INTRODUCTION TO RADAR SYSTEMS

UNIT-IV

Lecture-3

Detection Criteria

- The detection of weak signals in the presence of noise is equivalent to deciding whether the receiver output is due to noise alone or to signal-plus-noise.
- This is the type of decision probably made (subconsciously) by a human operator on the basis of the information presented at the radar indicator.
- When the detection process is carried out automatically by electronic means without the aid of an operator.

Contd.

- Almost all radar detection decisions are based upon comparing the output of a receiver with some threshold level. If the envelope of the receiver output exceeds a pre-established threshold, a signal is said to be present.
- The purpose of the threshold to divide the output into a region of no detection and a region of detection or in other words the threshold detector allows a choice between one of two hypotheses.

Contd.

- There are two types of errors that might be made in the decision process. These are unavoidable with observations of finite duration in the presence of noise.
- One kind of error is to mistake noise for signal when only noise is present. This occurs whenever the noise is large enough to exceed the threshold level. In statistical detection theory it is sometimes called a type I error. The radar engineer would call it a false alarm.

Contd.

- A type II error is one in which the signal is erroneously considered to be noise when signal is actually present. This is a missed detection to the radar engineer.
- The setting of the threshold represents a compromise between these two types of errors. A relatively large threshold will reduce the probability of a false alarm, but there will be more missed detections.
- The nature of the radar application will influence to a large extent the relative importance of these two errors and, therefore, the setting of the threshold.

Neyman-Pearson Observer

- The threshold level was selected so as not to exceed a specified false-alarm probability; that is, the probability of detection was maximized for a fixed probability of false alarm.
- This is equivalent to fixing he probability of a type I error and minimizing the type II error. It is similar to the Neyman-Pearson test used in statistics for determining the validity of a specified statistical hypothesis. Therefore this type of threshold detector is sometimes called a Nevman-Pearson Observer

Ideal Observer

- The criterion of Neyman-Pearson is not the only one which might be used for establishing a threshold level. One of the first mathematical criteria applied to the theory of radar detection was the Ideal Observer as formulated by Siegert.
- The term "Ideal" does not necessarily imply that this criterion is the ideal criterion.
- The criterion of the Ideal Observer maximizes the total probability of a correct decision (or minimizes the total probability of an error).

Sequential Observer

- Both the Neyman-Pearson Observer and the Ideal Observer assume that the integration time is fixed. However, the detection decision might very well be made on the basis of only a few observations, it would not be necessary to record the later observations that occur once the threshold has been crossed. Hence there may be some advantage to using a flexible detection criterion which takes account of this fact. Such a detection criterion is the Sequential Observer.