Designing a wearable sensor for neonatal seizure monitoring

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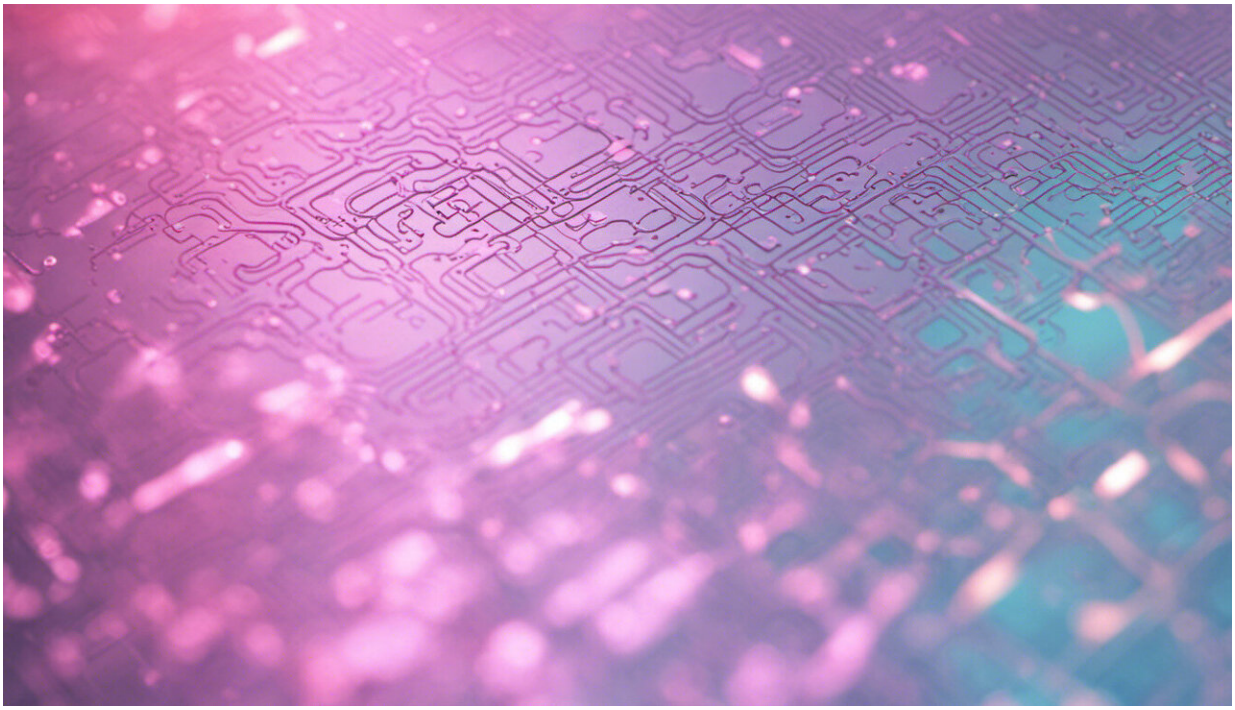

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eizures in neonates (newborn children) is the most common sign of neurological dysfunction and requires immediate medical attention. Therefore, the continuous monitoring of neonatal seizures is critical for their optimal treatment. For his Ph.D. research, Hongyu Chen sought to solve problems in neonatal seizure detection and focused on the design

of a wearable sensor system. The new sensor system is comfortable and non-invasive, while at the same time, providing continuous and efficient neonatal seizure detection.

Neonatal seizure is a clinical sign of brain dysfunction that occurs more commonly during infancy in comparison to childhood. Seizures can marked by specific behavorial and physiological changes, asuch as repetitive motion of the limbs or eyes. In some cases, a seizure may also involve fluctuating muscle contractions and changes in breathing and brain activiy as measured by electroencephalogram (EEG) and electrocardiogram (ECG) (to measure heart's rhythm and electrical activity). Overall, 1–5% of neonates can experience seizures, while 6 to 13% of preterm infants (a child born alive before 37 weeks of pregnancy) experience seizures.

New sensing system

One way to detect the onset of seizure is to use wearable sensor systems. These can prove invaluable with regards to monitoring the infant and also providing data on seizure events. As part of his Ph.D. research, Hongyu Chen applied the approach of the "Medical Technology Innovation Process"" to design and develop a new neonatal multi-parameter sensing system, which was also subject to extensive experimental tests to evaluate materials for the sensing system and its overall performance. In addition, he proposed an algorithm for the automatic detection of neonatal seizures based on ECG, respiration, and bodily movement.

Three detector cases

The proposed system was tested on 38 neonates at the Children's Hospital affiliated to Fudan University, Shanghai, China, and data sets

from four neonates were analyzed with the evaluation algorithm. To evaluate the approach of combining ECG, respiration, and movement, Chen and his collaborators compared the performance of three seizure detectors.

The first detector included features the ECG, respiration and acceleration recordings; the second detector incorporated respiratory-motion based features from respiration and acceleration recordings; and the third approach only used ECG-based features. The experimental results showed that the overall performance was better when multi-modal features were included, i.e. when data from ECG, respiration, and acceleration were considered.

Improving comfort

To improve the comfort of the system and the stability of the signal, Chen studied different flexible sensors, including textile electrodes and Carbonized Foam Electrode for ECG monitoring, and a Mesh PDMS-G Compound Sensor for respiration monitoring. The feasibility of these sensors was also verified by experiments.

The neonatal multi-parameter sensor system designed and developed by Chen and his collaborators could solve several problems associated with neonatal seizure detection. The system combines flexible, comfortable-to-wear sensors with multi-modal signal approach to achieve continuous and efficient neonatal seizure detection. Most importantly, the sensor system is non-invasive and relies on the measurement of pertinent data using external sensors, which is imperative for the comfort of the neonate during monitoring.

More information: Design of a wearable sensor system for neonatal seizure monitoring research.tue.nl/nl/publication … al-seizure-monitorin

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