SMART HEALTH

UNOBTRUSIVE CLINICAL AND HOME SLEEP MONITORING

Approximately 20% of the population struggles with sleep problems. Insight into heart activity (ECG) and respiratory activity while asleep can provide valuable information to diagnose sleep disorders, such as sleep apnea. Unfortunately, existing solutions to monitor vital signs while asleep tend to be uncomfortable, time-limited, costly and of limited availability. By embedding capacitive sensors into a mattress cover, imec developed a solution that does not affect users’ comfort and allows for long-term unobtrusive cardiorespiratory monitoring.

SLEEP MONITORING THAT DOES NOT DISTURB A GOOD NIGHT’S SLEEP

The most common type of sleep study today is a polysomnography test, which requires patients to spend the night in the hospital or sleep clinic while being hooked up to numerous wired sensors. Needless to say, this situation does not resemble patients’ natural sleeping conditions and affects the way they sleep. In addition, polysomnography studies are expensive, and capacity is limited to the number of available beds on the ward. In the last few years, wearable sleep trackers – e.g. integrated into wristbands – have emerged as consumer electronics and although their form factor significantly enhances comfort, they do not offer medical-grade monitoring.

In the last few years, imec has been working on a method to accurately measure vital signs in an unobtrusive way through capacitive sensors that can measure both the electrical activity of the heart (electrocardiogram – ECG) as well as respiratory activity (using bioimpedance) through clothing. Unlike traditional sensors, imec’s solution does not require any direct contact with the user’s skin but can be integrated into a mattress cover.

COMFORT WITHOUT COMPROMISING ACCURACY: IT’S OKAY TO TOSS AND TURN

Imec’s solution offers a number of important advantages in comparison to existing solutions. As the sensors are hidden in the mattress cover, users’ sleep is not affected by the monitoring itself.
This makes the technology ideal for long-term monitoring, not only at the hospital but also at home. Monitoring at nursing homes is another potential application.

The technology’s innovation, i.e. the fact that vital signs are measured without direct contact, is also its biggest challenge. In real life, people tend to toss and turn while asleep, causing motion artefacts and noise. The mattress is covered by numerous different sensors and – depending on the position of the sleeper – other sensors might manage to get the best measurement. To make sure the best signal is selected, imec researchers developed state-of-the art quality indicators to select the most reliable and accurate measurements from the combination of sensors.

Initial pilot studies – e.g. in collaboration with the Leuven University Hospital and KU Leuven – indicate that the technology makes it possible to obtain relevant information to diagnose sleep disorders, such as sleep apnea. Further clinical validation is ongoing. Compared to other contactless approaches using mechanical sensors (e.g. inertial sensors, pressure sensors, etc.), the amount of information and the reliability of the measured parameters is significantly higher.

Key features in a nutshell:

- Through-clothing electrocardiogram (ECG): up to 98% correlation with medical-grade reference
- Respiratory activity via bioimpedance measurements
- Long-term unobtrusive monitoring
- State-of-the-art quality indicators for sensor & data selection

Next Steps: Long-term Monitoring at the Hospital and at Home

In hospitals or residential care, the sensors could be used to diagnose disorders that require long-term monitoring, such as sleep apnea or heart arrhythmia. It could also be used to preventively monitor a patient’s vital functions, e.g. alerting medical staff when patients’ breathing rate or heart activity suggests unhealthy agitation.

As the technology does not require any inherently expensive building blocks and — once infrastructure is equipped — per-patient incremental effort is very small, a larger group of patients could be monitored cost-effectively. This collected data could then also be used for aggregated statistics, leading to new medical insights.

The same technology could of course also be useful outside the medical context. Imec researchers have also developed a similar approach to monitor driver’s vital signs, by integrating sensor and radar technology in the driver’s seat.

Looking for: Industry and Medical Partners

Having completed a number of successful pilot studies that confirm the value of our approach for medical diagnosis and monitoring, we would now like to further validate our technology in the medical field and fine-tune it to the needs of patients and staff. In addition, we would also like to collaborate with industry partners that are interested in integrating our technology (e.g. in hospital beds or tools for sleep monitoring at home or nursing homes).