Flow velocity estimation in combination with NSI

Fabian Fool, Martin Verweij
Email: F.Fool@tudelft.nl

1. Project description and problem definition

In order to make a good diagnosis using ultrasound, it is important that different tissues and structures in the human body can be well separated. This implies that the spatial resolution has to be as high as possible. One way to do this is by using a higher frequency pulse, but the downside of this is that a higher frequency limits the penetration depth into the body. Another method is to make the ultrasound transducer as wide as possible to create a large aperture, but this is expensive and the width is limited due to the anatomy of the body itself. In the last few years, a lot of work has been done in signal processing methods that can improve the resolution. One of those methods is Null Subtraction Imaging (NSI). This method improves the resolution by smartly adding and subtracting images from the same data that are created by using a different weighing or apodization of the transducer elements. As can be seen in Figure 1, the wires in the center of the image appear significantly smaller in the lateral direction in the image created with NSI.

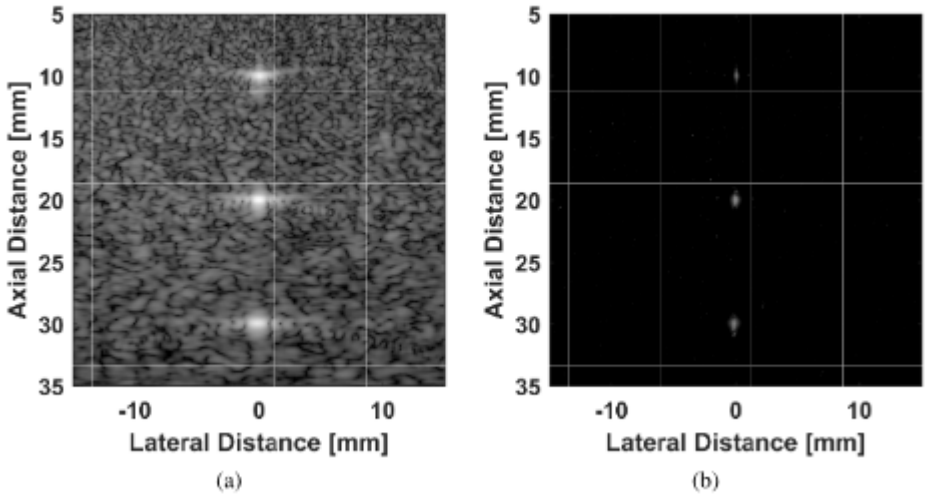

Figure 1: Images of a tissue mimicking ultrasound phantom containing wires. (a) Conventional image. (b) Null Subtraction Imaging.

One of the possible applications of NSI is to more accurately measure blood flow, for example in the carotid artery to map the course of atherosclerosis. The increased lateral resolution will decrease the mixing of velocities usually present in blood flow estimation, which results in less underestimation. However, it is known that non-linear methods, like NSI, can result in more dissimilarities between subsequent images from which the flow is estimated, which makes flow estimation less accurate. It is currently unknown how similar subsequent images are. In this project, it will be investigated whether it is possible to measure flow velocities based on images created with NSI, and what accuracy improvement this will give.

2. Objectives and the research goals

The goal of this project is to investigate whether flow velocities can be accurately measured based on images created with NSI.

3. Approach and activities

- Literature research
- Build a numerical model to simulate flow in a vessel
- Implement NSI
- Estimate flow velocities from the simulated images
- Compare results with existing methods
- Writing a BSc thesis