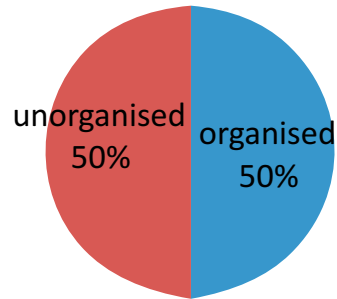
57% respondents enjoy the ambience, parking and facilities provided by the big retail chains

Chart IV Influence of price and quality on buying habits of respondents



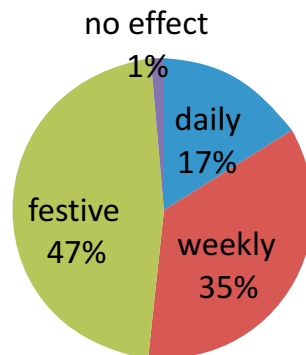
68% of the respondents are influenced by price and quality.

Chart V Respondents preferences due to Customer Relationship Management



50% of the respondents prefer CRM of organized and a similar percentage of respondents prefer CRM of unorganized sector.

Chart VI Time of purchase from organized retail



Customers switch more to organized retail sector during weekends and festive season and less on daily basis.

6. FINDINGS

- Majority of the respondents buy their Grocery and FMCG requirements from unorganized retailers.
- Majority respondents prefer bulk buying from organized sector due to reasonable prices and quality.
- 57% respondents enjoy the ambience and facilities which are being provided by the big retail outlets.
- Price, parking and quality product influence the buying habits of about 68% of the respondents.
- The customer relationship management of both the sectors was equally preferred by the respondents.
- Respondents are switching more to organized retail sector during weekends and festive season but not on daily basis

7. HYPOTHESIS

H0 – There is no association between gender and source of purchases.

H1 – There is an association between gender and source of purchases.

S. No	Source Gender	Organized	Un Organized	Total
1	Male	26	92	118
2	Female	22	60	82
	Total	48	152	200

For $v=1$ and $p=0.05$ the critical value of $\chi^2=3.841$. The calculated value of χ^2 is 0.60 and therefore is insignificant. The null hypothesis is accepted and thus there is no association between gender and source of purchases.

H0 – There is no association between age and source of purchase.

H1 – There is no association between age and source of purchase.

S. No	Source Age	Organized	Un organized	Total
1	Less than 30	18	44	62
2	30-40	12	42	54
3	40-50	10	30	40
4	50 and above	8	36	44
	Total	48	152	200

For $v=3$ and $p=0.05$ the critical value of $\chi^2=7.815$. The calculated value of χ^2 is 1.78 and therefore is insignificant. The null hypothesis is accepted and thus there is no association between age and source of purchases.

H0 – There is no association between facilities, price, quality and source of purchase.

H1 – There is an association between facilities, price, quality and source of purchase.

S. No	Source Reason for buying	Organized	Un organized	Total
1	Ambience and parking	114	86	200
2	CRM	100	100	200
3	Price and Quality	136	64	200
	Total	350	250	600

For $v=2$ and $p=0.05$ the critical value of $\chi^2=5.99$. The calculated value of χ^2 is 13.53 and therefore is significant. The null hypothesis is rejected and thus there is an association between facilities, price, quality and source of purchase.

8. CONCLUSION

There is a need to study the impact of the existing retail outlets in various cities and a proper analysis of what is happening and where we need regulations in the interest of all the stakeholders. This study was conducted at Bhopal but we can arrive at some strong conclusion only after similar study in many cities of India. The apprehensions that the FDI in retail will ruin unorganized retailer and that the entry of global retail giants would throw the neighborhood mom 'n' pop stores out of market is true to the extent that the organized retail in Bhopal is effecting the unorganized retail for some specific items and at some specific time of purchase. But the unorganized can easily compete due to its favorable location for items of daily needs. The future study can concentrate on issues like the retail revolution may be limited to cities and that the rural India may be deprived of it and that the entry of global players may bring an artificial increase in the real estate prices.

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INVESTMENT IN GOLD – AN EMPIRICAL STUDY ON SHINING OPTION

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ABSTRACT

Gold is one of the most popular shining yellow metal having wide investment options. It is not only required for investment but also for jewellery needs in marriages and festivals. Gold's extensive appeal and functionality, including its characteristics as an investment vehicle, are underpinned by the supply and demand dynamics of the gold market. It is considered as a safe haven against all national, political and cultural crises. When the economy is not stable, the price of gold appreciates. An investor has numerous investment options to choose from, depending on his risk profile and expectation of returns. Various investment options available are Bank Deposits, Commodities like Gold, Silver etc., Post Office Savings Schemes, Public Provident Fund, Company Fixed Deposits and Stock Market options like Bonds and Debentures, Mutual Funds, Equity Shares etc., of the various types of investment options in the Stock Market, Gold happens to be one of the best options to be included in the portfolio for diversification of risk. The purpose of the study is to show gold as an investment in derivative market, the risks involved, comparison made with other commodities and the various reasons responsible for the rise in the gold rates. Secondary sources have been used to analyse the paper.

Keywords: Investment Options; Stock Market Option; Bonds and Debentures; Derivative Market; Investment Risk Tolerance

1.INTRODUCTION

For thousands of years gold has been able to keep its existence in the human history as the symbol of wealth, prestige and glory. Gold today remains also the representation of the value of our money therefore gold is also used in many transactions and investments as well. Unlike the money gold is not easily devaluated by any external causes so this is why making an investment on gold is way much better and more potentially result us more profits. Gold is the most popular and useful metal among other metals available in this world. It is used for both investment and consumption purposes worldwide. Gold, besides having an ornamental value, is a great investment option. Like all other goods, the price of gold is determined by supply and demand; however, factors like hoarding and distribution play a greater role since the production of gold is not scarce like most other goods. Investors usually buy gold as a hedge or harbor against economic, political or social fiat currency crisis. As gold is the most liquid asset in the world. The standard gold bar of 995 or 999 purity is accepted across the world and returns the full asset value which makes it the least risky. More importantly, India being the largest consumer, it has always been linked to the international bullion market. All developed economies allow for “derivatives” trading in gold comprising of futures, swaps, options etc. these derivatives have immense benefits to different strata of the market. India is estimated to be sitting on over 13,000 tons accounting for more than 8% of total global gold reserves, which amounts to nearly 65% of the country's gross domestic product. India's insatiable hunger for gold is growing at an estimated 20% annually. However, India's share is hardly 1% of the global trading in gold.

Gold has always been fancied for use as Jewellery. Though gold has been hoarded for a rainy day, it was not really seen as investment asset. However, things are set to change partly, and many people have started looking at gold as an investment instrument. There have been many changes in the Indian gold trade over the last few years, with banks being allowed to import. While some banks, and especially the foreign ones, have closed down their operations after showing an initial interest, the rest are still struggling to handle the high volatility in the global price of the commodity. Considering all the negatives for an average investor, the best way out is to promote gold-based mutual funds or gold-deposit schemes. Even if it is assumed that one still has to hold gold in physical form, it is best to invest in gold bars rather than Jewellery because price appreciation happens only in pure gold. However, investment at current price levels is a bit risky as there are never quick gains in gold trading. The futures trading in gold is expected to fill in the gap and may even occupy the place of most preferred investment instrument ahead of equities and fixed income securities.

2. OBJECTIVE OF STUDY

- 2.1 To study gold as a derivative option
- 2.1 To find the causes of rise in gold prices
- 2.1 To analyse the different derivative instruments to make a comparison with gold as a standard

3. THE GROWTH OF DERIVATIVE MARKET

The gold derivative market has grown rapidly over the last decade. There are several ways of measuring the size of a derivatives market. A key measure in the gold market is the amount of liquidity provided to the market by official sector and other lending. Gold has been a very active derivative instrument vis-a-vis with other commodities. Gold accounts for 45% of the world's commercial banks' commodity derivatives portfolio, but for just 0.3% of their total derivatives portfolio. There is little doubt that the growth of the derivatives market has been of considerable benefit to users individually. Central banks have been able to get a current income on gold holdings. Gold fabricators have been able to insulate themselves from the impact of fluctuations in the price of gold on their inventory holdings. Hedging has enabled producers to develop new mines using project finance. Speculators too have benefited by being enabled to take long or short positions in the gold market efficiently

