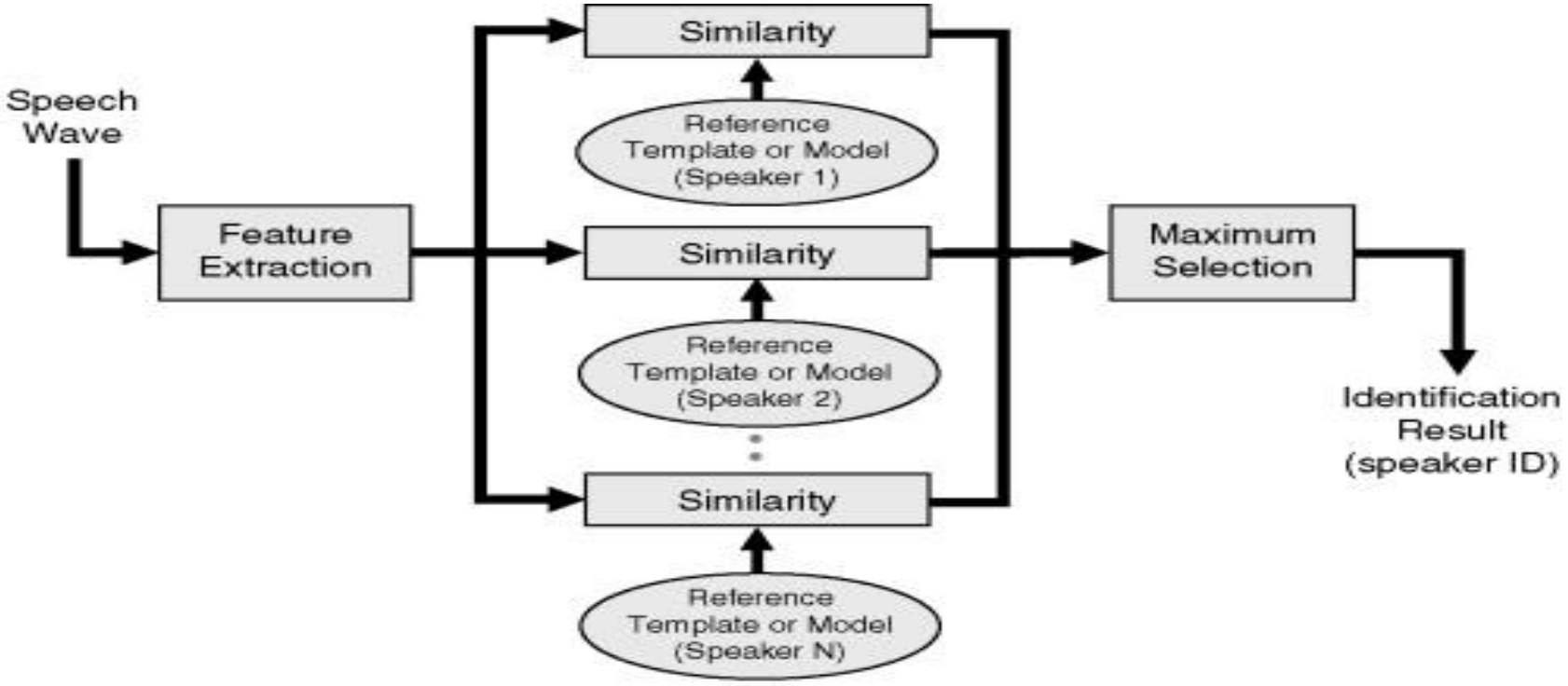
Module 6

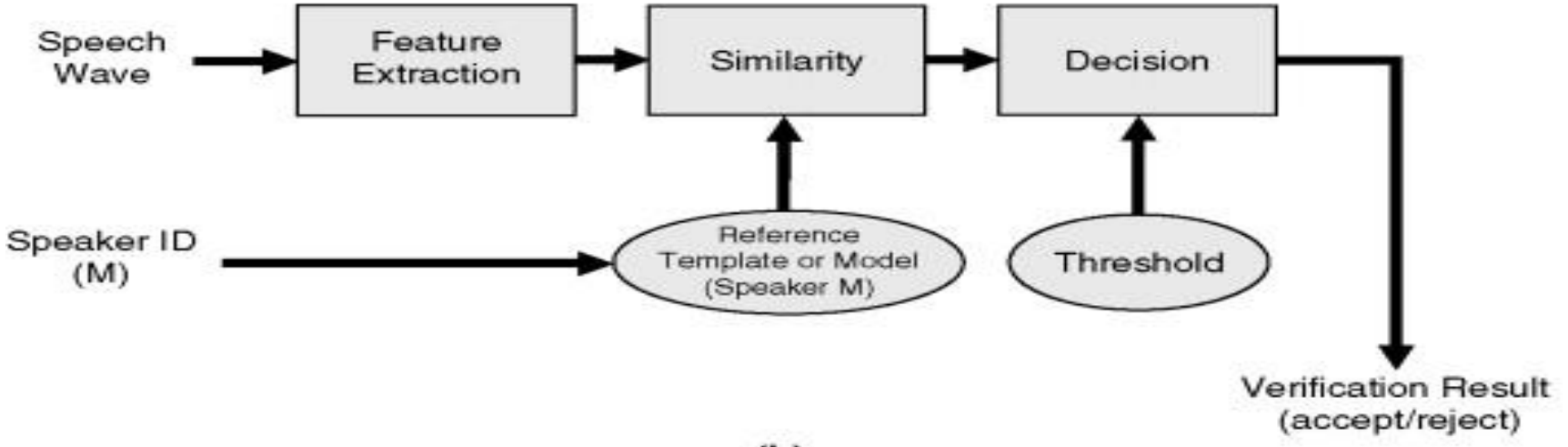
Applications of DSP in speech and Radar

Speaker recognition

- A **speaker verification system** takes the speech of an unknown **speaker** with his/her claimed identity, and it determines whether the claimed identity matches the speech. ... A **speaker identification system** only takes the speech of an unknown **speaker**, and it determines which enrolled **speaker** best matches the speech.

