Using biosensors for wearable stress and seizure detection

Patrick Mannion - March 09, 2016

Fitbit is great, but what's next after counting the steps? Biosensors can now detect seizures and stress levels, all using mood-aware wearable devices that can help monitor mental health, moody teenagers, and be a red flag for those of us in high-stress jobs such as pilots, air-traffic controllers, and possibly engineers and editors/writers on a deadline.

There have been immense improvements in sensor technology in the last couple of years alone. Along with hardware advancements for the body-worn wearable devices, these advanced sensors allow medical practitioners to monitor patients outside clinics and hospitals with greater accuracy and efficiency.

There are two fundamental types of mood-aware wearable sensors—on clothes, smartwatches, bracelets, fitness bands, etc.—that can gauge the level of anger, stress, and anxiety. First, skin sensors that track electro-dermal activity (EDA) by measuring skin conductivity. Second, heart rate variability (HRV) or heart rate monitoring (HRM) sensors that collect data from the cardiovascular and nervous systems to determine a person's stress levels.

Electro-dermal skin sensors

In 2007, MIT professor Rosalind Picard was studying stress levels in non-verbal autistic children by measuring EDA when she noticed a spike in activity that caught everyone by surprise when it turned out to indicate a seizure. That discovery led to her co-founding Empatica, Inc. to create wearable sensors and analytics to improve health, and Affectiva, Inc. to deliver technology to help measure and communicate emotion. Empatica has since developed Embrace, a wristband that measures EDA to not only detect seizures, but also to help the general population to detect and manage stress.
The Empatica Embrace wristband measures EDA to detect seizures and stress. **Source:** Twitter

An EDA sensor typically using a [galvanic skin response](https://en.wikipedia.org/wiki/Galvanic_skin_response) (GSR) technique, sending a tiny electrical pulse to one point of the skin, and measuring the level of that impulse at another point to track the skin’s conductivity (Figure 1).
EDA sensors are critically important as the skin is the only organ that is purely innervated by the sympathetic nervous system. That system is activated upon excitement or stress, whether physical, emotional, or cognitive.

A new breed of EDA sensors integrated into smartwatches and wearable bands like Embrace are now replacing wearable patches that we are used to seeing attached to specific body parts; these patches are usually posture-dependant and limit the mobility of users. Thankfully, engineers at the Florida International University and North Carolina State University are building sophisticated skin sensors that ensure greater accuracy by measuring cortisol and other physiological bio-markers.

Heart rate sensors

HRV or HRM sensors, which measure the time difference between heartbeats, are generally based on the photoplethysmography (PPG) sensing technique that measures blood volume pulse (BVP), from which heart rate, heart-rate variability, and other cardiovascular features can be derived.

PPG sensors measure pulse rate by sampling light modulated by the blood vessels, which expand and contract as blood pulses through them. These heart-rate sensors might be a serious substitute for cumbersome ECG chest straps when paired with accelerometers.

Sensor supplier ams AG introduced a sensor module that converts the PPG readings into digital
HRM and HRV data using an emotion recognition algorithm. The Austria-based company claims that its AS7000 sensor module—comprising a photosensor, analog front-end (AFE), LEDs, and controller—overcomes limitations that have long hindered the potential of bio-feedback sensors in consumer applications.

**Figure 2** The ams AS7000 sensor module converts PPG readings into digital HRM and HRV data and comes with electrical, mechanical, and optical design guidelines.

The sensor comes with advanced analog-based noise reduction, motion compensation, and power management, all to ensure relatively fool-proof stress-level monitoring in space- and power-limited wearables.

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- [Wearables as second galvanic skins](#)
- [Galvanic skin response stimulates wearable electronics](#)
- [Optical heart-rate measurement's top 5 challenges](#)
- [Facial-recognition sensors adapt to track emotions, mood, and stress](#)