Applications of DSP in Radio Detection & Ranging (Radar)

M Tech I Sem, Credit Seminar

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Outline

- Modern Radar
- Clutter Rejection Technique
- Adaptive Threshold Detection
- Digital Beamforming
- Synthetic Aperture Radar (SAR)
- Case Study

  Radar Synthetic Vision System

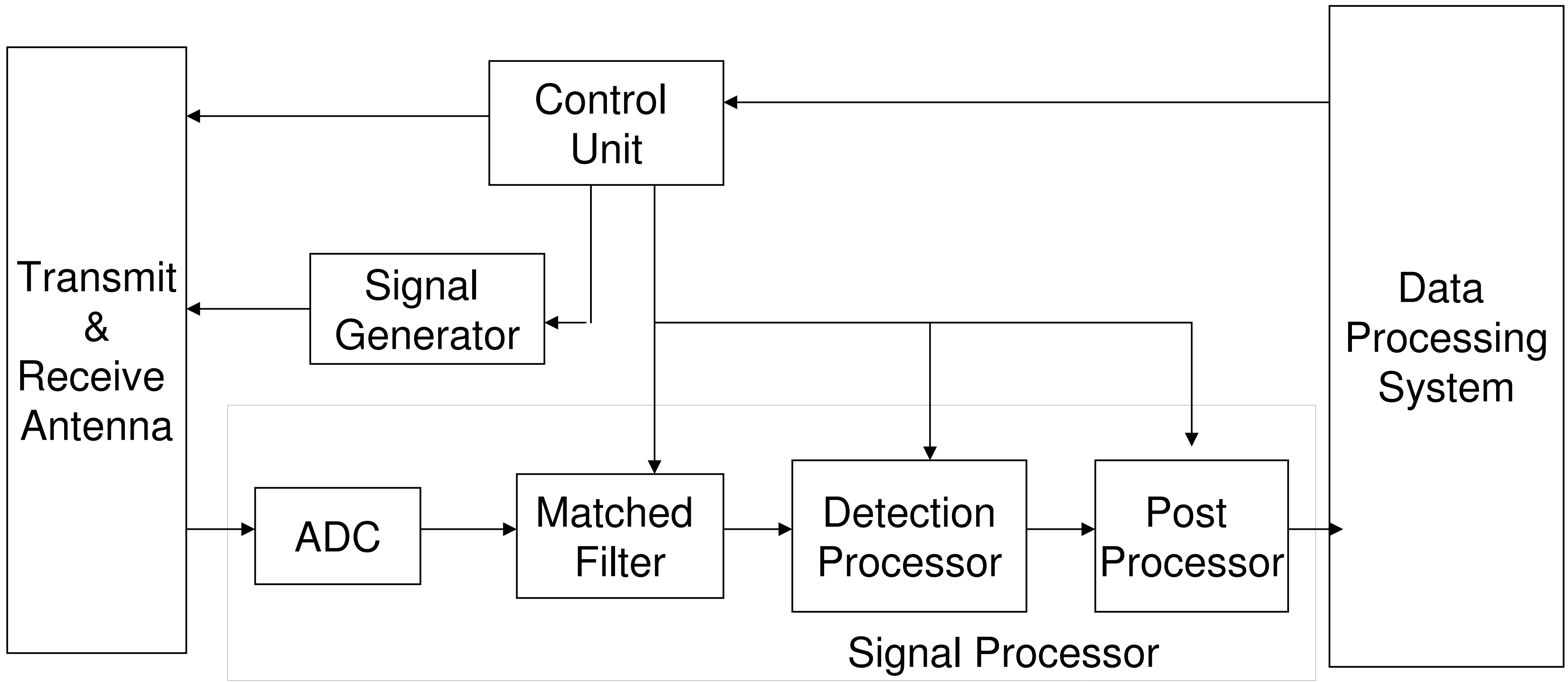
Few Modern Radars

- Synthetic Aperture Radar
- ISAR
- EWACS
- Ground Penetrating Radar
- AirTraffic Control Radar
- Weather prediction Radar
- Commercial