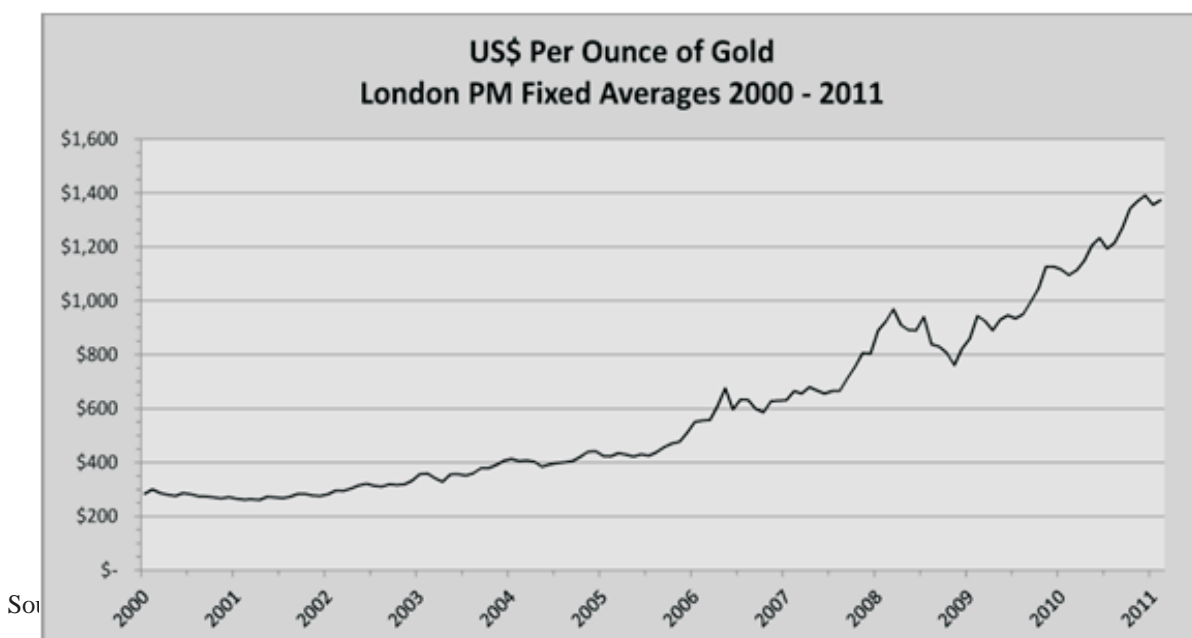


Fig. 1: Growth of Gold Market

4. GOLD AS AN INVESTMENT

Reasons for holding physical gold vary widely. In markets with poorly developed financial systems, inaccessible or insecure banks, or where trust in the government is low, gold is attractive as a store of value which is portable, anonymous and readily marketable anywhere. In countries with a stable political and financial system, the prime attraction of gold is as an investment which has a very low, or negative, correlation with other assets, and which may hold or increase its value if for some reason investors flee from purely financial assets like bonds and equities. If gold is held primarily as an investment asset, it does not need to be held in physical form. The investor could hold gold-linked paper assets or could lend out the physical gold on the market. An investor who wants exposure to gold, particularly if his position is more than, say, 10,000 ounces, will normally be able to achieve an increase in return of perhaps 1% by lending out his gold over the return he would gain by holding physical gold. In addition he will save on the storage costs. Investors who hold their gold with a bank in unallocated form (where they have a claim on the bank for a fixed quantity of gold, but they have no claim to specific bars) allow the bank to lend out 'their' gold. The bank normally retains any interest on lending the gold, but passes on some of the benefit to its customers by remitting storage charges. The reasons normally given for holding gold as a reserve asset are varied – it is not a claim on another state and is therefore not affected by the actions of any other state; it increases public confidence in the currency in the way that foreign currency reserves may not; in extremis it may retain its value better than foreign currencies; as returns are little correlated with other reserves holding a certain quantity may improve the risk/return trade-off of the reserve portfolio as a whole. On the other hand, it is an asset which pays little or no interest, and whose price has not performed particularly well in recent years. Gold prices are clearly trending upwards over the long term. The macro-economic and supply-demand drivers point to a continued increase in gold prices.

5. GOLD PRICE VALUATION

Gold has been used throughout history as money and has been a relative standard for currency equivalents specific to economic regions or countries, until recent times. Many European countries implemented gold standards in the latter part of the 19th century until these were temporarily suspended in the financial crisis involving World War I. After World War II, the Bretton Woods system pegged the United States dollar to gold at a rate of US\$ 35 per troy ounce. The system existed until the 1971 Nixon shock, when the US unilaterally suspended the direct convertibility of the United States dollar to gold and made the transition to a fiat currency system. The last currency to be divorced from gold was the Swiss franc in 2000. Since, 1919, the most common benchmark for the price of gold has been the London gold fixing, a twice daily telephone meeting of representatives from 5 bullion trading firms of the London bullion market. Furthermore, gold is traded continuously throughout the world based on the intra-day spot price derived from the Over-the-Counter (OTC) gold trading markets around the world. Though there are several factors influencing the price, the three main reasons for price movement include

- Jewellery
- Demand for paper backed products traded on exchanges
- The US dollar

The following factors affect the price of gold;

- Demand-Supply fluctuations
- Currency fluctuations
- Interest rates by central banks of countries like India, US, England, Japan etc.
- Crisis situation like war, invasion, political unrest etc.
- Gold reserve fluctuations – transfer of reserves, sales and purchases by central banks.
- Returns on investment compared to other avenues like stocks, currencies, real-estate, bonds etc.

6. GOLD TRADING IN INDIAN DERIVATIVE MARKET

Emerging economies like India were not affected that much as in the developed countries. Reserve Bank of India (RBI) announced that the impact of current global financial crisis on the Indian financial environment was almost negligible. But, it could not be completely denied that the Indian financial sector was not affected. The financial institutions and commodity exchanges are interlinked worldwide and also investment depends on the psychology of the investor, during the financial downturn investors might have diverted their investments from financial market to commodity markets especially on gold to protect themselves from the losses due to the global recession. In the multi commodity exchange (MCX) in India, it is observed that there have been the increases in the trading value and number of contracts of gold. Since 2001 the gold price has risen steadily. This increase has a clear correlation with the growth of US national debt and the weakening of the US dollar relative to other currencies. In 2005 the gold price US\$ 500 for the first time since 1987. Three years later, in 2008, the rate was at more than US\$ 1,000. The financial crisis increased the demand for physical gold and exchange traded funds (ETF). The gold reserves of the biggest gold ETF, SPDR Gold Trust, reached 2010 a record of 1320 tons. Therefore, this gold fund controlled more gold than the Chinese National Bank. In the same year, several central banks planned to ramp up their gold reserves, among others the Chinese National Bank, the Reserve Bank of India and the Central Bank of Russia.

Table 1: Effective Annualized Returns in Gold

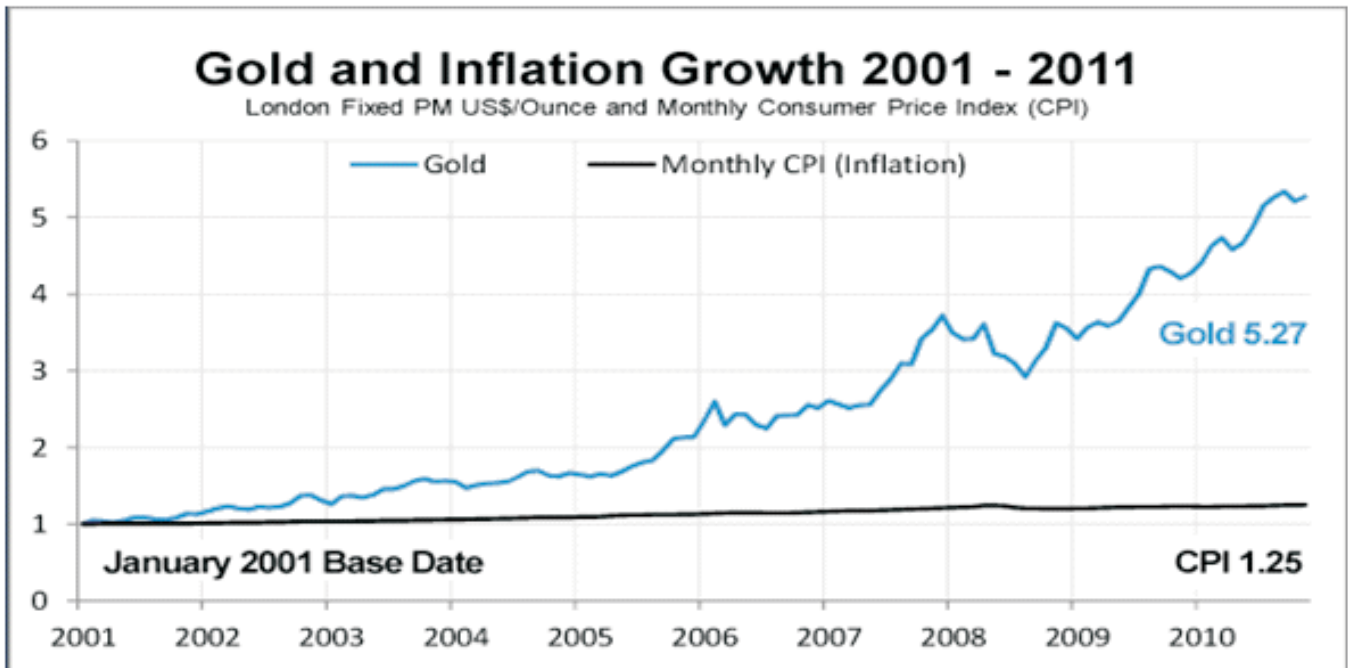
Period	Gold Value Rupee/10 gm	Effective Actualized Return in %
1970-71 to 2010	184.96-18620.13	12.00
2000-01 to 2010	4473.60-18620.13	15.05
2005-06 to 2010	6900.56-18620.13	21.96

