UNIT-II

part-B

MTI RADAR

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ANITS

MTI and Pulse Doppler radar

1. Introduction
   1. **CW Radar types, applications**
   2. **MTI Radar types**
2. Delay line cancellers
   1. **SDL,DDLC, Transversal DLC**
3. Moving target detector
4. Pulse Doppler Radar
5. Limitation to MTI performance
6. MTI from moving platform

3. Moving target detector

- MTD is an MTI radar processor developed for airport surveillance radar (ASR)
- The ASR medium range 60nmi radar located at major cities
- It operates at s band 2.7 GHz -2.9 GHz with a pulse width of less than 1 ,1.4° azimuth beam width an antenna rotation rate of from 12.5 to 15 rpm depending on model
- A PRF from 700 to 1200 Hz (1030Hz typical)
- Average power of from 400 to 600 watt
- The MTD processor employs several techniques for the increased detection of moving targets in clutter

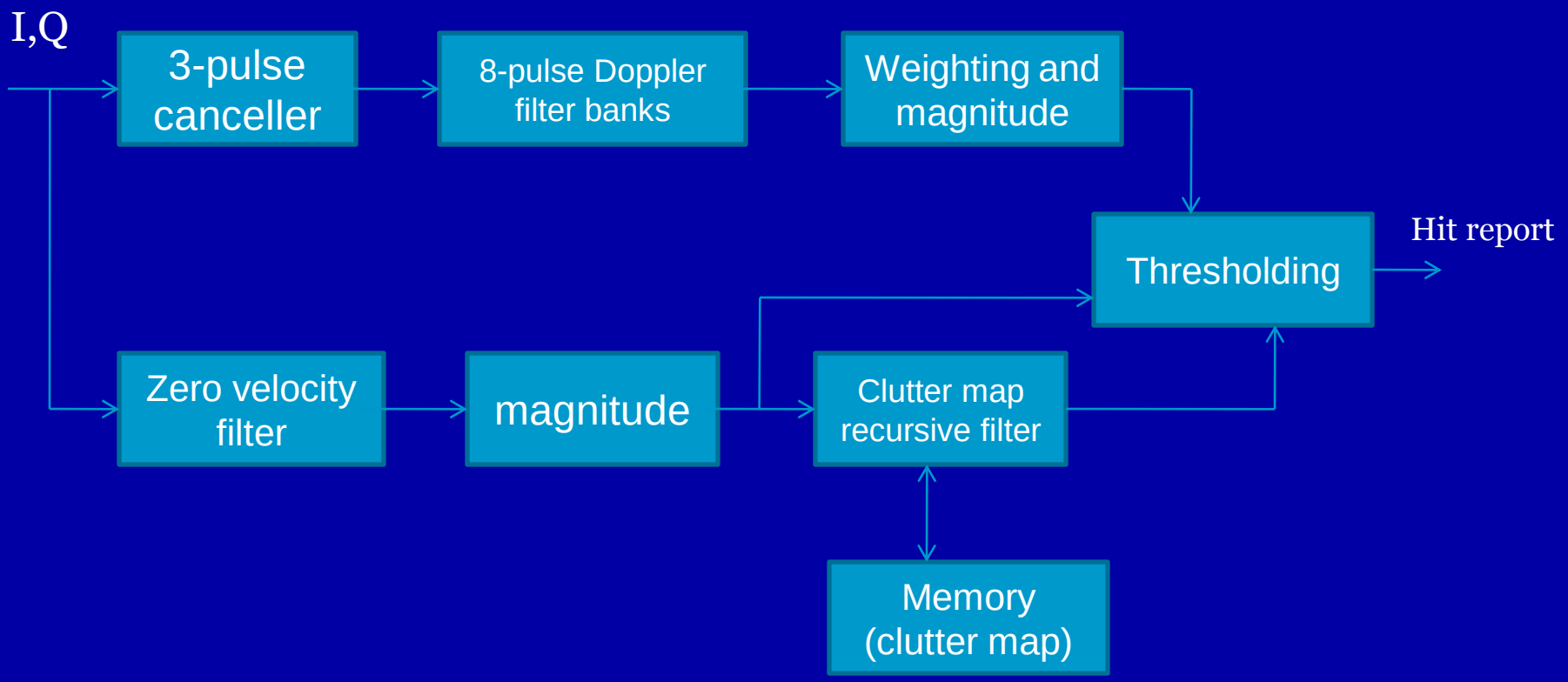
3. Moving target detector cont…

- The output of IF amplifier is fed to I and Q phase detectors
- The analog signals from the phase detectors are converted into digital words by A/D
- MTD uses 3-pulse canceller followed by 8-pulse FFT Doppler filter bank with weighting in frequency domain to reduce filter side lobes.
  - ✓ An alternate PRF's to eliminates blind speeds, adaptive thresholds, and a clutter map that is used in detecting crossing targets with zero crossing velocities.
- The output of MTD is a hit report which contains the

  azimuth, range and amplitude of the target return as well as the filter number and PRF

