Research team introduces 'phyjama,' a physiological sensing pajama

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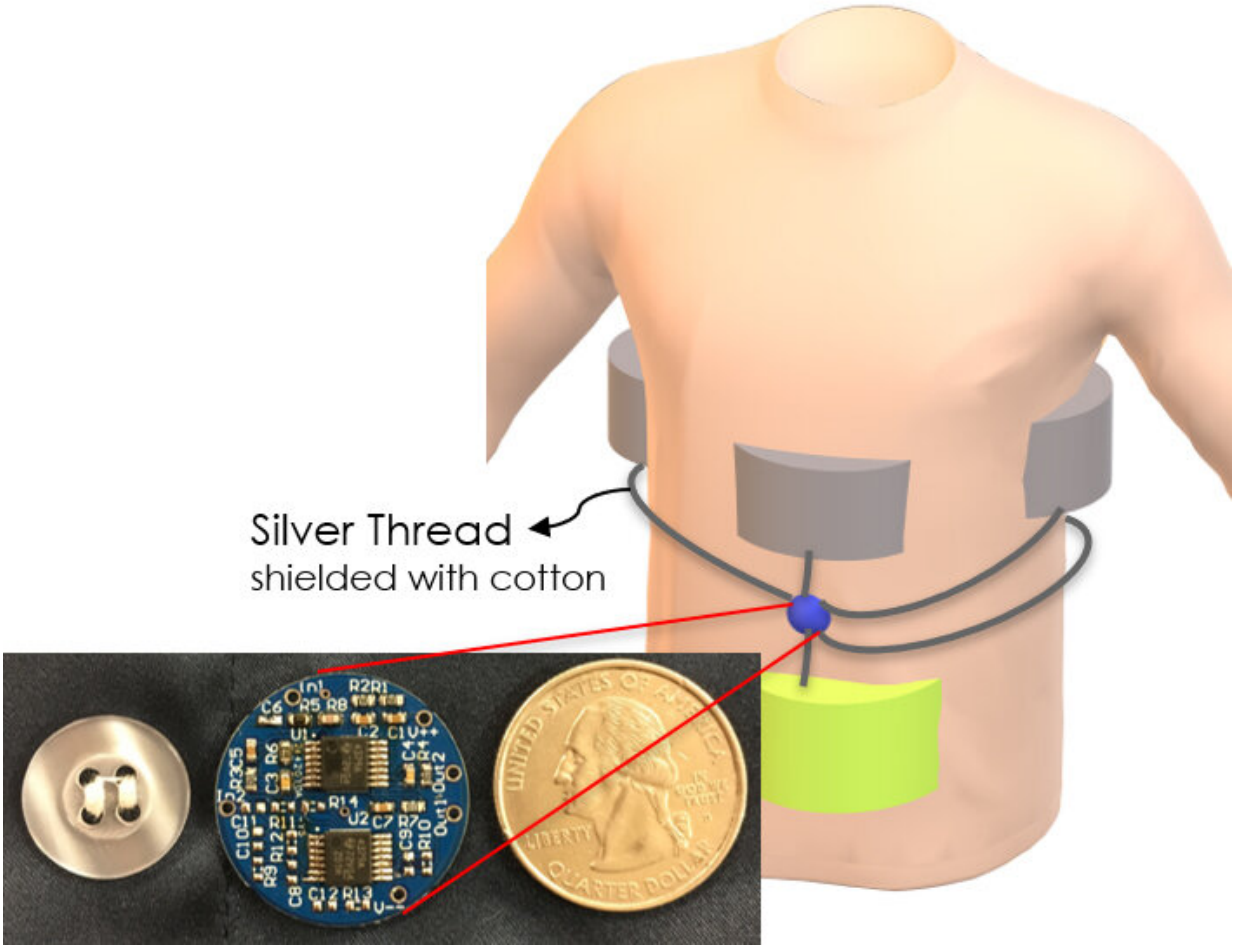

UMass Amherst researchers have developed physiological-sensing textiles that can be woven or stitched into sleep garments they have dubbed "phyjamas."

Their work rests on the insight that though sleepwear is worn loosely, in places sensors may press against the body through contact with external surfaces, such as the torso against a chair or bed, an arm resting on the body or light pressure from a blanket. Credit: UMass Amherst/Andrew lab

Scientists expect that in the future, electronically active garments containing unobtrusive, portable devices for monitoring heart rate and respiratory rhythm during sleep, for example, will prove clinically useful in health care. Now researchers at the University of Massachusetts Amherst have developed physiological-sensing textiles that can be woven or stitched into sleep garments they have dubbed "phyjamas."

Graduate students Ali Kiaghadi and S. Zohreh Homayounfar, with their professors Trisha L. Andrew, a materials chemist, and computer scientist Deepak Ganesan, will introduce their health-monitoring sleepwear at the Ubicomp 2019 conference this week in London, U.K. A paper detailing the work has been chosen for publication in the Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies (IMWUT).

As Andrew explains, "The challenge we faced was how to obtain useful signals without changing the aesthetics or feel of the textile. Generally, people assume that smart textiles refer to tightly worn clothing that has various sensors embedded in it for measuring physiological and physical signals, but this is clearly not a solution for everyday clothing and, in particular, sleepwear."

Ganesan adds, "Our insight was that even though sleepwear is worn loosely, there are several parts of such a textile that are pressed against the body due to our posture and contact with external surfaces. This includes pressure exerted by the torso against a chair or bed, pressure

when the arm rests on the side of the body while sleeping, and light pressure from a blanket over the sleepwear."

Fabric-based pressure sensor combined with a triboelectric sensor. Credit: UMass Amherst/Andrew lab.

"Such pressured regions of the textile are potential locations where we can measure ballistic movements caused by heartbeats and breathing," he explains, "and these can be used to extract physiological variables." The difficulty is that these signals can be individually unreliable, particularly in loose-fitting clothing, but signals from many sensors placed across different parts of the body can be intelligently combined to get a more accurate composite reading.

Andrew, Ganesan and colleagues explain that their team had to come up with several new ideas to make their vision a reality. They realized that

there is no existing fabric-based method to sense continuous and dynamic changes in pressure, particularly given the small signals that they needed to measure. So they designed a new fabric-based pressure sensor and combined that with a triboelectric sensor—one activated by a change in physical contact—to develop a distributed sensor suite that could be integrated into loose-fitting clothing like pajamas. They also developed data analytics to fuse signals from many points that took into account the quality of the signal coming in from each location.

The authors report that this combination allowed them to detect physiological signals across many different postures. They performed multiple user studies in both controlled and natural settings and showed that they can extract heartbeat peaks with high accuracy, breathing rate with less than one beat per minute error, and perfectly predict sleep posture.

"We expect that these advances can be particularly useful for monitoring elderly patients, many of whom suffer from sleep disorders," says Andrew. "Current generation wearables, like smartwatches, are not ideal for this population since elderly individuals often forget to consistently wear or are resistant to wearing additional devices, while sleepwear is already a normal part of their daily life. More than that, your watch can't tell you which position you sleep in, and whether your sleep posture is affecting your sleep quality; our Phyjama can."

This work was enhanced by Ganesan and Andrew's affiliation with UMass Amherst's Institute of Applied Life Sciences (IALS), which focuses on translating life science research into products that improve human health. Director Peter Reinhart at IALS says, "It's exciting to see the next generation of wearable technology that is zero effort and addresses the issue of comfort and unobtrusiveness head-on. The data generated by fabric-based sensors have the potential to improve health and well-being, and could possibly contribute to the early diagnosis of

multiple disorders."

Provided by University of Massachusetts Amherst