How AI can help save lives in high-risk pregnancies

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Image: Hobo Mama (Flickr)

Pregnancy is a very special time for the expectant parents. While most women experience uncomplicated pregnancies, some pregnancies are high-risk, where close monitoring of the fetus is critical to avoid

complications or even death. Unfortunately, current fetal monitoring solutions have proven to be insufficient to accurately detect fetal distress and prevent poor perinatal outcome. In her research, Ph.D. student Eleni Fotiadou has developed an alternative method for fetal monitoring, called fetal electrocardiography, and achieved improvements over other existing methods, which can help the spread of this technology in clinical practice.

Monitoring of the fetal heart rate is widely used to assess the condition of the fetus both during pregnancy and labor. Currently most hospitals use ultrasound technology to do this. The problem with this technology is that in case of obese patients or during movement of the mother or the fetus the quality of the fetal heart rate measurements significantly degrades.

Noise

The fetal heart rate can also be measured through fetal electrocardiography. where an electrode patch is placed on the maternal abdomen. Unlike ultrasound, this method is suitable for obese patients and long-term monitoring. However, the abdominal electrodes measure the fetal electrocardiogram (ECG) together with many other signals and noise.

"Separating the signals is not an easy task," says Fotiadou, who works in the Biomedical Diagnostics Lab at the department of Electrical Engineering. "Complex signal processing methods are used for this, but still the fetal ECG signals that we obtain with these methods are very noisy, making it virtually impossible to reliably assess the fetal heart rate."

"I believe that this is the main reason why only few devices based on fetal electrocardiography are commercially available. For fetal

electrocardiography to be successfully used in hospitals, the methods for detecting the fetal heart rate must be significantly improved."

Because some of the noises that corrupt the fetal ECG signals are complex and have unknown characteristics, the researcher explored the use of deep learning to find hidden patterns in the data. In that way she achieved more accurate and reliable fetal heart rate estimation than state-of-the-art signal processing methods.

Wave form

Unfortunately, even in cases that a reliable heart rate is available, obstetricians cannot always conclude on a diagnosis and even frequently disagree. Complementary diagnostic measures are therefore often necessary, and analysis of the fetal ECG waveform could be one of them. The fetal ECG waveform contains vital information about oxygen deficiency, the presence of congenital heart diseases and cardiac arrythmias.

Until now, analysis of the fetal ECG waveform is however only possible when the fetal ECG is obtained invasively with a scalp electrode. This can be done only during labor and is risky. Ideally, one would like to use the waveform analysis of the ECG signals that are measured from the maternal abdomen as complementary measure. Unfortunately, this is not currently possible because of the noise that is present in the noninvasive fetal ECG signals.

In her Ph.D. research, Fotiadou focused on enhancing the quality of the fetal ECG signals and achieved significant quality improvement that can potentially enable the desired waveform analysis on the non-invasive fetal ECG signals.

Non-invasive fetal electrocardiography could support clinical decisions

and aid in diagnosis of fetal distress and heart abnormalities. Improvements of the technology like the ones achieved in this thesis are necessary so that the technology can fulfill its full potential.

More information: Artificial Intelligence for Noninvasive Fetal Electrocardiogram Analysis. research.tue.nl/en/publication …-electrocardiogram-a

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