Ultrasound in various media and tissues

Ultrasound is a cyclic sound pressure wave with a frequency greater than 20kHz(the upper limit of the human hearing range). Ultrasound devices operate with frequencies from 20 kHz up to several gigahertz. Ultrasound is used in many different fields. Ultrasonic devices are used to detect objects and measure distances. Ultrasonic imaging (sonography) is used in human and veterinary medicine. In non-destructive testing of products and structures, ultrasound is used to detect invisible flaws. Industrially, ultrasound is used for cleaning and for mixing, and to accelerate chemical processes. Organisms such as bats and porpoises use ultrasound for locating prey and obstacles.

In order to use ultrasound for diagnostic or therapeutic purposes, a beam of ultrasound must be directed into the tissues of the subject over the site of interest. The ultrasonic energy then interacts with the tissues along its path.

Ultrasound from the physical point of view

Acoustic Impedance is the measure of the resistance of the particles of a medium to mechanical vibrations. This resistance increases in proportion to the density of the medium and the velocity of ultrasound in the medium and is defined by the equation:
Z = density x velocity
Acoustic Boundaries are positions within tissue where the acoustic impedance change. These boundaries are very important in ultrasound imaging.
Relflection of ultrasound occurs when a beam of ultrasound strikes an acoustic boundary. Part of the energy beam is transmitted across the boundary while some is reflected. There are two types of Reflection; Specular and non-specular
Specular reflections occur when the acoustic boundary is smooth and larger than one wavelenght of the ultrasound beam, while non-specular reflections occur when the boundary is smaller than one wavelenght of the ultrasound beam.The reflected beam produced is called an Echo. This is Particularly important in ultrasound imaging. For Specular eflection: Angle of incidence =Angle of Reflection.
Refraction of Ultrasound This a change in the direction of a beam of Ultrasound at a boundary between two media.
Absorption of Ultrasound This is the process where energy from the Ultrasound beam is transferred to the medium through which it travels, mostly as heat. the extent of Absorption depends on
1.The viscousity of the medium.
2.The relaxation time of the medium.
3.The beam frequency
Beam Divergance nad Interference This is The spreading out of an Ultrasound Beam as it moves away from the source, while interference is the manner in which different parts of the waves intereact with each other.
Attenuation of Ultrasound in Tissues This is the process where the intensity of the ultrasound beam is diminished as it passes through tissue. This is differs from absorption because absorption is the conversion of ultrasonic energy to thermal energy whereas attenuation is the the loss in intensity as the beam progreses. Attenuation of Ultrasound increases rapidly with increasing beam frequency.
These properties of Ultrasound propagation in various media makes it useful in a wide variety of fields. Its reflective properties in particular makes it useful for imaging in medical fields as well as others.

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