ULTRASOUND PHYSICS 2025-2026

3.st Stage

Lecture 5 - Theory

AMPLIFICATION

Lecturer

Amin Kadhum Awad

References: **المصادر:**

Thayalan, K., and Ramamoorthy Ravichandran. *The physics of radiology and imaging*. JP Medical Ltd, 2014.

2.8.2 Amplification

Amplification is used to increase the size of the electrical pulses coming from the transducer after an echo is received. The amount of amplification is determined by the gain setting. The principal control associated with the amplifier is the time gain compensation (TGC), which allows the user to adjust the gain in relationship to the depth of echo sites within the body. This function will be considered in much more detail in the next section.

2.8.3 Scan Generator

The scan generator controls the scanning of the ultrasound beam over the body section being imaged. This is usually done by controlling the sequence in which the electrical pulses are applied to the piezoelectric elements within the transducer. This is also considered in more detail later.

2.8.4 Scan Converter

Scan conversion is the function that converts from the format of the scanning ultrasound beam into a digital image matrix format for processing and display.

2.8.5 Image Processor

The digital image is processed to produce the desired characteristics for display. This includes giving it specific contrast characteristics and reformatting the image if necessary.

2.8.6 Display

The digital ultrasound images are viewed on the equipment display (monitor) and usually transferred to the physician display or work station.

One component of the ultrasound imaging system that is not shown is the digital storage device that is used to store images for later viewing if that process is used.

2.8.7 Things to Consider

For any ultrasonic gauging application, the choice of gauge and transducer will depend on the material to be measured, thickness range and accuracy requirements, geometry and temperature, and any special conditions that may be present. Listed below, in order of importance, are brief descriptions of some of the conditions that should be considered.

- **Thickness Range**

Thickness ranges will also dictate the type of gauge and transducer to be selected. In general, thin materials require high frequency transducers and thick or attenuating materials require lower frequencies. Very thin material may not be within the range of a gauge utilizing contact transducers; a delay line transducer may then be the answer. Similarly, gauges with delay line and immersion transducers have limited maximum thickness capabilities primarily due to potential interference from a multiple of the interface echo.

- **Geometry**

A contract transducer is preferred for most ultrasonic measurements, unless sharp curvature or small part size makes contact measurements impractical. As the surface curvature of the test piece increases, the coupling efficiency from the transducer to the test piece is reduced. In general, as the surface curvature increases, the size of the contact transducer should be reduced. Extreme curvature or inaccessibility of the test surface requires a system with a delay line or an immersion transducer.

- **Temperature**

When heated above a certain temperature (about 350ºC for PZT), called its "Curie Temperature", transducers lose their piezoelectric properties. Transducer probes should obviously not be autoclaved (nor should they be immersed in water unless waterproofed). Thin slices of naturally occurring quartz crystals also show the piezoelectric effect, and are used in digital timers and computers.

- **Accuracy**

It should be considered that many factors may affect accuracy: sound attenuation and scattering, sound velocity variations, poor coupling, surface roughness, nonparallelism, curvature, echo polarity, etc. Selection of the best possible combination of gauge and transducer should take into account all these factors. With proper calibration, measurements can usually be made to an accuracy of 0.001inch or 0.01 mm.