Abstract
Automated measurement of fetal head circumference

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Ultrasound imaging is one of the most commonly used imaging technologies. Since it is low-cost, real-time and non-invasive, it can be easily utilized for the monitoring of pregnant women. However, the images may not be easy to interpret.

During pregnancy, it is essential to determine the gestational age (GA) of the fetus and monitor its growth. After 13 weeks, the head circumference (HC) is used to estimate the GA. These biometric measurements should be obtained manually by a trained sonographer. Due to the involvement of human factor, inter-observer variation may cause problems, even in developed countries.

Meanwhile in developing countries there is a lack of trained healthcare workers, so a proper examination is mostly out of reach. To resolve this issue, an automated system, which is able to determine the HC from an ultrasound image, would be very useful. With the help of this automated system, inexperienced observers could also perform examinations, providing skilled care during pregnancy, saving the lives of women and newborn babies.

There are various ways to begin the developing of such systems. In my thesis, I focused on Deep Learning techniques, and at the same time I presented other considerable solutions from the related works on the topic.

At first, I reviewed the theoretical background of the task from several sides, reading articles and publications from the field of medicine, mathematics and computer science.

An insight into the history and structure of the ultrasound imaging system is provided at the beginning of my thesis.

Afterwards, the concept and mathematical interpretation of the neural networks are presented from the bases, next to the background of Deep Learning from the perspective of computer science.

The goal of this thesis is to train a specific neural network, that is similar to the so-called U-Net, which is used mainly for medical image segmentation, to segment the head of the fetus on the ultrasound image.

The used data was collected in the Netherlands, then it was uploaded to a website (Grand Challenge), which organizes competitions related to data science. I obtained the data from that site. It included ultrasound images of fetal skulls and the annotation of the head circumference by a trained sonographer.

At this point, several models were trained. Next, ellipse fitting is applied for the measurement of the head circumference.

At the end, my achievements are presented and compared to each other and to literature. The best result of mine was 1.9223 mm mean absolute difference on the selected test set images.

Since the field of Deep Learning and Data Science is still developing, this task stays relevant. In the future, I would be interested in trying new methods to resolve this issue and dive even deeper into the topic.