Block Diagram of Modern Radar



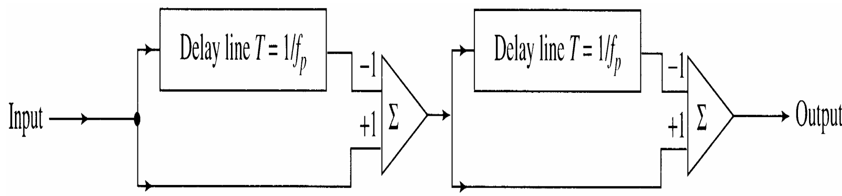
Tasks of DSP in Radar

- **Combining information**
- **Forming Tracks**
- **Resolving Ambiguities in range or Doppler measurements**
- **Ground Clutter Mapping**
- **Time and Power Management**
- **Countering Interference**

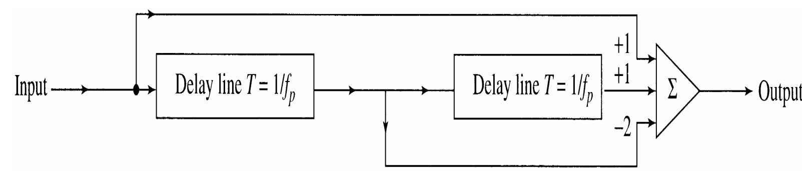
Detection of Signals in Radar

¬ Clutter rejection Techniques

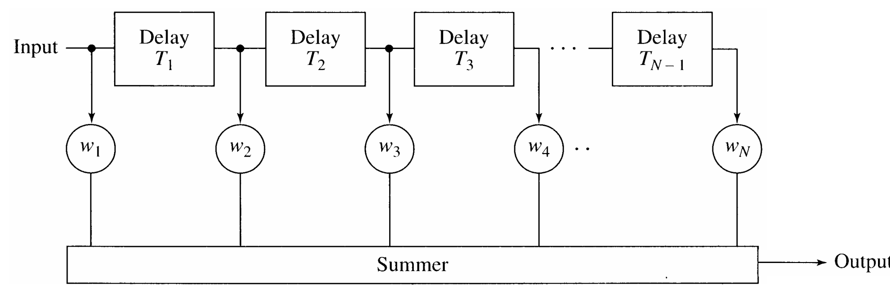
Two line Delay Cancellor



Three line Delay Cancellor



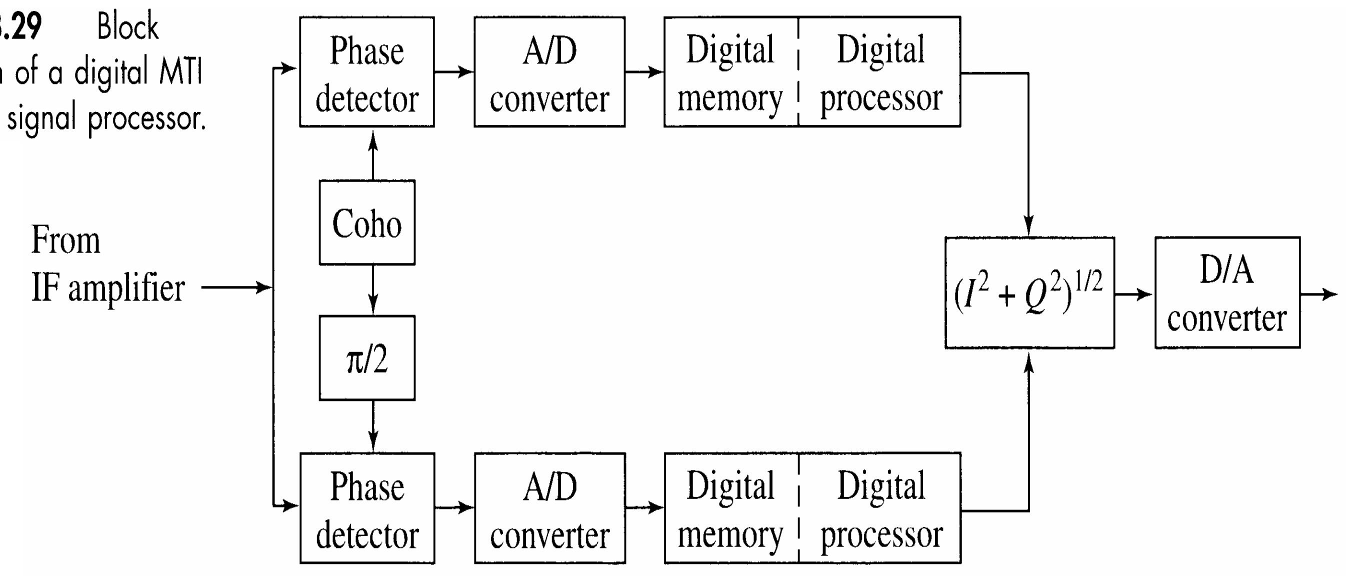
Transversal Filter



Detection of Signals in Radar

- **MTD Doppler Signal Processor**

Figure 3.29 Block diagram of a digital MTI doppler signal processor.



Detection of Signals in Radar

¬ **Adaptive Thresholding and Automatic Detection**
  - **Reference signal is generated internally from the observations, permitting more sensitive & faster thresholds**

