



AL- MUSTAQBAL UNIVERSITY COLLEGE
DEPARTMENT OF BIOMEDICAL ENGINEERING

Biomedical Instrumentation Lab

BME 514

Lecture 5

- Ultrasound -

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Ultrasound

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- An ultrasound imaging system is a medical diagnostic tool that uses high-frequency sound waves to capture live images from the inside of the body.
- The instrument has become increasingly important in medicine and has taken its place along with X-rays for imaging internal body structures.
- Unlike X-ray, no ionizing radiation exposure is involved ultrasound imaging.
- Since ultrasound images can be captured in real time, dynamic images can show the movement of the body's internal organs and blood flowing through the blood vessels.



- The application of ultrasound in medical field is based on the sonar principle
- It is totally noninvasive procedure.
- Ultrasonic imaging is based on the use of sound waves produced at frequencies beyond those detectable in human hearing, that is, $>20\text{kHz}$.
- Ultrasound frequencies generally employed for medical imaging range from 1 to 15MHz.

Principle



- Ultrasound can be used for obtaining images of internal organs by sending high frequency sound waves into the body.
- Most medical ultrasound imaging systems use the pulse-echo method to obtain images.
- The reflected sound waves are recorded and processed to reconstruct real time visual images by the computer.
- The returning sound waves reflect the size and shape of the organ and also indicate whether the organ is solid, fluid or something in between.

The Ultrasound Transducer



- The transducer is a device capable of changing one form of energy into another.
- The ultrasonic transducer is a very important component of an ultrasound imaging system.
- In ultrasound, the transducer is both sender and receiver of ultrasound pulses and echoes.
- The transducer converts electrical impulses into ultrasound waves and vice versa.

The Ultrasound Transducer



- As the receiver, the transducer has many functions like amplification, demodulation, compression and rejection.
- The ultrasound transducers are designed to achieve high sensitivity and penetration, optimum focal characteristics, and the best possible resolution.
- Transducers are available in a variety of configurations designed with varying frequency capabilities that are meant for various applications.
- Transducers should offer a field of view which is large enough to display the entire region of interest.



- The basic parts of a diagnostic ultrasound imaging system consist from
 - Transducer
 - Processing blocks needed for image formation
 - System controller
 - Power supply module

- Whose design and processing of the signal varies from one manufacturer to another

Technology used



- Type of technology used for carrying out these operations that may be involved
 - Application-specific integrated circuit (ASIC).
 - Field-programmable gate array (FPGA).
 - Digital signal processors (DSPs).
 - Personal computer (PC).



- The circuits comprise the ultrasound beam transmission and receiving parts.
- The transmit beam former is responsible for generating the excitation pulse, which is given to transducer elements after amplification.
- The transducer then emits acoustic waves into the region of interest in the body.
- Immediately after the transmission pulse is delivered, the transmit/receive (T/R) switch changes over to the receive mode by the controller.



- The received echo acoustic signal by the transducer elements is then converted into corresponding electrical signals.
- These signals are adequately amplified and converted into digital data streams by an A/D converter.
- The sampling rate of the A/D converter is very high and may vary from 20 kHz to 50MHz.



- Multiple scan lines are made to cover the entire region of interest by repeating the process either sequentially or simultaneously.
- The ultrasound image is formed from the useful information contained by the echoes of the ultrasound which are reflected back while traversing and interacting with the tissues of the body.
- This interaction contributes to image formation and images vary as the tissues vary themselves.

Ultrasound consists



- It consists of a computer with a display unit, circuitry and a hand held transducer.
- The transducer has the shape of a microphone.
- It is meant to send out the ultrasound beam and to receive the reflected sound waves.
- The reflected sound waves are fed to a computer which with the help of algorithms, process them to create the images.



- Ultrasound scanners are used for obtaining images of almost the entire range of internal organs.
- These include the liver, spleen, pancreas, major blood vessels, and, of course, the foetus during pregnancy.
- This is possible in structures where other diagnostic methods by themselves were found to be either inapplicable, insufficient, or unacceptably hazardous.

Advantages of Ultrasound



- Ultrasound is relatively inexpensive and noninvasive.
- It does not expose patients to ionizing radiation and hence it is safe.
- It is preferred for children and pregnant women.
- The machine is also comparatively inexpensive.

Disadvantages of Ultrasound



- Ultrasound imaging system is highly operator dependent.
- It cannot be used for full body survey.
- The resolution of the ultrasound image is inversely related to the depth of penetration.
- The quality of image decreases in the case of obese patients.

