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Introduction of Radar

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Abstract: *RADAR means Radio Detection and Ranging. It is an electromagnetic system for the detection and location of target such as airplanes, ships, spacecraft, Automobile vehicles, people. RADAR works by radiating electromagnetic waves towards the target and analyze echo or the reflected back waves to determine the angle, range and speed of the target. This paper gives an outline of RADAR Working principle, Types, display and some of the RADAR applications.*

Keywords: RADAR, Target, Applications, Electromagnetic

I. Introduction

RADAR means **Ra**dio **D**etection **A**nd **R**anging. Detection refers to whether the target is present or not in RADAR Range. The target can be stationary or moving form i.e., non-stationary. Ranging refers to the distance between the Radar set and the target. **RADAR** is basically an electromagnetic system used to detect the location and distance of an object from. It works by radiating energy into the radar set and monitoring reflected signal from the objects for determining different parameter of target.

II. Literature Survey

[1] This paper gives summary of RADAR, principle and some of the RADAR applications, which range from air traffic control, forest and climate, natural disasters monitoring.

[2] This paper analyses the main trends that push for the merging of radar type sensors and wireless communications. It presents the most significant use cases that can be currently foreseen and identifies the main technology trends and issues to reach a developed technology, focusing on OFDM type waveforms that will permit a smooth integration with 4G and 5G.

[3] This paper Initially overview the application scenarios and the research development in the area of communication and radar spectrum sharing, with particular emphasis on: 1) Radar-communication coexistence; 2) Dual-functional radar-communication (DFRC) systems. In the remainder of the paper they propose a novel transceiver Architecture and frame structure for a DFRC base station operating in the millimeter wave and, using the hybrid analog-digital beam forming method.

[4] This paper focus on hardware implementation of orthogonal frequency division multiplexing (OFDM) based joint radar and communication system for the vehicular application. Improvement of the communication system

[5] In this paper the basic Moving target indicator concepts and definitions are presented, and the real problems of modern surface-based MTI radar systems are covered.

III. Basic Principle Of Radar

Radar is used for detection of the objects and finding their location. The **basic principle** of Radar is described from the following figure.

As shown in the figure 1, Radar mainly contains transmitter and a receiver. It uses the same Antenna for both transmitting and receiving purpose. The function of the **transmitter** is to transmit the electromagneticsignal in the direction of the target. Target reflects this transmitted signal in various directions. Thesignal, which is reflected back towards the RADAR Antenna gets received by the **receiver** and find different parameters of RADAR like range, speed etc.

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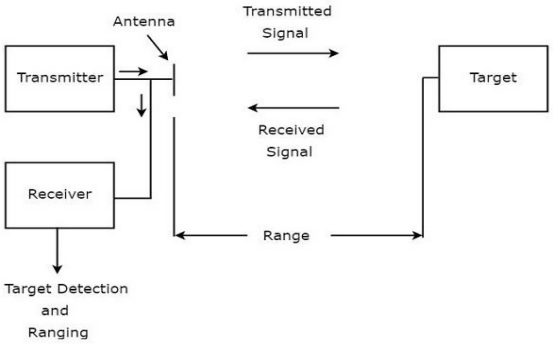

Figure 1: Basic Principle of Radar

IV. TYPES OF RADAR

This Section provides the information briefly about the different categories of Radars. Radars can be classified into **two types** based on the type of signal with which Radar can be operated.

- Continuous Wave Radar
- Pulse Radar

4.1 Continuous Wave Radar

The Radar, which operates with continuous signal or wave is called Continuous Wave Radar.

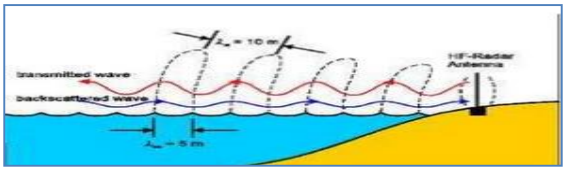

Figure 2: Continuous Wave Radar

They use Doppler Effect for detecting non-stationary targets. Continuous Wave Radars can be classified into the following two types.

- Unmodulated Continuous Wave Radar
- Frequency Modulated Continuous Wave Radar

A. Unmodulated Continuous Wave Radar

The Radar, which works with continuous wave for detecting non-stationary targets is called Unmodulated Continuous Wave Radar or simply, **CW Radar**. It is also called as CW Doppler Radar.

This Radar requires two Antennas.One Antenna is used for transmitting the signal towards the target and the other Antenna is used for receiving the signal from the target. It measures only the speed of the target but not the distance of the target from the Radar set.