ϖ **Adaptive Threshold CFAR Processors**
  - **Distribution of processed data is known generally**

ϖ **Distribution free CFAR Processors**
  - **When the background has a unknown distribution**

Digital Beamforming

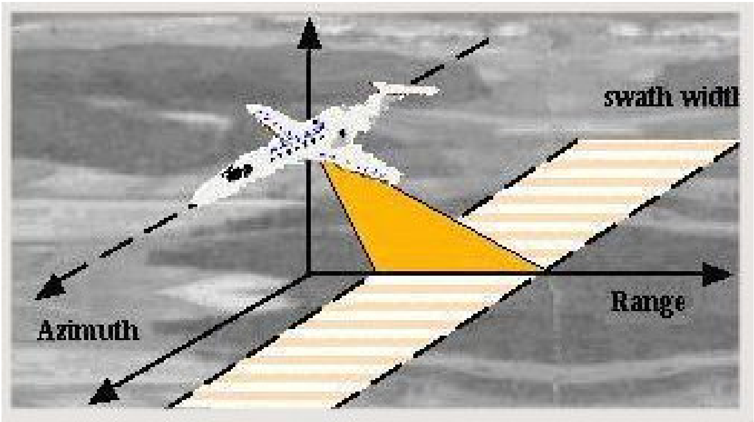
•Phased array- consists of small antenna elements with a phase shifter behind each element.

In digital arrays, there is an A/D converter behind each antenna element and the beam steering can be performed by digital signal processors.

•The beam steering is accomplished by multiplying the signal from each array element by a complex weight.

Synthetic Aperture Radar

- signal processing technique
  for improving azimuth resolution
- Strip Map SAR
- Spotlight SAR



- Matched Filtering in both
  range & azimuth
- Computational requirements are
  more

  Different azimuth pulse
  compression filter required for
  each range resolution cell.

