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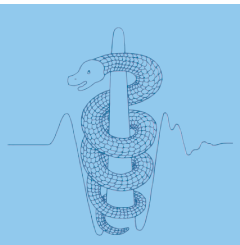
European Federation of Societies for Ultrasound in Medicine and Biology



Winners of the EFSUMB Young Investigators' Award

Best technical abstract – Thomas LA van den Heuvel

Thomas van den Heuvel is a postdoctoral fellow at the Radboud university medical center in the Netherlands. His research focuses on combining point-of-care ultrasound devices with deep learning solutions to facilitate diagnosis in resource limited countries. During his PhD, he developed a deep learning software that automatically detects twin pregnancies, estimates gestational age and determines fetal presentation. The system is so easy to operate that any health care worker can use the device after two hours of training. Currently, the methods are implemented in Android based smartphones to further facilitate widespread use of this technology.

Introducing prenatal ultrasound screening in resource-limited settings using artificial intelligence

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Abstract

Introduction

Each day, more than 820 women die as a consequence of their pregnancy. Worldwide, 99 % of these maternal deaths occur in resource-limited settings [1]. Ultrasound imaging is widely used for prenatal screening. These days, ultrasound devices only cost a few thousand dollars and they can be connected to tablets and smartphones, making them suitable imaging devices for areas in the world that are difficult to reach and which lack stable power supply. Even though these devices have become more affordable and portable in recent years, they are still barely used in resource-limited settings while the World Health Organization recommends "one ultrasound scan before 24 weeks of gestation" [2].

The main reason that pregnant women in resource-limited settings have limited access to ultrasound imaging, is caused by the lack of well-trained medical personnel that is capable to both acquire and interpret prenatal ultrasound images. Training midwives to be able to perform prenatal ultrasound screening takes months till years, which impedes widespread application of ultrasound in these countries. In my work, I have focused on development of artificial intelligence software that can automatically interpret prenatal ultrasound images. By combining this software with a standardized acquisition protocol, it becomes possible to train a midwife in two hours to acquire the ultrasound images, which can be automatically interpreted by the software.

Methods

For the acquisition of the ultrasound data we used a standardized acquisition protocol that consists of six predefined sweeps with the ultrasound transducer over the abdomen of the pregnant woman (▶ **Fig. 1A**). This protocol was introduced by DeStigter et al. [3] and takes less than two hours to learn. My research focused on the development of deep learning software that could automatically interpret the ultrasound data acquired using these sweeps. First, a system was developed for automated measurement of the fetal head circumference (HC), using 1334 acquired ultrasound images acquired with the high-end Voluson E8 and Voluson 730 (General Elecric, Austria) [4]. Secondly, a study was performed in Ethiopia, were the standardized acquisition protocol was acquired from 183 pregnant women using the mid-range SonoAce R3 (Samsung Medison, Korea) [5]. Thirdly, the standardized acquisition protocol was acquired from another 318 pregnant women in Ethiopia using the portable and low-cost MicrUs (Telemed, Lithuania) [6].

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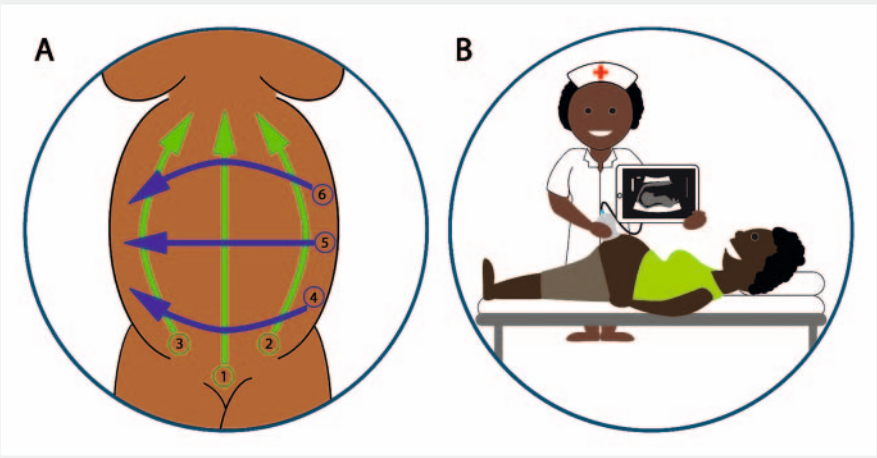
Results

The system for automated measurement of the HC using the high-end ultrasound device showed state of the art results on the largest dataset described in literature [4]. The study showed that automated measurement of the HC in 2 D images was feasible with an accuracy similar to the measurement made by a trained sonographer. This dataset was made publicly available



▶ **Fig.1A** Visualization of the standardized acquisition protocol, consisting of six predefined free-hand sweeps with the ultrasound transducer over the abdomen of the pregnant woman. **B** Clipart showing a midwife using a hand-held ultrasound device for prenatal screening.

[7] and I setup a challenge (https://hc18.grand-challenge.org/) which has currently more than one thousand submissions.

Using the dataset acquired from 183 pregnant women using the mid-range ultrasound device in Ethiopia, I was able to show that a deep learning system could automatically estimate gestational age using the standardized acquisition protocol. The dataset of 318 pregnant women scanned with the low-cost ultrasound device was used to develop artificial intelligence algorithms that not only automatically estimates gestational age, but also determines fetal presentation and detects twin pregnancies. This makes it possible for midwives to know when to send a woman to a health care facility for treatment, which is of great importance in resource-limited setting because this can take more than one day to reach. Both breech presentation and twin pregnancies are high risk deliveries that preferably should take place in close proximity of a health care facility.

Discussion and Conclusion

I have developed artificial intelligence software that can be combined with a standardized ultrasound acquisition protocol to automatically detect prenatal risk factors. This makes it possible to train midwives within two hours in order to perform prenatal ultrasound screening in rural areas of resource-limited settings. Current efforts are focusing on the development of the first prototype that can be used in clinical practice and therefore hopefully improves prenatal care in resource-limited settings.

References

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