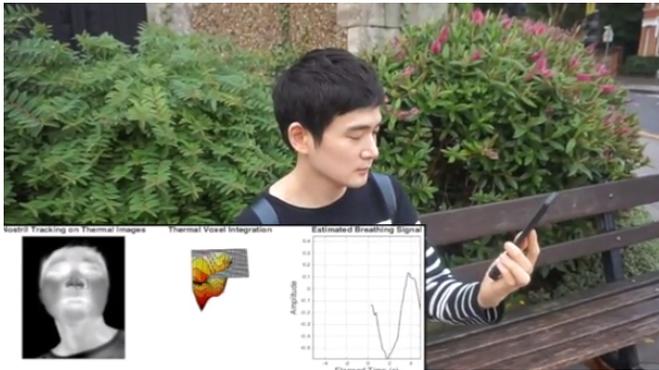# New software turns mobile-phone accessory into breathing monitor

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Researchers have developed new software that makes it possible to use low-cost, thermal cameras attached to mobile phones to track how fast a person is breathing. This type of mobile thermal imaging could be used for monitoring breathing problems in elderly people living alone, people suspected of having sleep apnea or babies at risk for sudden infant death syndrome (SIDS).

In The Optical Society (OSA) journal *Biomedical Optics Express*, the researchers report that their new software combined with a low-cost thermal camera performed well when analyzing breathing rate during tests simulating real-world movement and temperature changes.

"As thermal cameras continue to get smaller and less expensive, we expect that phones, computers and augmented reality devices will one day incorporate thermal cameras that can be used for various applications," said Nadia Bianchi-Berthouze from University College London, (UK) and leader of the research team. "By using low-cost thermal cameras, our work is a first step toward bringing thermal imaging into people's everyday lives. This approach can be used in

places other sensors might not work or would cause concern."

In addition to detecting breathing problems, the new approach could one day allow the camera on your computer to detect subtle breathing irregularities associated with pain or stress and then send prompts that help you relax and regulate breathing. Although traditional video cameras can be used to track breathing, they don't work well in low-light situations and can cause privacy concerns when used for monitoring in nursing homes, for example.

"Thermal cameras can detect breathing at night and during the day without requiring the person to wear any type of sensor," said Youngjun Cho, first author of the paper. "Compared to a traditional video camera, a thermal camera is more private because it is more difficult to identify the person."

Personal thermal cameras

Thermal cameras, which use infrared wavelengths to reveal the temperature of an object or scene, have been used in a variety of monitoring applications for some time. Recently, their price and size have dropped enough to make them practical for personal use, with small thermal cameras that connect to mobile phones now available for around $200.

"Large, expensive thermal imaging systems have been used to measure breathing by monitoring temperature changes inside the nostrils under controlled settings," said Cho. "We wanted to use the new portable systems to do the same thing by creating a smart-phone based respiratory tracking method that could be used in almost any environment or activity. However, we found that in real-world situations this type of mobile thermal imaging was affected by changes in air temperature and body movement."

To solve these problems, the researchers developed algorithms that can be used with any thermal camera to compensate for ambient temperature changes and accurately track the nostrils while the person is moving. In addition, the new algorithms improve the way breathing signals are processed. Instead of averaging the temperature readings from 2D pixels around the nostrils, as has been done in the past, Cho developed a way to treat the area as a 3D surface to create a more refined measurement of temperature in the nostrils.

Testing in real-world situations

In addition to indoor laboratory tests, the researchers used the mobile thermal imaging approach to measure the breathing of volunteers in a scenario that involved [breathing exercises](#) with changes in ambient temperature and in a fully unconstrained test where volunteers walked around inside and outside of a building. During the walking tests, the thermal camera was placed between 20 and 30 centimeters from a person's face using a rig that attached the camera to a hat. A cord then connected the camera with a mobile phone carried by study volunteers. It is also possible to hold a smartphone with an imaging camera about 50 centimeters from the face to measure breathing.

"For all three types of studies, the algorithms showed significantly better performance in tracking the nostril area than other state-of-the-art methods," said Cho. "In terms of estimating the breathing rate, the tests outside the laboratory showed the best results when compared with the latest algorithms. Although the results were comparable to the traditional breathing belt sensor, for mobile situations our approach seems to be more stable because the belt tends to get loose."

Because the new approach is more stable than standard chest belt respiratory sensors, the method could potentially be used to optimize an athlete's performance by providing more reliable and accurate feedback on breathing patterns during exercise.

The researchers took their work one step further by inferring a person's mental load or stress through automatic breathing analysis. They used their thermal imaging software to track the breathing of people who were free to move around while performing various types of tasks, and the results aligned well with findings from studies that used much more sophisticated equipment, indicating the portable [thermal-camera](#) based approach could be a useful tool for apps that help people relax.

"By using mobile thermal imaging to monitor only breathing, we obtained results very comparable to what other studies had found," said Bianchi-Berthouze. "However, those studies used complex, state-of-the-art techniques that involved multiple sensors monitoring not just breathing but also heart rate."

The current version of the software doesn't estimate the breathing rate in real time, but the researchers are working to incorporate this capability and to test their algorithms in more real-life situations.

Provided by Optical Society of America

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