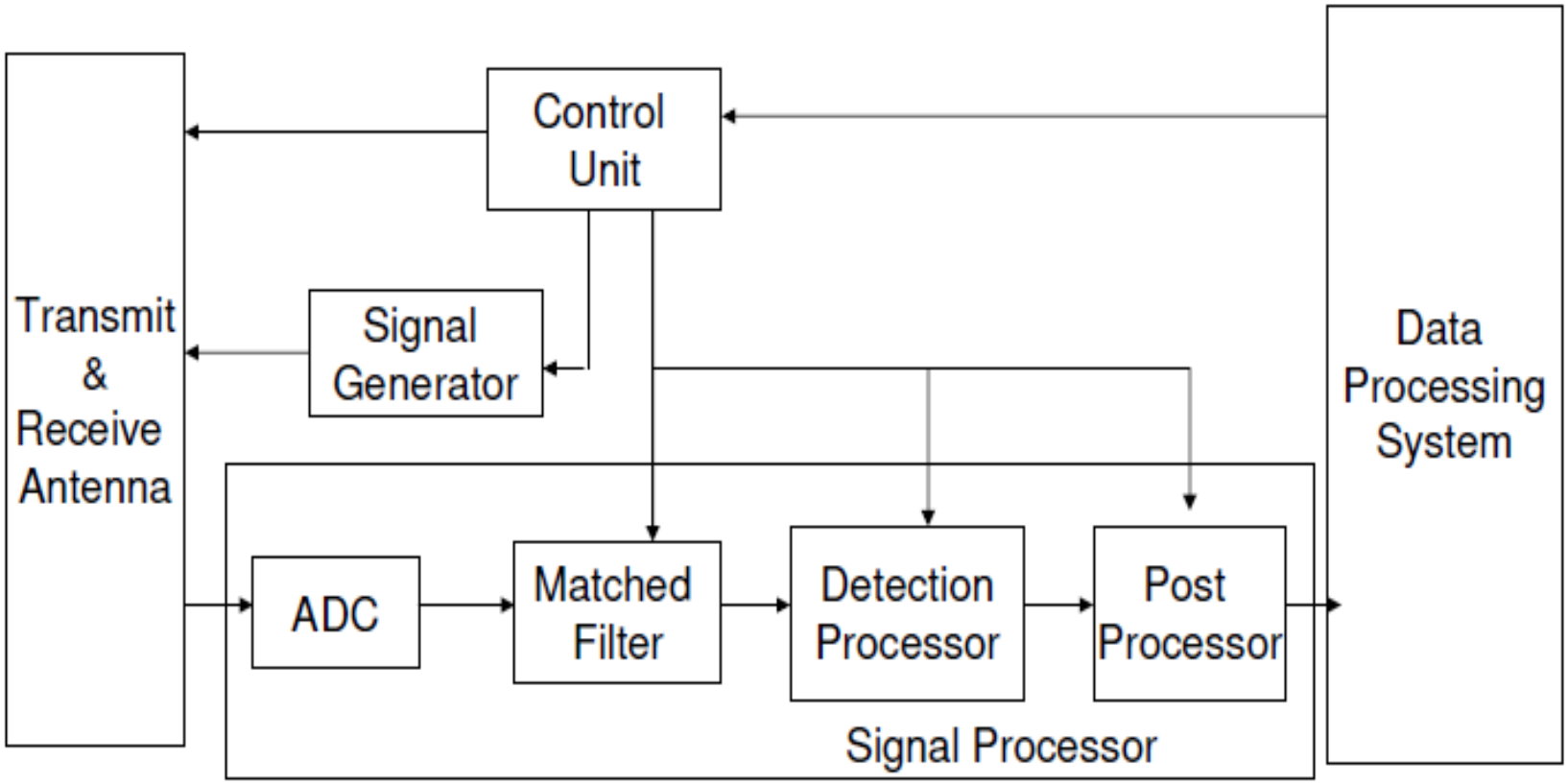

Speech Wave
Feature Extraction
Similarity
Reference Template or Model (Speaker 1)
Similarity
Reference Template or Model (Speaker 2)
Similarity
Reference Template or Model (Speaker N)
Maximum Selection
Identification Result (speaker ID)

(a)


Speech Wave
Feature Extraction
Similarity
Decision
Speaker ID (M)
Reference Template or Model (Speaker M)
Threshold
Verification Result (accept/reject)

(b)

Block Diagram of Modern Radar



Radar working

- RADAR **transmits** radio signals at distant objects and
- **analyzes** the reflections.
- Data **gathered** can include the position and movement of the object,
- radar **identify** the object through its "**signature" - the distinct reflection it generates**.

The tracking computer and the signal generator

The tracking computer in the modern radar does all the functions.

- **Schedule** the appropriate antenna positions and transmitted signals as a function of time, **keeps track of** targets and
- **running** the display system.

Threshold detecter

- **Target returns** often are **no stronger than twice the average noise level**, sometimes even suppressed under it.
- It is quite **difficult to define a threshold** for the decision whether a given peak is noise or a real target.
- If the **threshold is too high** then **existing targets are suppressed**, that is, the probability of detection (PD) will drop.

Threshold detecter

- If the threshold is too low then noise peaks will be reported as targets, that is, the probability of false alarms (PFA) will rise.
- A common compromise is to have some 90% probability of detection and a false alarm rate of
- 10^-6
- It maintains a given PFA known as CFAR, for **Constant False Alarm Rate.**

Threshold detecter

- Rather than keeping the threshold at a fixed point, CFAR circuitry inspects one range bin after the other and compares the signal level found there with the signal levels found in its neighboring bins.
- If the noise level is rather high in all of these) then the CFAR circuit will raise the threshold accordingly

Outline :-**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**

Combining information

- Secondary surveillance radars like **those located on airports** can ask **an aircraft's transponder** for information
- like height,
