# INTRODUCTION TO RADAR SYSTEMS

UNIT-IV

Lecture-2

# Correlation Detection

Cross-correlation Receiver:

- The cross-correlation function is a measure of the coherence between two waveforms $V_1(t)$ and $V_2(t)$. A cross-correlation function is the long-time average of the product of two functions.
- The principle of the cross-correlation function may be used as a basis for radar receiver design.
- The correlation receiver determines whether or not the waveform is present. It also determines the range R (time delay $T_r$). The noise waveform that accompanies the pulse is random and unknown to the receiver.

# Contd.

- An operator viewing a CRT display might be described as performing a cross correlation in the process of recognizing a target signal. He stores in his memory an image of the display that corresponds to the target he wishes to find on the scope.
- In fact, he has a multitude of images, each corresponding to a different position on the face of the scope. The expected image corresponds to the form of S(t), and the various positions on the scope correspond to the parameter $T_r$.

# Contd.

- The process of cross correlation is a basic concept in the detection of signals in noise.
- In the previous section, the similarity between the matched-filter receiver and the cross correlation function was described.
- Mathematically, the matched filter performs a cross correlation between the received signal and a replica of the transmitted signal stored in the frequency-response function of the matched filter.

# Contd.

- A cross-correlation receiver may be obtained directly by multiplying the input signal y(t) by a delayed replica of the transmitted signal $s(t - T_r)$ and averaging as indicated in the block diagram. The product of y(t) and $s( t - T_r)$ is averaged in a low-pass filter. The filter output is the cross-correlation function for the fixed time $T_r$ .
- Because the low-pass filter is not a perfect integrator, the output is only an approximation to the cross-correlation function.

# Contd.

- It was assumed above that the frequency of the received signal was known; that is, the transmitted pulse suffered no doppler shift in frequency, or if it did, the amount of shift was presumed known.
- When the frequency of the echo signal is unknown, a number of correlation receivers must be paralleled to cover the band of frequencies in which the echo is expected. The reference signals $s(t - T_r)$ of each receiver are at different frequencies.

# Contd.

- Cross-correlation technique is well suited for use with a noise waveform. Radar transmitting this type of signal does not have the problem of ambiguous range/doppler measurements associated with periodic waveforms. Broadband noise waveform is readily generated than other types of complicated waveforms.  Noise waveform has advantage in environment of electronic countermeasures: it is more difficult for enemy to recognize a noise signal than one with repetitive characteristic