Source: www.capitalvia.com

6.1 GOLD COMPARED WITH OTHER DERIVATIVES The above table shows that if an investor would have invested in gold in the year 1970-1971 at a price of Rs. 184.96/10 gm, the returns that the investor would have made on the same in the year 2010 would be nearly 12% (Effective Annualized Return) in the last 40 years and the prices of gold have rallied from Rs. 184.96/10 gm to nearly Rs. 21000/10 gm in the year 2010. Also, if we look at the effective annualized returns from the period of 2000-01 till Nov. 2010 have given return to the tune of nearly 15.05% and 15.06% and the returns from the period of 2005-06 till date have been 21.96% and 22.03% respectively. Thus, the returns in gold during different phases have shown an increasing trend.

The comparison between gold and oil prices, the stock indices, the US dollar and inflation are important in the context of this present study. The data show that the relationships either never existed, or disintegrated since the financial crisis of 2008. It generally leads to the high increase in the sky soaring gold rates.

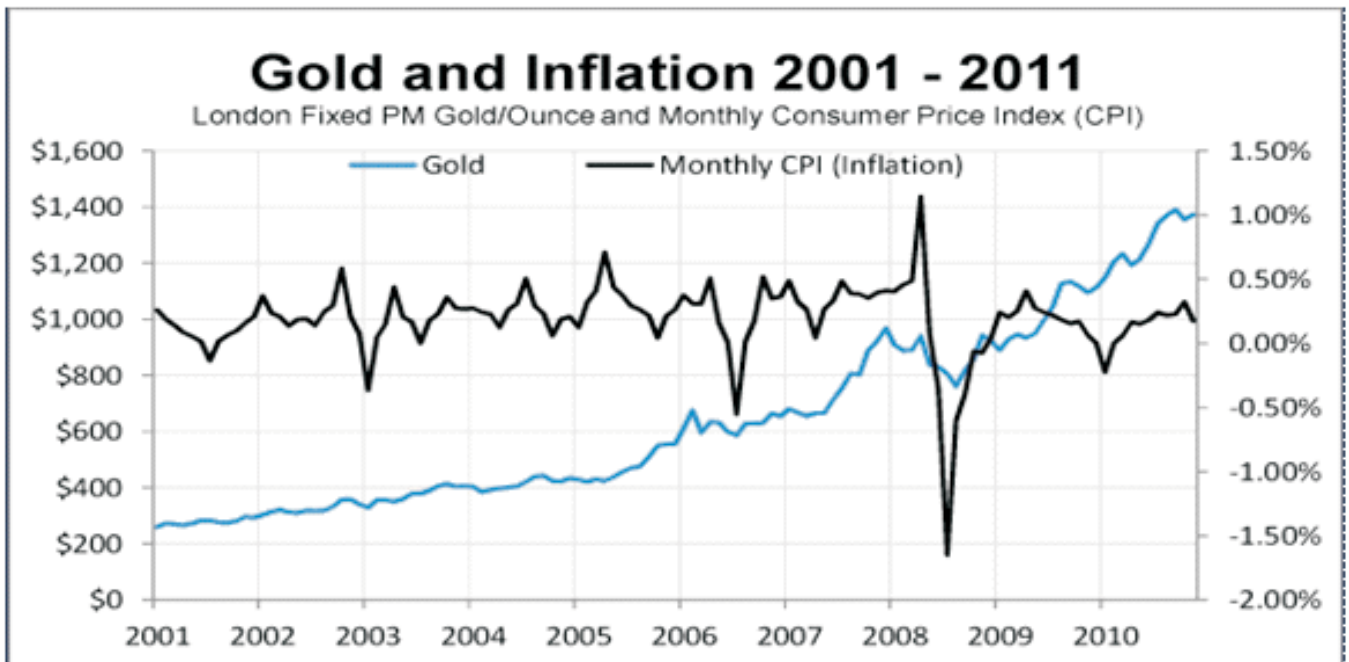
What is a sign of the strength (or weakness) of a currency? – It's inflation rate. It can be argued that the prices of both commodities have a similar trend is not because one influences the other, but because their price is driven by a common factor. And this is the inflation rate.



Source: www.goldratefortoday.org

Fig. 3: Gold and Inflation Growth

Especially remarkable is the inflation decrease in the middle of 2008. If the theory of a positive correlation held true, the gold price would also go down. But the opposite was the case: inflation went down and gold went up. This rather points to an inverse correlation between gold and inflation



Source: www.goldratefortoday.org

Fig. 4: Gold Relationship with Inflation .

All of this points towards a weak or even non-existing relationship between the gold price and the inflation rate. Still there are some reasons which show a positive correlation between gold price and inflation. First, the Wall Street Journal commissioned a study from the research firm Ibbotson Associates. According to their research, between 1978 and 2010 gold and the inflation rate have a correlation value of 0.08. This is nearly no correlation (on a scale ranging from -1 to 1, where 1 is perfect correlation, and -1 perfect negative correlation, and zero is the absence of a relationship).

Second, also Citibank comes in 2009 to the conclusion that “there is no obvious relationship between the gold price and inflation”.

Sometimes the development of gold follows inflation, at other times there is an inverse trend or just an obvious pattern at all. Therefore, it can be concluded that there is no, or only a weak, relationship between the gold rate and inflation levels. The history of gold has provided 16.91% annualized return over the past 10 years. In last 5 years since 2008 the gold prices have risen nearly 125% (Rs.12,500/- to Rs.28,000/-) making a strong case for having its portfolio.



Source: www.goldprice.org

Fig. 5: Historical Gold Price (in Rs.) Graph over the Decades

As fewer people have confidence in paper money as store of value, the price of gold is increasing and will continue to rise in future also.

7. RISK INVOLVED IN GOLD TRADING

Exchange risks refer to the exchanges where gold and futures are traded, and not to currency risks. The two major gold futures exchanges are the New York Mercantile Exchange (NYMEX) and the Tokyo Commodity Exchange (TOCOM). Trading at these and all other exchanges is subject to their rules and regulations. The exchanges can on purpose or accidentally foster market outcomes by changing their trading rules. What events could happen at an exchange?

7.1 MARGIN REQUIREMENT CHANGE A margin requirement states how much money needs to be available in the futures account to be able to speculate on future contracts. The higher the margin requirement, the more money is needed to control the same amount of the underlying asset. If the margin in the margin account is below the margin requirement, then the investor either has to increase the margin, or sell securities. Thus, rising the margin will in average result in more selling and as a consequence in price droppings.

In December 2009, COMEX raised the margin requirements for gold (and silver) contracts. It was speculated that this increase would result in a bearish future gold market for three to six months.

7.2 LIQUIDATION ONLY This rare event means that the exchange temporarily restricts buying, so that only selling can happen thus driving the prices down. COMEX restricted silver buying in 1980, when this metal reached an all-time high of US\$ 50. Will the exchange also declare a "liquidation-only" policy on gold, which also trades for a record price?

7.3 HALT TRADING This event is the most extreme measure. Here, an exchange temporarily halts the trading of a particular future contract.

8. VOLATILITY OF GOLD

The price of gold, as of every traded asset, is subject to the ups and downs of the market. The rate of this precious metal can fluctuate fundamentally. The volatility of gold must be a concern to all short- and long-term investors. However, thinking that it is possible to exactly calculate and predict the gold price is plainly wrong. There are many factors that influence the price, but cannot be predicted, such as the discovery of new gold deposits, natural disasters that destroy gold mines, the interplay of the international financial system, inflation, interest rates and alternative investments, and lastly the irrationality of investors. In average, especially since the beginning of the 21st century, the gold price has been raising. This is because of the increased

demand in emerging market (predictable), China, India, Russia and other country's decision to diversify their reserves towards gold (partly predictably) and the financial crisis which made gold a more attractive investment (unpredicted by most). The volatility of gold is a market risk. Another risk of this category is the liquidity risk. This occurs in thinly traded markets, where sellers have difficulties in finding willing buyers. Futures of not actively traded contracts might run into this risk. Shares of small stock mines might also face liquidity problems.

