Unobtrusive, wearable blood pressure sensor for long-term continuous monitoring

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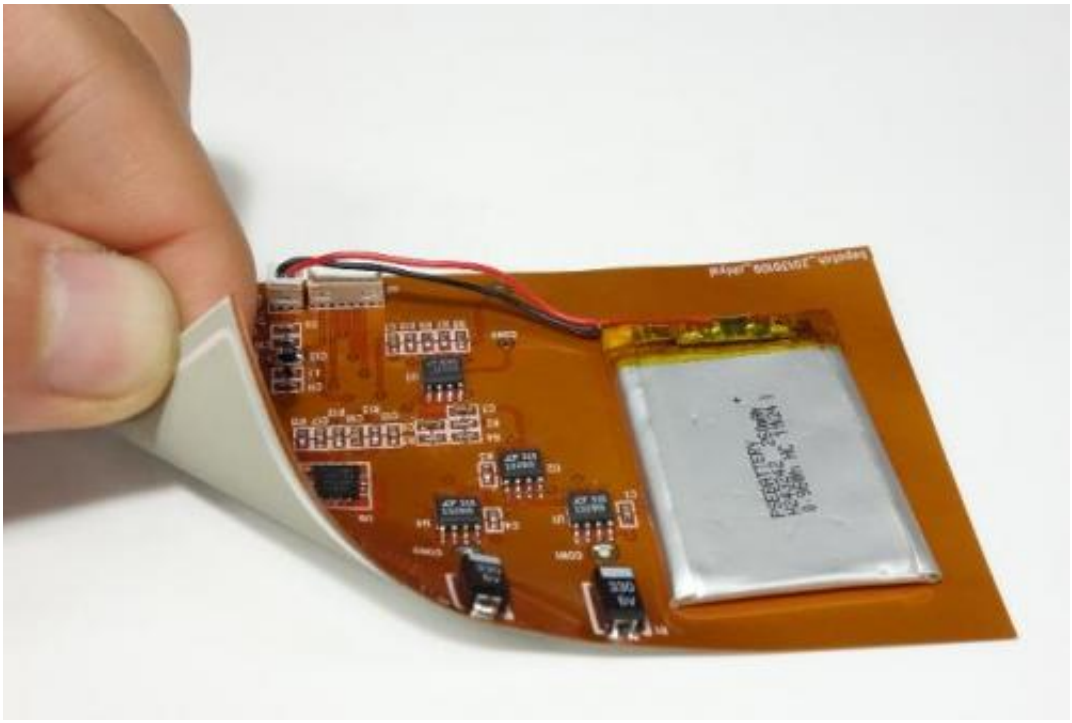


The completed monitor including power supply is compact and thin enough to wear under clothing.

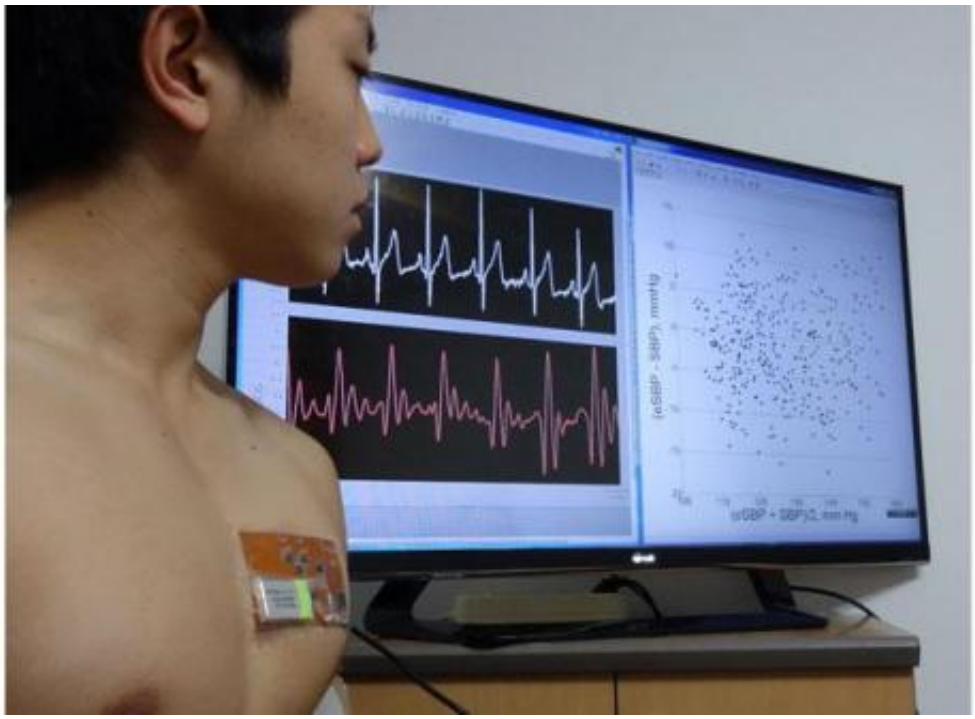
A team of researchers in Korea have developed a wearable blood pressure sensor that is sufficiently compact and unobtrusive which can be used to provide long-term continuous monitoring without affecting the daily activities of the user.