  The MTD processor eliminates the large amount of clutter and as a low false detection rate ,it's o/p can be remoted via telephone circuits

Moving Target Detector (MTD) signal processor



Block diagram of the Moving Target Detector (MTD) signal processor

4. Pulse Doppler

PDR

1. Medium and high PRF
2. Range ambiguity may occur
3. Improvement factor is needed
4. High power klystron amplifier is used as a transmitter(Tx)
5. Analog filter banks
6. Receive more clutter signal

MTI

1. Low PRF
2. No range ambiguity
3. Improvement factor is need not be improved
4. Magnetron oscillator is commonly used as transmitter (Tx)
5. Uses analog delay line cancellers
6. Receive less clutter signal

Moving Target Indicator Radar (MTI)

Limitations of MTI Performance

1. Instabilities of Equipment/System instabilities
2. Internal fluctuations of clutter
3. Antenna scanning modulation
4. Limiting in MTI radar

Moving Target Indicator Radar (MTI)
Limitations of MTI Performance

1 Equipment Instabilities:

Changes in signal from pulse to pulse will result in apparent clutter Doppler shift

These changes can have many sources

- pulse to pulse change in amplitude
- pulse to pulse change in frequency
- pulse to pulse change in phase
- Changes in pulse width
- Changes in oscillator frequency between Tx and Rx

Limitations of MTI Performance

3.Antenna scanning modulation

When antenna of a pulse radar scans, the duration of echo signal received from a target or clutter scatterer is given by

$$t_o = \frac{\theta_B}{\theta_S} = \frac{n_B}{f_r}$$

4.Limiting in MTI radar

Moving Target Indicator Radar (MTI)
Limitations of MTI Performance

- 2. Internal Fluctuation of Clutter:
- Many sources of clutter are capable of motion of one sort or another (translation, oscillation)
- Examples:
  - Trees: leaves/branches oscillate with magnitude/frequency depending on the wind speed
  - Vegetation: similar to trees (possibly less than trees)
  - Sea: translational motion with variation in phase and magnitude
  - Rain: translational motion with oscillation due to turbulence (thunderstorms)
  - Chaff: similar to rain with higher magnitude

Moving Target Indicator Radar (MTI)

Limitations of MTI Performance

- Internal Fluctuation of Clutter:
- The spectrum of clutter can be expressed mathematically as a function of one of :

1. σ_C, the RMS clutter frequency spread in Hz
2. σ_v, the RMS clutter velocity spread in m/s

the clutter power spectrum is represented by W(f)

MTI from Moving Platform

- An MTI Radar when used on a moving platform is called AMTI, where letter A- stands for Airborne
- **When the radar is mounted on a ship or an aircraft and it is in motion ,** the detection of a moving target in presence of clutter becomes more difficult than when it is in stationary
- **The design of an MTI is more difficult** with an airborne radar in comparison to a shipborne radar due to
  - ✓ higher speeds, and greater range of elevation angles

Doppler Frequency:

- ✓ Doppler frequency shift of the clutter varies with direction of the antenna in azimuth and elevation angles to the clutter
- ✓ Its spectrum is also widened

MTI from Moving Platform

The spectral width can be obtained ≈ by the differential of the Doppler frequency Doppler frequency is

$$f_d = 2\left(\frac{v}{\lambda}\right)\cos\theta$$

v *is* plat form speed
λ is wave length
θ is azimuth angle
$\Delta\theta$ is the beam width

if $\theta =$ zero Doppler shift of the clutter is maximum

but the spectral width is minimum

There fore spectral width is

$$\Delta f_d = 2\left(\frac{v}{\lambda}\right)\sin\theta\,\Delta\theta$$

$$if\ \ \theta = 90^0\ ,\ \ f_d \text{ is zero}, \Delta f_d \text{ is maximum}$$