B. Frequency Modulated Continuous Wave Radar

If CW Doppler Radar uses the Frequency Modulation (FM), then that Radar is called the Frequency Modulated Continuous Wave **(FMCW)** Radar or FMCW Doppler Radar. It is also called Continuous Wave Frequency Modulated Radar or CWFM Radar.

This Radar requires two Antennas. Among which, one Antenna is used for transmitting the signal and the other Antenna is used for receiving the signal. It measures not only the speed of the target but also the distance of the target from the Radar. In our subsequent chapters, we will discuss the operations of all these Radars in detail.

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4.2 Pulse Radar

The Radar, which works by sending short duration pulse signal is called the **Pulse Radar**.

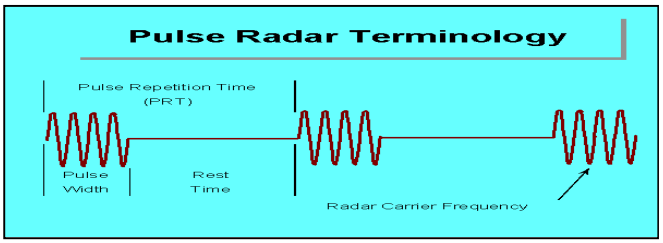

Figure 3: Pulse Radar Terminology

Pulse Radars can be classified into two types based on the type of the target it detects.

- Basic Pulse Radar
- Moving Target Indication Radar

A. Basic Pulse Radar

The Radar, which works with short duration pulse signal for detecting stationary targets, is called the Basic Pulse Radar or simply, Pulse Radar. Pulse Radar uses single Antenna for both transmitting and receiving signals by using Duplexer. Antenna will transmit a short pulse signal at every clock pulse. The period between the two clock pulses should be selected in such a way that the reflected signal corresponding to the present clock pulse should be received before the next clock pulse.

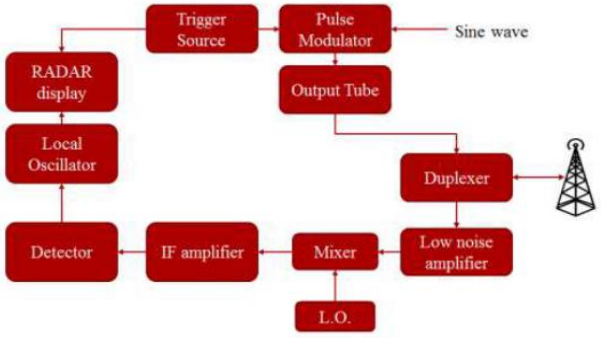

Figure 4: Block Diagram of Pulse Radar

Pulse Radar uses single Antenna for both transmitting as well as receiving of signals with the help of Duplexer. Function of each block of Pulse Radar is as follows.

- **Pulse Modulator** − It produces a pulse-modulated wave and it is applied to the Transmitter.
- **Transmitter** − It transmits the pulse-modulated wave, which is a train of repetitive pulses.
- **Duplexer** − It is a microwave switch, which connects the Antenna to both transmitter and receiver section alternately.
- **Low Noise RF Amplifier**–LNA amplifies the weak RF signal, which is received by Antenna. The output of this amplifier is connected to the Mixer.
- **Local Oscillator** − Local Oscillatorproduces a signal having stable frequency. The output of Local Oscillator is also connected to Mixer.
- **Mixer** − Mixer can produce both sum and difference of the frequencies that are given to it. Among which, the difference of the frequencies will be of Intermediate Frequency (IF) type.
- **IF Amplifier** − It amplifies the Intermediate Frequency (IF) signal. The IF amplifier allows only the Intermediate Frequency, which is obtained from Mixer and amplifies it. It improves the Signal to Noise Ratio at output.

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- **Detector** − It demodulates the signal, which is obtained at the output of the Intermediate Frequency (IF) Amplifier.
- **Video Amplifier** −It amplifies the video signal, which is obtained at the output of detector.
- **Display** − In general, it displays the amplified video signal on CRT screen.

B. Moving Target Indication Radar

The Radar, which works with pulse signal for detecting non-stationary targets, is called Moving Target Indication Radar or simply, MTI Radar. It uses single Antenna for both transmission and reception Mode with the help of Duplexer. MTI Radar usages the principle of Doppler effect for distinguishing the non-stationary targets from the stationary objects.