Daily pressures

Hypertension (high blood pressure) is a serious medical condition affecting a large number of people worldwide. Blood pressure (BP) varies significantly throughout the day and in response to environment such that a single measurement at home or in a clinic cannot be used to reliably diagnose and monitor the disease.

Home monitoring using an automated BP device with a traditional arm inflation cuff and the necessary air pump in the unit is unwieldy and disruptive, limiting where and how often readings can be taken. It is certainly not possible to use such devices for continuous monitoring as a user goes about their normal activities.

To that end, wearable solutions have been developed. However, these devices still use an inflatable cuff method to measure BP, albeit attached to the user's fingers rather than encircling their whole limb. Even so, the periodic inflation of the cuff to apply occlusive pressure to the user's finger is still an annoyance and painful in long-term use.



The monitor can be simply adhered to the user's skin.

BP monitors using other methods, including electrocardiogram (ECG) and photoplethysmogram (PPG), have been also been developed and built into objects including chairs, toilet seats and bathroom scales. These devices are more compatible with normal daily life but require the user to remember to measure themselves and do not provide continuous monitoring.

Dual readings

The device, developed by the team from Seoul National University and the Electronics and Telecommunications Research Institute in Daejeon, on the other hand, promises to provide continuous BP monitoring with minimal impact on the user's normal activities.

Their monitor calculates BP by combining ECG with ballistocardiograph (BCG) data – a measure of the physical forces exerted through the body by the heart's contractions. Devices have been developed for this method before, using multiple sensor types to gather the signals for ECG and BCG, increasing the complexity of the system and power consumption; both particular issues in wearable systems.

Team member Prof. Hee Chan Kim explained the work did not start with BP in mind. "Initially, the idea stemmed from a non-BP-related project. We were primarily focusing on applications of BCG, which is a recently resurgent heart signal owing to the advent of new sensors. Use of BCG to monitor heart rhythm is advantageous in terms of user compliance since very lightweight sensors (e.g. accelerometers) can be used and no direct contact with the body is required. Moreover, BCG can be sensed passively using a piezoelectric film, reducing power consumption. In order to interpret the BCG, ECG needs to be obtained synchronously. Thus, we were motivated to develop a unified sensor that can measure both the BCG and ECG to avoid complications during experiments. At this point, our BP-related project began since we knew that BP can be estimated using the two signals. The greatest challenge was the design of the electrode shape and the selection of its material."

The team's device uses a single electromechanical film (EMFi) structure to measure both the ECG and BCG signals. EMFi structures have commonly been used to measure BCG signals but by altering the conductive layers of the film structure the team allowed it to pick up the ECG signal as well.

Second skin

With regard to accuracy, the sensor satisfies both the American standard from the Association for the Advancement of Medical Instrumentation and the British standard from the British Hypertension Society. Attached

to the user's skin, the sensor can be worn unobtrusively under clothing, powered by the on-board battery. Team member Professor Hee Chan Kim explained that "next to the accuracy of readings, which is the most basic requirement, the user's compliance with continuous usage is what guarantees the success of an ubiquitous-health system. In this respect, our device features superior user compliance compared to previous continuous BP monitors. We expect that our findings will contribute to the realisation of a true u-healthcare service system, which is a 'megatrend' in healthcare technology."

Prof. Kim believes the team is particularly well placed to develop this kind of healthcare device: "Our group is unique in that we have a foothold in a big university hospital with more than 2000 beds and are aiming to develop new medical devices that can be directly applicable to the clinical environment. Apart from BP estimation, we are now trying to develop another application of this particular sensor since its synchronous BCG and ECG measurement adds great diagnostic value in other areas of clinical application."

More information: "Ferroelectret film-based patch-type sensor for continuous blood pressure monitoring." S. Noh, et al. *Electronics Letters*, Volume 50, Issue 3, 30 January 2014, p. 143 – 144 DOI: 10.1049/el.2013.3715

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