Detection of Targets in Foliage in UHF SAR

Target Detection Techniques

¬ **Baseline approach**

- **Combination of CFAR algorithm and Clusterring algorithm**

¬ **Adaptive Change Detection**

- **Uses adaptive filters for noise cancellation**

¬ **Multiple Aperture Detection**

- **Splitting the integration aperture, multiple images are formed**

Case Study-
Radar Synthetic Vision System

- Use of Radar Imaging to aid aircraft takeoff and landing in adverse weather

Radar image Analysis

- Monitoring of synthetic Vision developed by navigation and terrain Data

Obstacle Detection

- Extraction of simple runway structures from radar image

Radar Synthetic Vision -

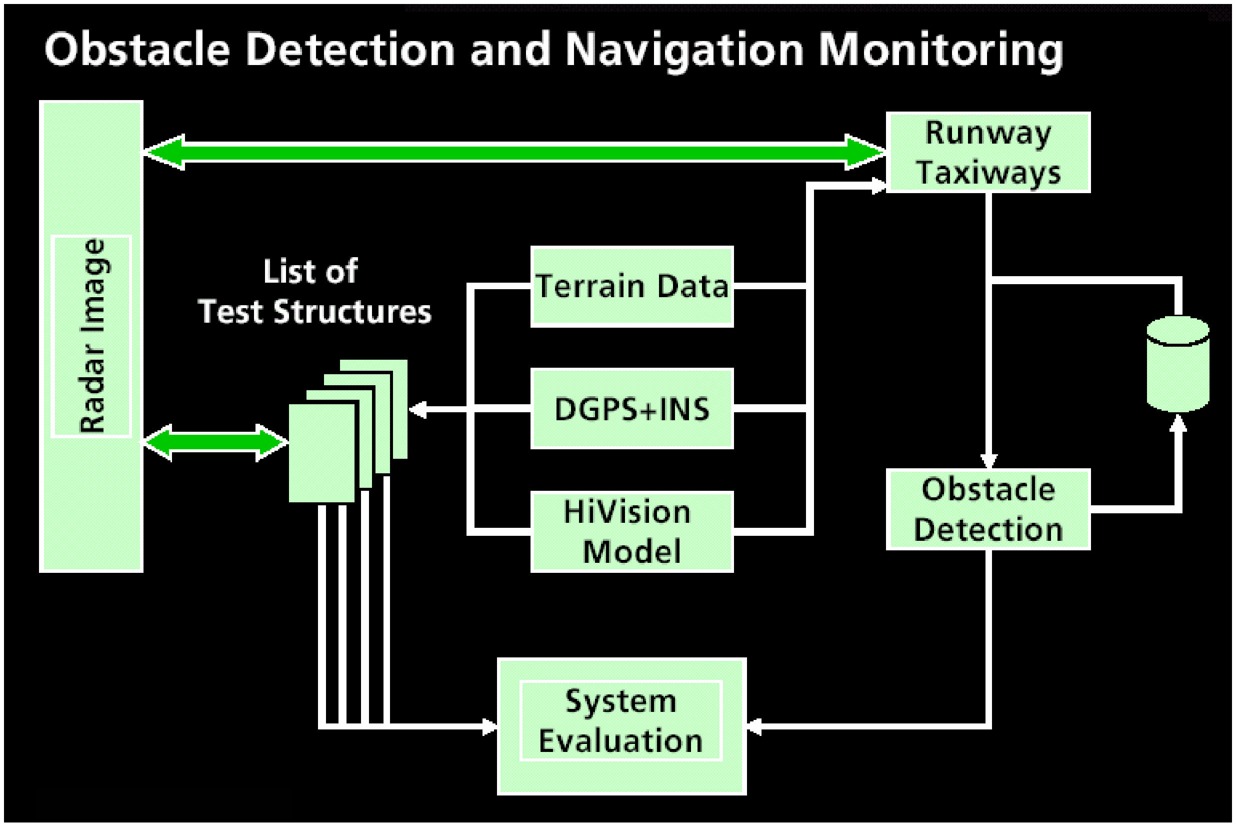


Figure 3. HUD Terrain Display

Radar Synthetic Vision Radar

DSP algorithms are implemented to improve azimuth range resolution

- pulse integration is used to improve the SNR
- image is rotated to perform image enhancement on rows of data.

Image Enhancement

- Beam Sharpening
- Noise Suppression
- Motion Compensation

Conclusions

- We have seen that DSP is an integral part of radar
- Advances in DSP is going to facilitate better processing in future Radars