9. GOLD PRICE TREND 2013 AND BEYOND

Trend in terms of supply and demand of gold like all other commodity, the demand of gold is categorized mostly in four sectors i.e. Reserve Bank, Jewellery, Industrial and Investment. In most of country Reserve Bank is adopting approach to buy gold continuously, this trend will continue in 2013 and beyond. High gold prices and economic uncertainties will likely keep gold demand from Jewellery moderate in 2013.

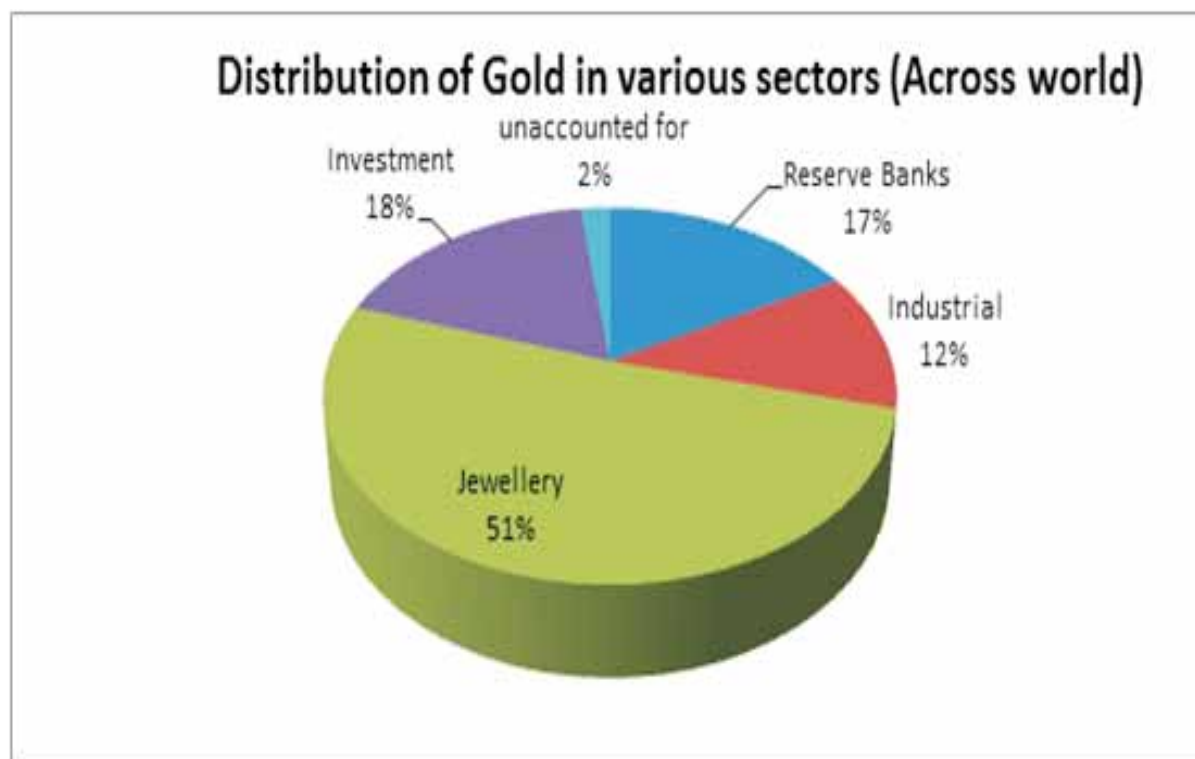


Fig. 6: Distribution of Gold in Various Sectors

Industrial demand for gold was 10% of total demand and due to higher price demand in this sector likely to get reduced. In addition to demand and supply side is also important for deciding trend. Gold production by mining reached a new high in 2010 and expected to increase by about 10% until 2013. Other governing factor for gold price in 2013 and beyond will be global financial situation.

Forecast by	Forecasted Gold Rate in Ounce (in \$)	Converted Rate per 10 gm. (in Rs.)	Year
BNP Paribas	2280	38635	2013
Thomson Reuters GFMS	2000	33890	2013
Morgan Stanley	2175	36856	2013
Newmont Mining	2500	42363	2013
Standard Chartered	2000	33890	2013
Standard Chartered	2107	35703	2014

Source: www.trustablegold.com

From the above table shows some forecast which seem to be speculations but due to the economic uncertainties, unfortunately the global financial problems are not yet stabilized. This may cause gold price to rise further.

10. CONCLUSION

World gold demand rose 11% to 981.3 tonnes in the first quarter of 2011 compared to 881 tonnes a year ago. But demand declined 2.2% from 1,003.7 tonnes in the last quarter of 2010. Jewellery demand, which accounts for 57% of total gold demand, stood at 556.9 tonnes in the first quarter of 2011 and a reduction of gold supply from 2001 the global gold production fell within a decade by 10%. Still, demand in Jewellery and by industry continues to increase due to India's and China's steady economic growth. Additionally, at the end of the decade central banks began to step up their gold reserves.

Other important factors are since 2001 increasing US national debt and the weakening of the US dollar relative to other currencies. Further, the financial crisis of 2008, during which the US government nationalized the two biggest US mortgage lenders and the biggest US insurer, drove up demand for physical gold and exchange traded funds. SPDR Gold Trust, the biggest ETF gold fund holds currently more gold reserves than the Chinese Central Bank. To stimulate the economy, the US Treasury reduced the federal funds rate to a mere 0.25 per cent. This low interest rate also made gold investments more attractive. The Nine Eleven attacks had only a short-term direct effect on the gold rate. The London PM gold price experienced within this trading day an increase by more than 5%. Usually daily differences are 10 – 20 times lower. In the long-term, the September 11 terrorist attacks had no direct effect on the gold rate. However, it can be argued that the costs for the US war on terror led to an increase of US national debt which finally resulted in a weakening US dollar and a higher gold price. Thus investment in gold is an important derivative instrument which has been widely accepted in order to avoid any kind of financial downturn in future and is regarded to be one of the safest investments. Gold is an evergreen investment option and certainly the choice during difficult times. For Indians, gold has traditionally been the first investment choice, ahead of stocks, debt or real estate.

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OPPORTUNITIES AND CHALLENGES OF CYBERSPACE NETWORKING: AN EXPLORATORY STUDY

(Invited Paper)

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ABSTRACT

This paper articulates the importance and future role of social and professional Internet-based networking websites. It investigates the history, growth, and global impact of cyberspace networking sites: social networking sites Facebook, MySpace, and Twitter for both the home users and business users; and professional networking issues related to LinkedIn, ZoomInfo, and Bright Fuse. This paper also discusses the interplay and inter-impact between events in the real world and the virtual world. In the context of social and professional Internet based networking, several issues emerge: online and offline social capital; where the real and virtual meet; humans turning into hermits in a virtual hangout culture; the generation gap among users; legal nuances and privacy invasions; fraud and misuse; virtual networking in real classrooms; marketing innovations; cyber bullying; security breaches; erosion of trust; promoting democratization from oppressive government regimes. The survey research methodology assesses the use of diverse features and services on popular as well as non-mainstream social and professional networking websites; inquires about future use of these websites and their importance and impact on society today and tomorrow.

Keywords : Social networking, public cyberspaces, computer-mediated communication, privacy in the cyberspace, FaceBook, Twitter, Linked-In, MySpace, QQ, Orkut, virtual worlds, advertisements with social networking, cyberspace abuse, hang over culture, YouTube.

1.INTRODUCTION

Networking, simply defined, is a supportive system of sharing information and services among individuals and groups having a common interest (dictionary.com). In the cyber world, new networking terminology such as social networking, professional networking, and even multimedia networking are sprouting up. All of these networking websites with their social and professional aspects help users connect with one another by allowing posting of messages, sharing of ideas, sharing of photos, and much more. Some of these websites include FaceBook.com, MySpace.com, Twitter.com, Linked-In.com, YouTube.com, and the list continues to grow. These websites are some of the largest and most visited spots on the Internet today. The Web information company, Alexa, lists Facebook.com, MySpace.com, Twitter.com, and YouTube.com in the top twenty most visited websites in the world. The user-base for Facebook is as large as 600 million users. If Facebook were a country, it would be the third largest in the world, more than the population of the United States. As technology continues to evolve, more and more people will start to access these networking sites.

