

Exercise 2- Use of ultrasound scanner

Problem 1

- The difference between using and not using gel is the difference in medium in which the wave propagates. Without the gel we have air between the probe and biological material, and air have lower acoustic impedance than water. By applying the gel the propagation of the signal will remain constant between the probe and the biological material.
- Ultrasound is cheaper, and it can measure object that are in motion(heart, artery). MR and CT are much expensive and demand maintenance. They can also just measure still images.
- For heart imaging we use phased array, because of the ribs and lungs coming in the way for imaging the heart. With the phase array we can sweep the beam dynamically in the lateral direction to image the heart. Since the heart is at a certain depth, we use lower frequency to image it compared to the carotid. For the carotid we use linear probe, because we don't have anything in the body which causes attenuation or absorption of the probe when imaging it. We also use higher frequency in this case to get better resolution.
- The LED is just to keep orientation of what we are imaging. The LED is showing the left side of the image.

Problem 2

- The sponge act like the lungs and the wooden plate is like the bones in the body.
- The lungs have air which have lower acoustic impedance, which will cause reflection and result in white/grey picture. The wooden plate will cause the wave to attenuate, creating dark areas in the picture.
- The sponge has many holes filled with bubble which causes diffuse reverberations. The wooden plate has a much smoother surface resulting in mirror artifacts.
- I see the same picture but with worse lateral resolution. This is due to the transducer only using subarrays on the aperture, which smoothens the picture, resulting in a poor lateral resolution.
- I see my finger two times; this is due to the echo time of the signal. Some of the beam will directly hit my finger and get reflected to the transducer with distance, $t=2r/c$. While some of the beam will hit the wooden plate and then my finger, which result to a different travel time, $t_1=2r/c$ which is longer. This will create two fingers at different depths, when there's only one.

Problem 3

- By adjusting the tgc(time gain constants) up, I get brighter areas. What happens is that we increase the amplitude only at a certain depth by multiplying it with an exponential function. In other word; we increase the power at a certain depth.
- The thermal noise is stronger far away from the probe. The reason for this is that signals that travel greater distance are weak and easy affected by noise. This result in lower signal to noise ratio than signal that travel much less distance.
- Increasing the frequency, will increase the radial resolution. But higher frequency will also attenuate faster which reduces the depth of the probe. If we reduce the frequency, then we reduce the radial resolution. But we increase the depth because the attenuation is lower.
- Changing the focus depth result in better radial and lateral resolution in the focus.