Use of a Smart Watch for seizure/abnormal motion activity monitoring and tracking

Chandan Gope
SmartMonitor, USA

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Epilepsy is a common and serious neurological disorder affecting about 1–3% of the world’s population, with about 50% of these patients suffering from generalized tonic–clonic seizures. Over 50,000 Americans die each year from seizures and related causes. Unwitnessed and uncontrolled seizures can cause serious bodily injuries and brain damage and can even lead to death. Early detection of a convulsive seizure episode with timely alerting allows caregivers to administer medication and call upon emergency response services, thus avoiding potentially dangerous and harmful situations.

In this work, we describe a completely automated noninvasive approach for detecting and alerting upon the onset of convulsive seizures that are characterized by repetitive shaking (nonrhythmic) motions. The device is a “smart” watch worn by the patient on the wrist or ankle. It can detect excessive repetitive shakings similar to those caused by generalized tonic–clonic (GTC) seizures and sends this information to a smartphone via Bluetooth. The smartphone in turn sends out the alert to designated care providers. All of this is completely automated, and the care provider gets to know the time, duration, and location of the event as it is happening in real time. All episodic data are saved in a log for use to guide care.

The “smart” watch uses a miniaturized 3D accelerometer to detect abnormal motions. The detected motion patterns are then analyzed by pattern recognition algorithms within the watch to classify them as seizures or nonseizures. When a seizure-like activity is detected, the SmartWatch logs its time, location, duration, motion severity, and frequency in addition to the accelerometer data. Any associated vocalizations are also recorded by the patient’s smartphone. All information is logged into a cloud-based webservice, and the patient can choose to authorize their care providers or physicians to access them. Cloud-based analytics of such information gathered over a period of time can be very useful in understanding the patient’s seizure patterns, such as seizure counts per week or month and day or night, seizure-free periods, variability between seizure episodes (such as duration, severity, and frequency), and the latest trend of episodes.

The SmartWatch also offers other abilities and features beside the basic detection, alerting, and logging of convulsive seizure episodes. Seizures that are typically not associated with excessive shaking motions such as partial seizures can be logged by a mere push of a button on the SmartWatch. There is also a Panic button in cases where the patient can sense an episode in advance; pressing it will alert caregivers. For any alerts that were sent inadvertently, the patient can press the Cancel button. A Snooze button has been provided to put the device in a short sleep mode. As mentioned above, the SmartWatch communicates with a smartphone app via Bluetooth. This app offers additional features like medication reminders and user acknowledgment. This app also allows the user to configure the seizure detection software running on the SmartWatch. The user can control settings like sensitivity and duration of the motion pattern which should trigger seizure events.

Several clinical studies have been done to evaluate the efficacy and accuracy of SmartWatch on both adults...
and children. The first study was done by Stanford University Medical Center in the 2009–2010 period. The patients were in the range of 23–48 years of age, and there were a total of 8 GTC seizure episodes in this period, 7 of which were detected by the SmartWatch. In 2011–2013, the University of California at San Francisco conducted a study with pediatric patients and in over 500 + h of study, the SmartWatch detected all seizure episodes. Further, there was only one false alert which shows that the SmartWatch had a high true detection rate and low false alert rate.