1.1 TYPES OF NETWORKING

(i) Social networking services focus on building social relationships among people, especially teenagers, by facilitating sharing of interests, hobbies, events (birthday, prom, graduation, engagement, marriage, house-warming, promotion, death, etc.), and activities from anywhere at any time. (Palvia & Pancaro, 2010). Members are able to socialize, meet new friends, get feedback and comments on uploaded content, such as blogs, photos, thoughts, etc., along with staying in touch with other peers, including friends, family, and people with similar interests. Primary social networking sites popular in the United States are FaceBook, MySpace, and Twitter.

(ii) Professional networking services are of a business nature rather than social. These networking sites promote events and activities in the professional lives of people allowing them to share information related to a new job, a job achievement, job promotion, recommendation of another colleague in general or specifically for a job category, job availability in a company or in

the marketplace, and so on. A primary example of a professional networking site is LinkedIn. The purpose and focus of professional networking are narrower than those of social networking. Professional networking sites focus on work-related and career-oriented communications, while social networking sites focus on the personal lives and interests of individuals.

(iii) The emerging multimedia (including entertainment) networking services, facilitated by Web 2.0 technologies, allow both individual and business users the ability to share pictures/photographs, movies (video-clips), songs/speeches (audio clips), and other digital content at little or no cost. YouTube is a prime example of such services.

Social media can be defined as a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0 and that allow for the creation and exchange of User Generated Content (UGC). Kaplan and Haenlein [1] state that the UGC can be seen as the sum of all the ways in which people make use of social media. The term UGC describes the various forms of media content that are created by end-users and are publicly available. Although Wikipedia, YouTube, Facebook, and Second Life are all part of this large group, there is no systematic way in which different social media applications can be categorized. Kaplan and Haenlein [1] suggest two dimensions of social media: self-presentation/disclosure (low, medium, or high) and social presence or media richness (low, medium, or high). These two dimensions are used to classify social media applications, as summarized in Table 1. Social networking allows collaborative projects through wiki, which are websites that allow users to add, remove, and change the text-based content, and social bookmarking application, which are websites that enable the group-based collection and rating of Internet links or media content.

Table 1: Classification of Social media by social presence/media richness and self-presentation/self- disclosure [1]

		Social presence / Media richness		
		Low	Medium	High
Self-presentation / Self-disclosure	High	Blogs	Social networking sites (e.g. Facebook)	Virtual social worlds (e.g., Second Life)
	Low	Collaborative projects (e.g., Wikipedia)	Content communities (e.g. YouTube)	Virtual game worlds (e.g., World of Warcraft)

2. ISSUES

Based on the exhaustive literature review, we have identified several emerging issues due to the exponential increase in the use of networking sites. Briefly, these are:

(i) Online and offline Social Capital: Prior to the advent of the MySpace and FaceBook phenomena, social capital for most people was derived from offline forums, such as bars, clubs, musical events, theaters, sports events, camps, and picnics. With the creation of networking websites, there is another major source for social capital, cyberspace-based social networking.

(ii) Where the Real and Virtual Meet: Blogs, social networking sites, content communities, virtual game worlds, and virtual social worlds all have different functions, features, and commercial competitive advantages that make them viable for promoting products and services. Within virtual game worlds, advertising for real world products and services is becoming increasingly popular. Virtual social worlds can offer a multitude of opportunities for companies in the marketing of real products and services (advertising/communication, virtual product sales, and marketing research), human resource management, and internal process management. In Second Life games, real people are playing with virtual products/goods.

(iii) Humans Turning into Hermits in a Virtual Hangout Culture: According to Hosio et al [2], humans are losing rich social experiences to some degree because of the prospering online “hang around” culture. Peer pressure plays a role in the increased membership of social networking communities. Many teens feel required

Non-physical objects used in online communities or online games can also be digital gifts or clothing for avatars.to join these services to be seen as “cool” and not to be ignored by their schoolmates. This cyberspace social interaction makes students and members of communities lose touch with real social human interactions and experiences. The anonymity and low direct visibility in cyberspace networking lower the social barrier of natural interaction in public settings, thus making individuals more approachable to one another. Some users will start to live in their own virtual worlds and soon forget the real world they live in.

(iv) Generation Gap among Users of Networking Sites: The results of a study by Arjan et al [3] support the intuitive impression that teenagers 13- to 19-years of age make friends with just about anyone they may have an interest or similarity with based on birthday, musical group, movie, etc. On the other hand, older people over the age of 60 use these networking sites to connect with close friends and family members. Other findings were that teenagers use more self-references, negative emotions, and cognitive words than older people users aged 60 and over do, and older people use more articles and longer and essentially more formal words than teenagers.

(v) Legal Nuances and Privacy Invasions: Buchegger et al [4] emphasize that while exchanging instant messages (synchronous communication) and posting messages (asynchronous communication), users leave enormous amount of private information about themselves and their friends on the system of the social networking provider. Most networking sites allow their users to

access and to select appropriate privacy settings to protect the information that they leave behind. Freely shared information on social networking websites can be used to build a criminal case against a person and then used in a court of law.

(vi) Fraud and Misuse: According to Sullivan [5], FaceBook users are tempted to indulge in fraudulent acts, with the largest act being click fraud. Click fraud is defined as any paid-for click on an Internet advertisement that maliciously attempts to drain an advertiser's/competitor's advertising budget. The industry average for click fraud was 15.3% in the fourth quarter of 2009 and 13.8% in the first quarter of 2010. Although Click Forensics believes that click fraud might have subsided, it may become a political strategy for political parties.

(vii) Cyber Bullying: According to Eckholm et al [6], a social networking website is now yet another place where students can be preyed upon by their peers. In some cases, this has led to suicides by the victims.

Details of these issues are provided in Palvia and Pancaro [7].

3. RESEARCH METHODOLOGY

After deciding key issues to be explored, it was decided to prepare a detailed survey instrument, pilot test it, and then administer it on the Internet for efficiency of data collection as well as data analysis.

3.1 RESEARCH ISSUES EXPLORED Based on our experience and significant literature survey, we decided to explore the sixteen core issues for all networking sites – social and professional. This paper provides a brief overview of each specified issue with details pertaining to social and professional networking.

3.2 PREPARING SURVEY INSTRUMENT Based on the research goals cited above, an extraordinary amount of time was spent in discussing and finalizing questions, their sequence, and possible responses in the survey instrument. To comply with the legal restrictions on the use of human subjects for research, an application was submitted to the Long Island University Institutional Review Board, which reviewed and approved the survey instrument. The survey instrument was prepared using the popular survey creation/survey distribution management website SurveyMonkey.com. Many Fortune 500 companies use this website's service to obtain customer input about their companies' products and services. Survey Monkey allowed detailed questions to be posted in order to obtain information regarding the use of social and professional networking websites from the public. It also facilitates easy and efficient administration of survey to cyberspace networking users.

3.3 PILOT TESTING THE SURVEY INSTRUMENT The survey instrument was pilot tested by eight professors from “Long Island University”, with expertise in: business management, finance, statistics, management information systems, economics, etc. In addition, the Director of Career Planning at Long Island University was also requested to participate in the pilot-testing phase of the survey. The pilot testing was conducted to elicit detailed suggestions and feedback pertaining to the contents, clarity, sequencing, and possible missing questions in the survey instrument. Another useful feedback from the pilot testers was to improve the efficacy of using Survey Monkey. The pilot testers also provided feedback on the amount of time taken to complete the survey instrument. On an average it took the pilot testers 16.33 minutes to complete the survey. Both the median and modal times were 15 minutes. These times confirm the efficient design of the instrument, in its ability to elicit a lot of information in a short period of time without burdening the survey taker.

3.4 ADMINISTERING THE SURVEY INSTRUMENT The survey instrument was finalized on March 1, 2011. To improve the quality, quantity and timeliness of responses, three prizes (to be randomly picked) were announced for responses that were received by May 1. The three prizes announced were:

Apple iPad 2 32gb Black Model: Winner – First Prize
Apple iPod Touch 32gb Black Model: Winner – Second Prize
Apple iPod Touch 32gb Black Model: Winner – Third Prize

Five professors informed their students to go to the survey link and fill out the survey. Over 800 friends on Facebook were sent a private inbox message requesting that they take the survey and that prizes were available for their participation. By May 1, two hundred fifty survey responses were received. The analysis that follows is based on this sample.

After the close of the survey on May 1, 2011, a computer system randomly picked three out of the 250 respondents to win the three prizes. The winners were notified by telephone and e-mail about their prizes, which they have subsequently picked. A message on the survey website informed possible future survey takers that the survey period had ended.

