Physics of Ultrasound

Lecture10

Lateral resolution

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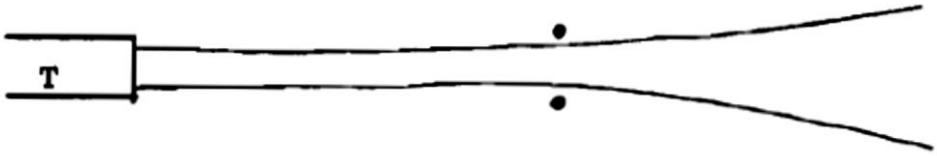
1. *Introduction*

In ultrasonic imaging, axial resolution is better than lateral resolution, besides showing less variation. This means that lateral resolution is the more limiting aspect of spatial resolution. It is therefore important that the factors affecting lateral resolution be well understood. These factors include:

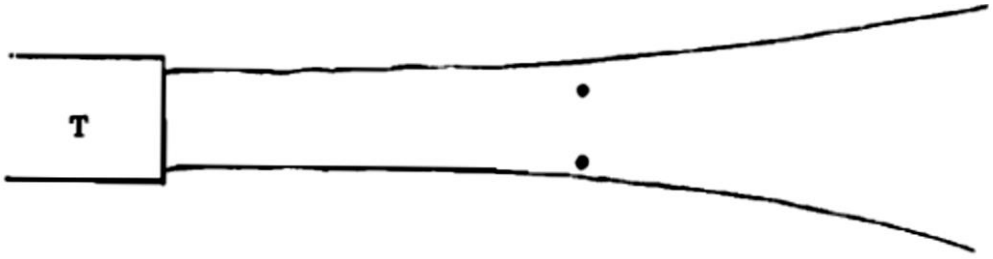
- beam width
- beam frequency
- scan line density.

Effect of beam width

Whereas axial resolution is limited by the length of the ultrasound pulse, the lateral resolution is limited by the width of the pulse. Although it is more common to refer to beam width rather than pulse width, the two are essentially the same, since the ultrasound beam comprises a series of identical pulses released in rapid succession. Lateral resolution is limited by the beam width in the plane of the reflectors being resolved. Reflectors closer to one another than the beam width cannot be resolved. Therefore, the narrower the beam width, the better the lateral resolution.



small beam width, Reflectors farther apart than the beam width are spatially resolved.



Larger beam width.

Effect of beam frequency

Frequency affects the beam shape, and hence has a major influence on lateral resolution. The ultrasound beam can be made narrower at higher frequencies. Therefore, the higher the frequency, the better the lateral resolution. Also, increased beam frequencies extend the Fresnel zone, although this advantage is partly counteracted by increased beam attenuation at higher frequencies.

Effect of scan line density

The image is formed by combining echo information from a large number of scan lines generated by scanning the beam across the selected plane of interest in the subject. The number of scan lines contributing to the image affects lateral resolution. Sampling the tissues at closer intervals improves resolution. Therefore, the higher the scan line density the better the lateral resolution. The line density may vary with tissue depth, depending on the type of scanner. In particular, the line density decreases with distance from the transducer in sector scanners, hence the lateral resolution will also diminish with increasing tissue depth. This effect is not present in systems in which the scan lines remain parallel to one another.