- flight number or
- fuel state.
- The radar's signal processor **combines this data with its own measurements of range** and angular direction and **plots them** all together on the on the scope.

Forming tracks(paths)

- By correlating the data sets which were obtained in successive scan cycles, the radar can calculate **a flight vector** which indicates:-
    1. an **aircraft's speed** and
    2. **expected position** for the **next scan period**.
- Airport radars are **capable of tracking hundreds of targets simultaneously**.
- Flight safety depends heavily on their reliability. **Military tracking radars use this information for gun setting or guiding missiles**

Resolving Ambiguities (uncertainty) in range or Doppler measurements:

- The signal processor is aware of the radar's **pulse repetition frequency (PRF)**, the readings for range, and
- It **selects a different PRF** when the object in question is measured again.
- With a suitable set of PRFs, **ambiguities can be eliminated and the true target position can be determined.**

Ground Clutter Mapping

- **Clutter** is the collective term for all **unwanted blips on a radar screen.**
- Ground clutter originates from
    a) buildings,
    b) cars,
    c) mountains etc,
- **A clutter map** serves to raise the **decision threshold** in areas where known clutter sources are located.

Time and power management

- **Phased array radars** can instantly switch their beam position to any position in azimuth and elevation(height or altitude).
- When the radar is tasked with surveying its sector and tracking dozens of targets .
- **If the track record isn't updated in time.,** there's a danger of either neglecting part of the search sector or **losing a target**
- **Time management serves** to maintain a priority queue of all the tasks and to produce **a schedule for the beam steering device**.
- Power management is necessary if the transmitter circuitry **is in the danger of overheating.**
- The only way of continuing regular operation is to **use less power when less power is required.**

Countering interference

Interference can be

- a) natural, or
- b) man-made.
- Natural interference can be
- heavy rain or
- hail storms,
- Man-made interference(created on purpose)

e.g. jamming is one of the means of electronic countermeasures(opposing).