ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY
AUTONOMOUS INSTITUTION
Approved by AICTE & Affiliated to Anna University
NBA Accredited for BE (ECE, EEE, MECH) | Accredited by NAAC with A+ Grade
Anjugramam - Kanyakumari Main Road, Palkulam, Variyoor P.O. - 629 401, Kanyakumari District.

DEPARTMENT OF BIOMEDICAL ENGINEERING

VII Semester

OBT357 BIOTECHNOLOGY IN HEALTH CARE

UNIT- 5 BASICS OF IMAGING MODALITIES

5.4 Ultrasonography

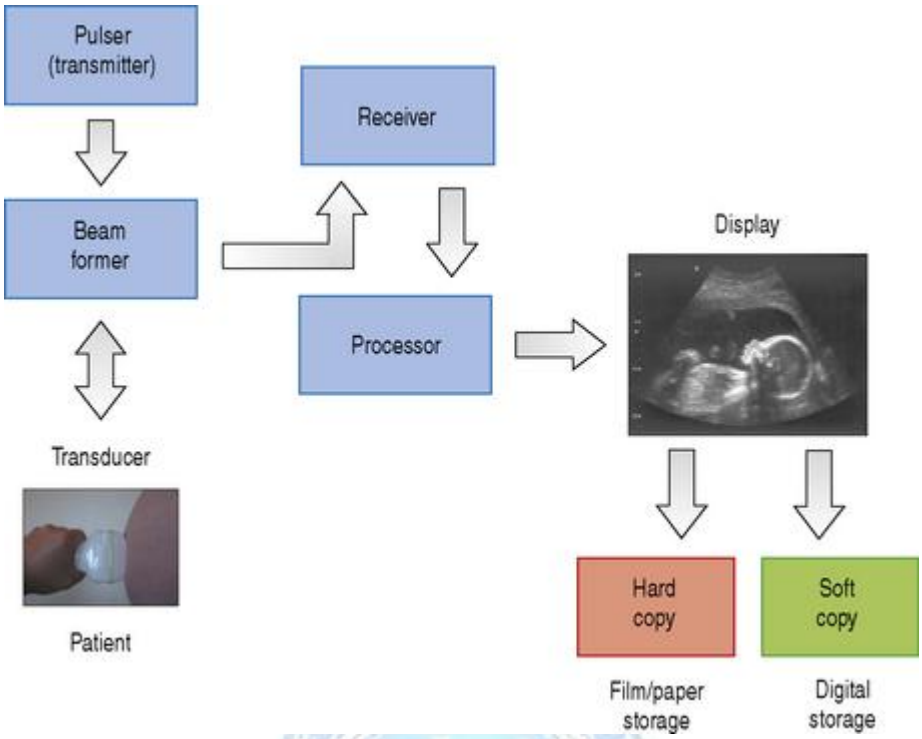
Ultrasonography, also known as ultrasound, is a medical imaging technique that uses high-frequency sound waves to visualize internal structures of the body. It's non-invasive, safe, and widely used for diagnostic purposes.

What is ultrasonography?

- Ultrasonography (also called ultrasound imaging) is a non-invasive medical imaging technique that uses **high-frequency sound waves** to create real-time images of the inside of the body. A device called a **transducer** sends sound waves into the body, which bounce back (echo) when they hit different tissues, organs, or fluids. These returning echoes are captured by the transducer and processed by a computer to form images on a screen.
- It is commonly used to examine soft tissues, monitor pregnancy, evaluate blood flow (Doppler ultrasound), and detect abnormalities in organs such as the liver, kidneys, heart, and thyroid. Ultrasonography is safe, painless, does not use ionizing radiation (unlike X-rays or CT scans), and can be repeated frequently.