4. DATA COLLECTION

4.1 DEMOGRAPHICS OF RESPONDENTS Two hundred and fifty-five people took this survey. The beginning of the survey asked survey respondents what types of networking sites they used, social, professional, or both. Based on this preliminary question, the rest of the appropriate survey questions were then administered to the respondents – the analysis is given below. Demographic information for this survey was obtained from answers to 34 questions. Over 90% of the respondents live in USA. The remaining 10% of the respondents were from China, Croatia, India, Italy, New Zealand, Sweden, and Turkey. Below is the summary of responses. Table-2 provides profile (% of total responses) based on gender and marital status.

Table 2: Profile according to Gender and Marital Status

Marital Status/Gender	Male	Female
Single, Never Married	82.3%	88.0%
Married	15.6%	9.6%
Separated	0.0%	0.8%
Divorced	2.1%	0.8%
Widowed	0.0%	0.8%
Total	100%	100%

Tables 3, 4, and 5 provide demographic profile information about age group, race, and educational level of the respondents.

Table-3: Profile according to Age Group

Age Group	13-17	18-24	25-34	35-44	45-54	55-64	65-74	>=75
Percent	1.4%	79.6%	5.0%	5.9%	2.7%	3.6%	1.8%	0.0%

Please note that the age group 18 through 24 had a large number of respondents due to the fact that the survey was administered on a college campus.

Table 4: Profile according to Race

Race	White (Caucasian)	Black (African American)	Hispanic (Latino)	Asian	Indian Subcontinent	Chinese	Filipino	Korean	Native American / AN	Others
Percent	70.4%	6.8%	5.5%	4.5%	3.2%	2.7%	1.4%	0.5%	1.4%	3.6%

India, Bangladesh, Pakistan, Nepal, Srilanka

The question about race or nationality was not mandatory. Thirty-five of our respondents chose not to answer this question

Table-5: Profile according to Education Level

Education Level	Less than High School	High School/ GED	Some College	Two Years College	Four Years College	Master's Degree	Doctoral Degree	Professional Degree/ Certification	Vocational Degree
Percent	1.4%	4.1%	28.5%	8.1%	43.0%	9.0%	5.0%	0.0%	0.9%

Another noteworthy profile dimension to understanding social networking was specific question: Do you have a MySpace Profile? This is an important question since MySpace was one of the modern Web 2.0 based and very popular cyberspace social networking websites. Only 22.7% of the survey respondents had a MySpace profile while 77.3% of the survey respondents did not. The results illustrate the decline in the usage of the once popular and frontier leading social networking website.

5. DATA ANALYSIS

Below is an analysis according to each of the research questions. The answers to these questions were based on the complete survey instrument.

Issue-1: Which networking sites on the Internet are being used?

This issue is captured by question #1 for social networking sites and by question #2 for professional networking sites.

Question #1: Which social networking sites do you currently use or are a member of?

Out of the 250 respondents in the survey, 88.8% of the survey takers used Facebook as their social networking of choice. MySpace was only able to muster 14.4% of the survey audience, and the new Twitter social networking website received affirmative responses in about 30.4% of the survey audience. Other social networking websites not listed and other popular social networking websites such as QQ and Orkut picked up 14% of the respondents' votes. It is important to note that 21 respondents out of our 250 survey takers, or about 8.4% of the survey takers, were not a member of any social networking website. It should be emphasized that respondents could check multiple boxes if they used multiple social networks. This question makes it clear that many people in the United States are using FaceBook as part of their daily life activities.

Question #2: Which of the following professional networking sites do you currently use or are a member of?

In only 26% of the cases, LinkedIn was the professional network of choice, followed by Bright Fuse. Most of the survey respondents taking this survey did not use professional networking websites, but were using social networking websites (e.g., FaceBook, Twitter, QQ, Orkut, etc.).

Issue-2: For what purposes are the networking sites being used?

The answers to this question are obtained through question #3 in the context of social networking sites. Since the purpose of professional networking sites, like LinkedIn is more niche-based, and especially used for leads for jobs and career advancement, we did not include this question for professional networking.

Question #3: For what purposes do you use social networking sites?

Over 96.5% of the respondents said they use social networking website for social/ friendship connection. Other uses of networking websites include business communication at 28.7% and multimedia promotion and sharing of music / movies / photos at 36.1%. Real-time sharing of ideas and idea generation came in at 37.4%, while other uses of social networking were noted at 6.1%.

Issue-3: How long is the loyalty of users to specific social networking sites?

Question #4 and #5 elicit information for this question.

Question #4: How long have you been a member of the following social networking sites?

Social Networking websites have been claimed by many to decrease productivity, analysis of the survey results support this generalization that many users of social networking sites share. Most of the survey respondents using FaceBook have been doing so for 2-4 years. Most MySpace users have been using the site for 0-2 years. Over the past few years, MySpace has made significant improvements to images and features. Due to these changes, some users are returning to MySpace, but this return rate is slower than the adoption rate for FaceBook, Orkut, and QQ. MySpace has the largest number of users in the over six years of usage category. This makes sense since MySpace was the "first" social networking website to make history in the Web 2.0 movement. As for Twitter, most of its users have joined 0-2 years back. Twitter has dramatically changed over the past couple of years and the new Twitter platform allows users to Tweet brief updates of information to their followers to view. QQ, Orkut, and others follow similar patterns of new user adoption among United States residents. Many survey respondents of Asian descent have been using QQ and Orkut for 2-4 years.

Question #5: How long have you been a member of the following professional networking sites?

Seventy percent of the survey respondents joined and used the LinkedIn Service for 0-2 years. The next biggest usage time duration is 2-4 years for 21.7% of LinkedIn members. Other professional networking websites, such as Bright Fuse and ZoomInfo, received very low usage rates among the survey audience.

Issue-4: How often do the users visit a site and how much time is spent during each visit?

Questions 6, 7, 8 and 9 capture information on these twin issues.

Question #6: How often do you visit any of the following social networking sites?

Many people who use FaceBook and Twitter use the platforms multiple times per day. MySpace users seem to sporadically check their profiles on a bi-weekly or monthly basis. Because of the sporadic responses, no conclusion can be drawn regarding the usage pattern of other social networking websites.

Question #7: How often do you visit professional networking sites?

Out of all survey respondents using professional networking, only 5.2% visit professional networking websites multiples times per day; 17.2% visit once per day; 25.9% visit these websites once per week; and the remaining respondents indicated they visit professional networking websites once per month. Linked-In was the primary professional networking website our survey indicated they were visiting.

Question #8: When you visit a social networking website, how much time do you spend on average?

Respondents report that they usually spend less than one hour per visit on a social networking website. However, FaceBook has the greatest percentage of users stating they spent over one hour during a visit.

Question #9: When you visit a professional networking website, how much time do you spend on average?

The majority of respondents using professional networking websites (86.2%) spend less than one hour on the site, while the next largest segment spend no more than 1-2 hours on professional networking websites (10.3%). One respondent stated he/she uses another type of professional networking website called TeamWorkOnline for over 5 hours per week. This site is dedicated to sports management and sports recruiting after leaving college.

Issue-5: Which features are important for each type of networking on the Internet?

Answers to this issue are captured by question #10 and #11.

Question #10: Rank your favorite social networking activities in order of priority, with number 1 indicating your most used networking feature and number 14 indicating your least used networking features. Click “N/A” for features you do not use.

A majority of the survey respondents primarily use the social networking website features of posting messages and sharing photos. However, sharing and downloading music and videos is also a popular function on networking websites. Although people have the ability to use telephone as a synchronous communication medium, most people prefer to use these networking websites for basic communication between “friends.” Other popular activities on these sites include blogging, creating and sharing virtual objects, participating in collaborative projects, etc.

Question #11: Rank your favorite professional networking activities in order of priority, with number 1 indicating your most used networking feature and number 14 indicated your least used networking feature. Click “N/A” for features you do not use.

Professional networking websites do not exactly have the same usage patterns as social networking websites. Though the most popular feature on both social and professional networking websites is posting message; the various multimedia based features such as sharing photos, music, and videos are not as popular on professional networking websites as they are on social networking websites. Updating personal websites or online profiles is the second most popular feature / use of professional networking websites. The remainder of the networking

Issue-2: For what purposes are the networking sites being used?

The answers to this question are obtained through question #3 in the context of social networking sites. Since the purpose of professional networking sites, like LinkedIn is more niche-based, and especially used for leads for jobs and career advancement, we did not include this question for professional networking activities for professional networking based websites such as downloading / uploading photos, music, and videos, blogging, creating new characters are not popular uses on professional networking websites.

Issue-6: What changes do the users want to see on each type of networking sites?

Responses to this issue were obtained through questions #12 and #13.

Question #12: What type of changes would you like to see to social networking sites in general? (Please choose all that apply)

An overwhelming seventy percent of our survey respondents wanted less number of advertisements and pop-ups on the social networking websites. The respondents believe that advertisements were the biggest issue with these online networking communities. Interestingly, personalization option for profile pages was the second most desired change on social networking websites. Complete privacy / security protection control came in third among users.