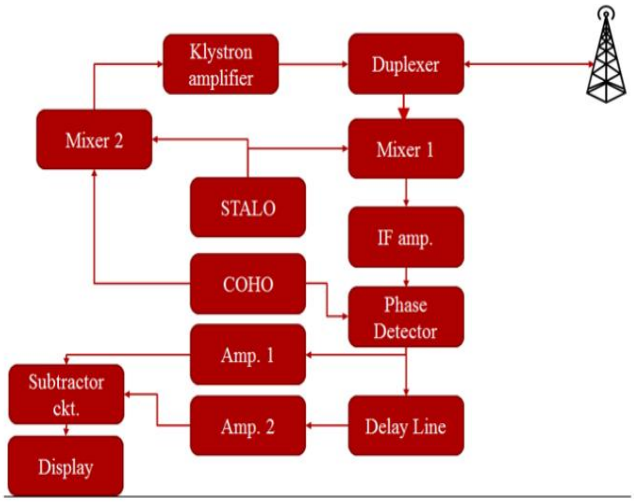

Figure 5: Moving Target Indication Radar

- The reflected signal or echo pulse from the target is received by MTI radar antenna. If echo is due to moving target, the echo signal undergoes a Doppler frequency that means frequency difference occur.
- The received echo signal then sent to mixer1 of the receiver. Mixer1heterodynes the received signal of frequency (Fo+Fc) with the output of the stable local oscillator at Fo. Mixer 1 generates a difference frequency Fc at its output.
- This difference frequency signal is then amplified by an IF amplifier. Amplifies output is given to phase detector. The detector compares to IF amplifier with reference signal from the Coherent oscillator that means Coho Oscillator. The detector produce an output which depends upon the phase difference between the two signals.
- Since all received signal pulses will have a phase difference compared with the transmitted pulse signal. The phase detector produced output for both fixed and also moving targets. The Phase difference is constant for all fixed targets like hill mountain, building etc. but varies for moving targets like ships, Airplane's automobile vehicles etc..
- Doppler frequency shift causes this variation in the phase difference of the received pulse.
- The output of phase detector will have an output frequency difference when there is moving targets. And for fixed target magnitude and polarity of output will remain.

V. Advantages Of Radar

- The main advantage of RADAR, is that it provide superior penetration ability through any type of weather or atmospheric condition, and can be used in the day or night time.

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- Very flexible –It can be used in a number of ways .
- Stationary mode is possible.
- Moving mode is possible.
- Two Directional mode .
- Beam spread can incorporate many targets .

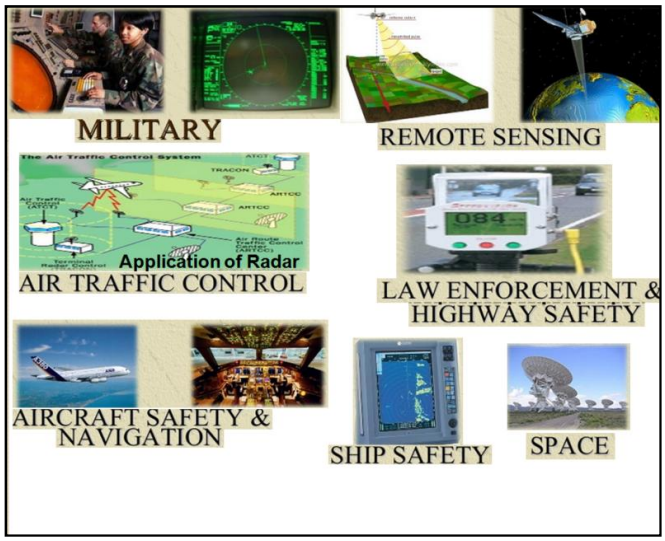
VI. Disadvantages Of Radar

- Time - Radar can take up to 2 seconds to lock on.
- Large targets close to radar can saturate receiver.
- Hand-held modulation can falsify readings .
- More interference sources.

VII. Application Of Radar

Radars can be used for various applications on ground, on sea and in space. The applications of Radars are listed below.

- Controlling the Air Traffic
- Ship safety
- Sensing the remote places
- Military applications



In any application of Radar, the basic principle remains the same. Let us now discuss the principle of radar.

VIII. Future Scope

- The US Military is currently using groundbreaking radar set.
- This Radar permits soldiers to see objects and people through walls

IX Conclusion

- RADAR is used to find velocity, range and position of the Target.
- Advantage of RADAR is that it provides superior penetration ability through any type of weather condition.
- LIDAR is advanced type of radar set which uses visible light from laser.

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