Common Uses of Ultrasonography:

- Pregnancy monitoring (fetal development, detecting abnormalities).
- Imaging organs (liver, kidneys, heart, thyroid, etc.).
- Guiding procedures (e.g., biopsies or fluid drainage).
- Assessing blood flow (Doppler ultrasound).
- Detecting conditions like gallstones, tumors, or cysts



Components of Ultrasonograph:

- **Pulser (transmitter):** Generates high-frequency electrical signals.
- **Beam Former:** Converts these signals into pulses that are sent to the **transducer**.
- **Transducer (probe):** Converts electrical pulses into ultrasound sound waves and directs them into the patient's body.
- The same transducer also detects echoes that bounce back from tissues/organs.
- **Receiver:** Collects the returning echoes (reflected sound waves) from the transducer.
- **Processor:** Processes the echo signals into data that can be converted into an image.
- **Display:** Shows the real-time image of internal structures (e.g., fetus in the womb).
- **Storage:** The image can be stored as
- **Hard copy** → film or paper printout.
- **Soft copy** → digital storage for later analysis.

Working:

- Ultrasonography works on the principle of transmitting high-frequency sound waves into the body using a transducer.
- The pulser generates electrical signals which are shaped by the beam former and converted into sound waves by the transducer.
- These waves travel into the body and are reflected back as echoes when they encounter tissues of different densities.
- In ultrasonography, when sound waves travel from one tissue to another with **different acoustic impedances**, part of the wave is **reflected** back (echo) and part continues forward. The greater the difference in impedance between two tissues, the stronger the reflection. This is the basic principle that allows ultrasound machines to create images of internal organs and structures.

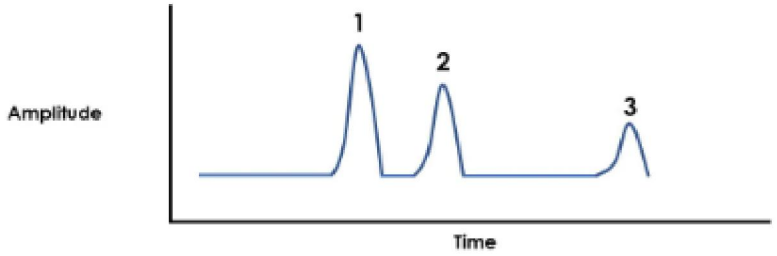
  Acoustic Impedance, $Z=\rho \times c$

  - ✓ Z = acoustic impedance
  - ✓ ρ = density of the medium
  - ✓ c = speed of sound in that medium
- The transducer then receives these echoes and converts them back into electrical signals, which are sent to the receiver.
- The processor interprets the strength and timing of the echoes to form an image that is displayed on a monitor in real time.
- The images can be stored as hard copies (film/paper) or soft copies (digital files) for diagnosis and record-keeping.

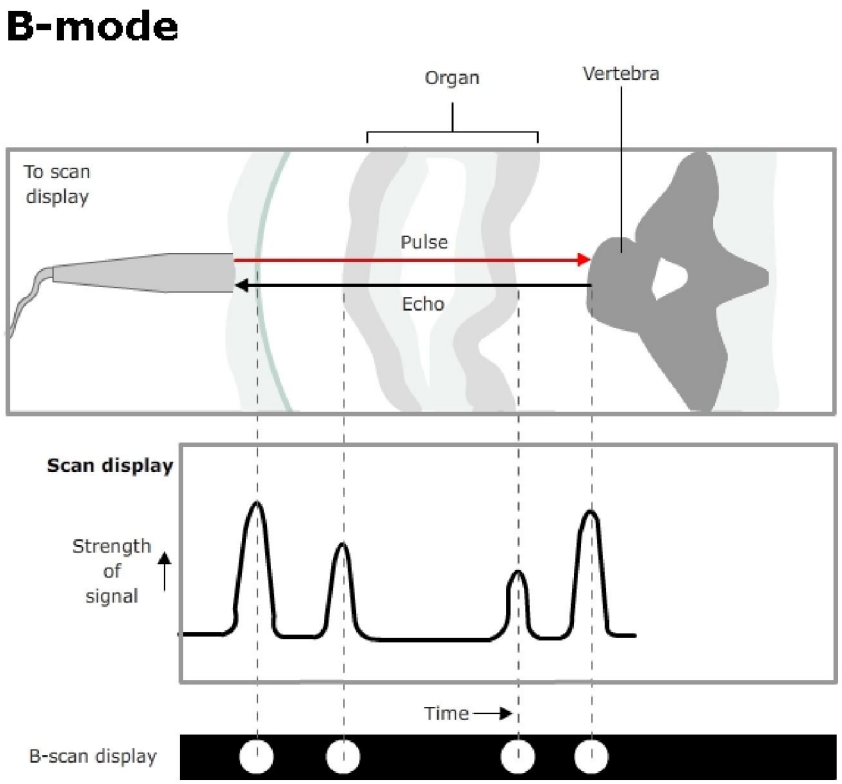
Display Modes:

The **display modes of ultrasound imaging** show how the returning echoes are visualized. The main modes are:

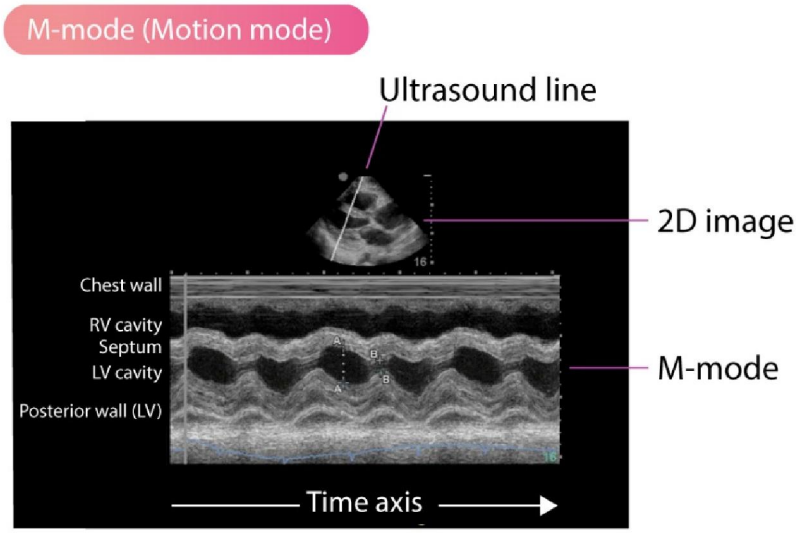
1. **A-mode (Amplitude mode):**
   - Simplest form of ultrasound.
   - Echoes are displayed as spikes on a graph (amplitude vs. depth).
   - Used mainly in ophthalmology for eye measurements.



2. **B-mode (Brightness mode):**
    - Echo strength is shown as dots of varying brightness on a 2D image.
    - Multiple scan lines combine to form a real-time picture of organs.
    - Most common mode used in medical imaging.

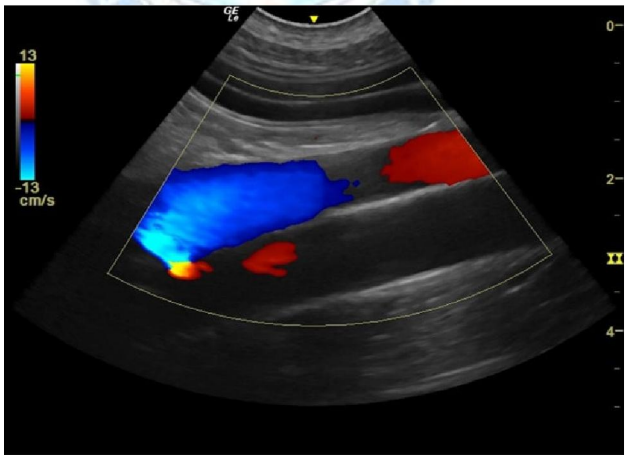


3. **M-mode (Motion mode):**
    - Displays movement of structures (like heart valves) over time.
    - One scan line is plotted continuously against time, showing motion as waves.
    - Commonly used in echocardiography.



M mode echocardiography

4. **Doppler mode:**
   - Uses the Doppler effect to measure and display **blood flow**.
   - Types:
     - **Color Doppler:** Shows direction and speed of flow in color.
     - **Power Doppler:** More sensitive, shows flow in smaller vessels.
     - **Spectral Doppler:** Displays flow velocity as a waveform.



Color Doppler Flow meter

****