Table-6: Survey Question 12-Analysis

Changes	% of Respondents
Personalization options for profile pages (backgrounds, music, themes, colors, etc.)	53.9%
Less advertisements	70.0%
More promotions / Free Coupons	25.7%
More social events: Planning vs. Social communication interaction	27.8%
Complete Privacy / security control options (please explain in the space below)	41.9%
Other	9.0%

What types of changes would you like to see to social networking sites in general?

(Please note respondents were allowed to choose multiple answers to this question to best identity all the features and changes they would like social networking websites to incorporate.)

Question #13: What type of changes would you like to see to professional networking sites in general? (Please choose all that apply)

Professional networking websites, unlike social networking websites had a lower and more evenly distributed percentage of requested changes per category. The most demanded feature for professional networking websites was to have an enhanced ability for more social event planning vs. social communication interaction. The needs and wants from professional networking website users, utilizing professional networking service though similar to users on social networking websites, have varying differences as Figure Eight indicates below.

Table-7: Survey Question 15 Analysis

What types of changes would you like to see to social networking sites in general?

(Please note respondents were allowed to choose multiple answers to this question to best identity all the features and changes they would like professional networking websites to incorporate.)

Changes	% of Respondents
Personalization options for profile pages (backgrounds, music, themes, colors, etc.)	36.7%
Less advertisements	38.3%
More promotions / Free Coupons	21.7%
More social events planning vs. Social communication interaction	40.0%
Complete Privacy / security control options (please explain in the space below)	28.3%
Other	20%

Issue-7: What is the impact of social networking on various aspects of users' lives?

Question #14 captures responses on this issue.

Question #14: How does social networking affect the following aspects of your life?

An overwhelming percentage of survey respondents did not believe that social networking had little or no impact on their physical activity (67.1%), classroom learning (48.5%), household responsibilities (65.9%), or work performance (65.3%). However, survey respondents did believe that social networking positively affects their daily social interactions 48.2%.

Issue-8: What are the users' experiences in regard to advertisements on the networking sites?

Questions 15-17 capture users' views on this issue.

Question #15: Please answer the following questions regarding advertisements on the social networking sites?

This question was added to the survey to gauge the opportunity for social networking websites to profit from advertising on their platform. Our survey respondents indicated that 50.6% of the time they never click on advertisements, while 41.1% of the time they click on advertisements. The last sub question, how often do you buy based on clicking, less than 2½% of the survey

respondents would actually make a purchase based on clicking an advertisement on social networking websites. A majority of the survey respondents never click advertisements, therefore, they never purchase from advertisements.

Question #16: Please answer the following questions regarding advertisements on professional networking sites?

On the other hand, professional networking websites within our survey group hardly see any type of advertisement usage by our respondents, compared to the minimal amount of advertisements our respondents noticed and clicked on for the social networking questions above. Only 35.5% of respondents never notice advertisements on professional networking websites. However, 19.6% of respondents did sometimes notice advertisements. In terms of sub questions two, how often do you click on advertisements, an overwhelming 67.3% of respondents do not click on advertisements, while a good majority of the other respondents, 24.4% rarely click on advertisements. Compared to advertisements on social networking websites, advertisements on professional networking websites are less viewed, clicked on, and used to favor the advertising companies in terms of sales.

Question #17: What type of advertisements on networking sites appeal or stand out in your mind? (Check all that apply)

This question pertains to advertisements on both social and professional networking sites. Advertisements that gained over 90% visibility on social networking websites include but not limited to: discount/coupons, music/music advertisements, social club engagements, and travel/vacation promotion. In contrast, most of the advertisements on professional networking websites were for financial/credit promotions, health/medical, and job opportunities/and promotions.

Issue-9: What is the expected continued use of favorite networking sites?

Questions 18 and 19 capture the responses to this issue.

Question #18: How long do you plan on continuing to use the services of your favorite social networking sites?

Almost fifty-percent of our survey respondents (49.1%) indicated that they would be on social networking websites five years from now and more. Over 22.1% of respondents provided other as a response. The most common other responses were: lifetime, as long as I need / want to, ten years, as long a social networking remains popular, as long as my friends still use it, etc. Our research has shown that social networking websites can be an addiction and now users have a long-term reliance to the information / content that these social networking websites hold.

Question #19: How long do you plan on continuing to use the services of your favorite professional networking site?

Like question #18, over 34.1% of survey respondents believed they would use professional networking websites for at least five years or more. However, other responses (40.7%) from the participants were also indicated such as: for the duration of my career search, for my life, until it interferes with company work performance, as long as I'm employed, etc. The focuses and uses of social and professional networking are both very different. Please see Table 8 below comparing questions 18 and 19.

Table 8: Survey Question #18 & #19- Analyses

Future Usage	Social Networking	Professional Networking
Six months from today	4.2%	8.4%
One year from today	8.4%	9.0%
Two years from today	16.2%	9.0%
Five years from today	49.1%	34.1%
Other responses	22.1%	39.5%
Total	100%	100%

Issue-10: What is the extent of use of “Location Sharing” application and for what purposes on social networking websites?

Questions 20 and 21 determined users' responses on this issue.

Question #20: Do you use the Places / Location sharing application available on touch.facebook.com or the Facebook App for smartphones (iPhone, BlackBerry, Android, HP webOS, or Windows Phone 7)?

The survey found that this popular new geo-tagging based service was not being used by 72.6% of the survey respondents; however, 27.4% out of the 250 respondents are starting to use this new feature. As a follow-up to this question:

Question #21: Why do you choose to use the Places / Location sharing application available on touch.facebook.com or the Facebook App for smartphones (iPhones, BlackBerry, Android, HP webOS, or Windows Phone 7)?

In 76.4% of the cases, the respondents wanted to share where they were and connect with friends that may be nearby. The survey indicated that 18.2% of the survey respondents for this question were looking to find local deals and discounts. With online target marketing growing daily, businesses can look at historic trends released from social networking companies to help them better allocate monetary resources toward improving their success of interacting with the customer in direct advertising campaigns. This new service will allow the technological savvy target audience of potential customers to benefit from this new form of direct

marketing as well as allowing the businesses to benefit from an affordable and more profitable advertising campaign.

Issue-11: How many Facebook friends, LinkedIn connections, and Twitter followers does a networking site user have?

Light is shed on this issue from responses to questions 22, 23, 24, and 25.

Question #22: How many FaceBook friends do you have?

The mean answer for this question is 477 friends. The median number in this set of data is 467 (which is very close to the mean). The mode or most frequent number in this questions data was zero (0). Some respondents who filled the question out did not have any FaceBook friends and were using other networking websites. The next most frequent number in the set of data was 500 friends. These numbers appear to be very high pointing to how friendship in the cyberspace is different from the one in the real space of past.

Question #23: How many Twitter “followers” do you have?

The mean answer is 48 followers. The median number for this set of numbers was zero – many people do not have Twitter Followers and the mode or most frequent number was also zero. The maximum value from the dataset was 4,324 followers. As the numbers indicate above, many of our survey respondents were not using Twitter as a social network. However, as the popularity of the social network continues to grow, we believe that the number of respondents in the future to this question would increase.

Question #24: How many profiles are you “following” on Twitter?

The average is 66 other Twitter users. The median number in this data set is zero meaning that a majority of survey respondents do not use or follow other Twitter users. The mode or most frequent number in the set of data was also zero, suggesting that many of our survey participants do use the social networking platform Twitter.

Question #25: How many LinkedIn “connections” do you have?

The average respondent has 16 connections. The median number for this set of data was zero signifying that many of the respondents do not use LinkedIn. In a similar fashion the mode or most frequent number in the set of data was also zero. The maximum for this set of data is 350 meaning that one survey respondent has 350 LinkedIn connections.

Issue-12: Does presence on cyberspace networking sites impact job search and career advancement?

Questions 26 and 27 make the requisite inquiries on this issue.

Question #26: Have you used networking sites to enhance your chances to obtain a job?

This question asks survey respondents whether they have used either social or professional networking websites to obtain a job. Many respondents indicated that they do not use social networking in finding a job. Contrary to the name, professional networking websites have not been used by the survey respondents either in terms of obtaining a job.

Question #27: How does the use of networking websites impact your chances of obtaining a job?

Question 27 takes question 26 one step further. The perception of the survey respondents is that using either social or professional networking services, in overall terms, no impact on a job search -- 23.1% thought using social networking would provide a positive impact; another 21.3% thought it would provide a negative impact. The responses, however, are different for professional networking sites. A significant proportion 44.4% of professional networking users perceived such websites potentially having a positive impact, while only 1.3% thought it would provide a negative impact.

Issue-13: Do the employers of respondents monitor and/or control their use of cyberspace networking sites?

Questions 28 and 29 capture necessary information from respondents on this issue.

Question #28: To what extent do you believe that the following organizations check your existence on social networking sites?

With the growing popularity of social and professional networking websites, more and more institutions such as corporate employers, mortgage lenders, auto lenders, and universities are turning to these new tools to help investigate and explore a possible employee and or candidate. Respondents “strongly agree” that prospective employers view applicant's presence on social networking websites. Survey respondents “moderately agree” that prospective mortgage lenders, prospective auto lenders, prospective university admissions offices, credit card companies, and other establishments may look at an individual's profile, thus impacting their decision-making process towards an individual applicant for a product or service.

Question #29: To what extent do you believe that the following organizations check your existence on professional networking sites?

Though question 29 asked the same question as 28, but in terms of professional networking, many people felt the same way as the ladder question – Please refer to Table below for a comparison between the perspective users have of organizations looking at professional networking profiles and the impact it has on the individual / decision makers' mindset compared with social

networking websites.

Table 9: Survey Question 28 & Question29 Analyses (Social Networking/Professional Networking)

	Strongly Agree	Agree	Moderately Agree	Disagree	Strongly Disagree	Total %
Perspective employers	38.0% / 42.6%	32.5% / 33.3%	23.5% / 21.0%	3.6% / 1.2%	2.4% / 1.9%	100% / 100%
Perspective mortgage lenders	6.7% / 9.2%	18.9% / 24.5%	39.6% / 38.1%	23.8% / 17.2%	11.0% / 11.0%	100% / 100%
Perspective auto lenders	4.9% / 6.1%	10.4% / 20.2%	40.2% / 37.5%	29.9% / 24.5%	14.6% / 11.7%	100% / 100%
Perspective university admission offices	19.5% / 16.6%	27.4% / 27.6%	30.5% / 30.1%	18.3% / 18.4%	4.3% / 7.3%	100% / 100%
Credit Card companies	6.7% / 9.4%	14.6% / 21.9%	37.8% / 35.6%	28.7% / 21.3%	12.2% / 11.8%	100% / 100%
Other	5.9% / 4.8%	7.8% / 7.9%	43.1% / 44.5%	25.5% / 20.6%	17.7% / 22.2%	100% / 100%

Issue-14: How do the providers of cyberspace networking make “user experience” satisfying in terms of answering any questions and providing timely relevant updates to the website?

Two questions #30 and #31 are designed to assess providers' support to make cyberspace networking “user experience” satisfying.

Question #30: How easy or difficult is it to resolve a question or a concern regarding the use of a networking website?

Many of the respondents in regards towards social networking website, Facebook, thought it would be easy to get questions they had with the website resolved. As for the other social networking websites such as MySpace, Twitter, QQ, and Orkut many people did not know or were not familiar with contacting support to get questions / issues, answered / resolved. However, for LinkedIn, ZoomInfo, and Bright Fuse professional networking websites, a majority of survey respondents did not know how to resolve questions / concerns they were having with the website.

Question #31: Which updates do you generally get from networking websites? (Check all that apply)

In each respective column social networking seems to be used for a wide variety of subjects such as entertainment, family updates, fashion, friend's updates, technology, etc. On the other hand professional networking seems to predominantly provided users with business and communication updates as well as technology information. Our data indicated that professional networking appeared to be a niche networking area.

Table 10: Survey Question 31- Analysis

	Social Networking Websites	Professional Networking Websites
Business and Communications	31.7%	68.3%
Entertainment	97.5%	2.5%
Family Update	97.5%	2.5%
Fashion	84.7%	15.3%
Technology	59.7%	40.3%
Other	42.9%	57.1%

Issue-15: What suggestions do the respondents have to improve social and professional networking sites?

Question #32 and Question #33: What suggestions do you have to improve social networking websites? What suggestions do you have to improve professional websites?

The survey respondents indicated they would like to see greater security and privacy protection on social networking websites. Furthermore, the constant upgrading implemented by some social networking companies forcing new looks on user profiles was the second most complained about problem. Overall, social networking website perform their service well, but users indicated that with the new forced layout and themes comes greater advertisement visibility forcing users to seem advertisements they

would otherwise not have noticed in the past.

Table 11: Survey Question 32 & 33- Analysis

Suggestions to Improve Networking Websites	
Social Networking	Professional Networking
1. Enhance privacy	1. Stop offering paid premium service options
2. Stop constant profile layout changes	2. Search options
3. Less advertisements	3. Job board for employers to list jobs
4. Anti-hacking protection	4. Greater mobile access
5. Greater global integration	5. Enhanced interface with multimedia ability

In terms of the professional networking websites, the removal of paid-for premium service / connection features was the biggest suggestion and feedback our survey respondents had to offer. Search options on some of these websites are quite poor and users would like to see enhancements so it is easier to find their contacts and enhance their network. Another requested feature was a job board for searching and posting jobs by regions or town, to allow employers looking to fill jobs a free option to locate and find talent / workers to fill vacancies.

Issue-16: What other networking sites are being used by the respondents besides the popular ones – FaceBook, MySpace, LinkedIN, Twitter, YouTube.

Question #34: Besides FaceBook, MySpace, Twitter, LinkedIn, and YouTube what other Internet-based networking sites do you use? Networking can vary from personal matchmaking to online sports talk communities. Below is a list of popular websites. Please check off all that apply, and if not specified, please state additional websites in the space provided below.

The most popular networking sites outside of the ones investigated in this survey are Flickr.com, LiveJournal, Stumbleupon.com, and Yahoo! 360.

6. CONCLUSIONS AND IMPLICATIONS

Through the survey instrument, our research has observed / concluded that Social and Professional Networking websites are becoming inter-woven into the fabric of our global society. Due to this, vast new implications for researchers, companies, and world citizens have been drawn. Researchers interested in obtaining more information about social networking services should try to understand the time spent on these social networking sites against other productive tasks that could be occurring. Though users in our survey identified what they were using social networking for, researchers must further understand, as noted above, the time management and specific networking features used while on these websites. For instance, do these websites encourage users to live their own lives or simply follow their “friends” lives? In terms of professional networking websites, investigators should look at the correlation between usage of professional networking sites and the ability for increased job promotions, business deals, and corporate connections leading to a positive outcome. Many people believe that professional networking can be annoying and difficult to use and create. In many circumstances it is a visible online resume – is this a true statement? Does professional networking offer more than basic services?

Implications and intricacies for companies in this newly created Social and Professional Networking landscape is also important to understand. Slow corporate adopters may find themselves without “friends” and customer connections online, therefore losing a potential for increased exposure and revenue stream. Companies such as FaceBook and Twitter must show adaptability to constantly changing technology; and needs and wants of the users. Popularity, status, prestige of a product, service or company is ephemeral in today's age. FaceBook is a popular social networking website, while MySpace is a dying platform that may not be able to survive its rapid loss of members. As the times change, social and professional networking based websites need to conform to the new wants and demands of its users. MySpace was very slow to adopt a new website interface and design for its users and in part, this has caused the network to lose millions of users. Even large organizations such as FaceBook are not immune from negative media or failure in its products and service it delivers users. Networking websites must continue to look at trends and even beta test new services of its website to specific users to ensure that users' needs, now and in the future can be met. Security and data safety among all networking websites is critical to a corporation's success on networking platforms.

Lastly, implications for world citizens using these growing platforms must also use caution. Even though social networking can allow for the connection of millions and, in the near future, billions of people instantly, true friends are not made on in the cyber space. Many users of social networking are getting carried away in this cyber world. It is important for users to not forget the real world. A balance must exist between the two worlds. In this research, we found that social networking users log into these websites multiple times per day and on an average are spending 1-2 hours per day. That takes away from their association with real people in the real world. People must continue to live their own lives and not get stuck in watching or even “living” the lives

of other people. On professional networking websites, we believe, the story is different. People use professional networking websites to connect with other people in order to support and help their friends / connections in achieving their career and professional goals and dreams. This virtual network of business professionals encourages fosters an online culture of professionalism and job enhancement.

As social networking sites such as FaceBook store more information and incorporate changes into their business model to hold financial information, could this possible vulnerability that Sony Entertainment experienced happen to social networking sties? Social and Professional Networking have already had a profound impact on the human race and planet in which we live today. The number of users has been and will continue to grow exponentially on these websites. The gradual and steady impact these sites are having on our social, economic, corporate, and governmental landscapes will be sustained. Features of liking, posting, tagging, and sharing are here to stay and users must proceed with caution and find the perfect harmony between the real world we live in and the virtual world that is increasingly becoming popular.

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