Wearable Epilepsy Monitor for Seizure Detection and Transfer of Data using GSM Module

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Abstract— Epilepsy is a chronic disorder in which nerve cell activity in the brain is disturbed, causing recurrent seizures. More than 1 million people in India are affected by epilepsy. During a seizure, a person experiences abnormal behavior, symptoms and sensations, sometimes including loss of consciousness. Therefore in the event of the seizure, a person's life is controlled by the seizure rather than the person himself. And hence a system which allows continuous monitoring of epileptic patients is essential. Current technologies that exist for seizure detection are EEG and vibration sensors but these can only be used for real time seizure detection in a hospital setting and can also miss more than 80% of non-convulsive seizures. A real time wearable, multi-sensor device which is helpful in detecting seizure in out-patients is developed using stretch sensor and accelerometer. The location of the patient is accessed using Global Positioning System (GPS). The data thus collected is transferred to the caregivers using Global System for Mobile communication (GSM) module.

Key words: Seizure, GSM, GPS

I. INTRODUCTION

Epilepsy is a chronic disorder, the hallmark of which is recurrent, unprovoked seizures. In India, more than one million people are affected by Epilepsy. As of 2013 study estimate about 22 million people in the world have epilepsy. Epilepsy becomes more common as people age. But in the modern world onset is common in older children and young adults.

A mobile, low power, 32-channel, miniature, narrow band RF telemetry system (902-928 MHz) for real-time electroencephalography (EEG) epilepsy monitoring and evaluations was developed and clinically tested. The transmitter units, which contain the amplification, analog-to-digital (A/D) conversion and the radio-telemetry circuitry and are powered by one regular 9 V battery, are small and light-weight such that they can be worn comfortably on a headband. 32-channel was the major disadvantage noted.[2]

Wearable EEG that was envisioned as the evolution of ambulatory EEG units from the bulky, limited lifetime devices available today to small devices present only on the head that can record EEG for days, weeks, or months at a time. Such miniaturized units could enable prolonged monitoring of chronic conditions such as epilepsy and greatly improve the end-user acceptance of BCI systems. The online compression of EEG data was required to reduce power consumption.[1]

A video electroencephalogram (EEG) is the gold standard test for the monitoring of long term epilepsy, differentiating types of epilepsy and investigations of non-epileptic seizures. The use of video EEG in current practice is significantly limited by cost and non-availability of resources, causing delays for patients. This development addresses whether the limitations can be overcome by mobile technology augmented by a web based ICT solution. The experiment demonstrated that disadvantages of hospital based video EEG can be addressed by using ambulatory EEG and IP cameras at the subject's home. The data obtained can potentially be of diagnostic significance, given sufficient technological rigor.[3]

II. PROPOSED SYSTEM

The project proposed aims to provide a real time wearable, portable multi-sensor device which is helpful in continuous monitoring of seizures in epileptic patients. Stretch sensor and accelerometer used aid in sensing the respiration and body movements respectively. The sensed signals are fed to the arduino.

Epileptic seizures are episodes that can vary from brief and nearly undetectable to long periods of vigorous shaking. These seizures tend to recur but have no underlying cause. The cause of most cases of epilepsy is unknown, although some people develop epilepsy as the result of brain injury, stroke, brain tumors, infections of the brain. In the event of the seizure, a person's life is controlled by the seizure rather than the person himself.

A system which allows continuous monitoring of epileptic patients is essential for effective diagnosis of the epilepsy so that the patient could be taken care more efficiently. The conventional systems that are used in determining the seizure onset are the EEG and the vibrational sensors. The major con of this system is that they can only be used in the hospital environment and can also miss more than 80% of non-convulsive seizures. Moreover people don't feel comfortable when connected to an EEG and the state of being wired add to the cause.

The arduino processes to detect the seizure in advance with the help of the respiration signal provided. Therefore, the seizure signals are detected in advance and the detected signal is to be transmitted to the care takers using GSM (Global System for Mobile communication) module. The GSM is also used to send the alert messages to the patient caretaker and also to those related to the patient. GPS is used here to provide the location of the patient so that the care takers could have an easy access to them and treat them as early as possible so that the adverse effects could be reduced.

The proposed system uses stretch sensor and accelerometer. It can be fitted comfortably around the patients' chest or abdomen. It thus minimizes patient's discomfort to the maximum extent by worn inside the clothing's of the patient.

It uses Arduino Pro Mini board which is the SMD version of Arduino Atmega328.It is of very small size compared to other microcontroller boards. Hence it is of very

less weight thus not disturbing the patient in his daily tasks. The whole kit is connected to the elastic belt linearly and can be easily worn and removed by the patient without needing anyone's help.

A. System Design

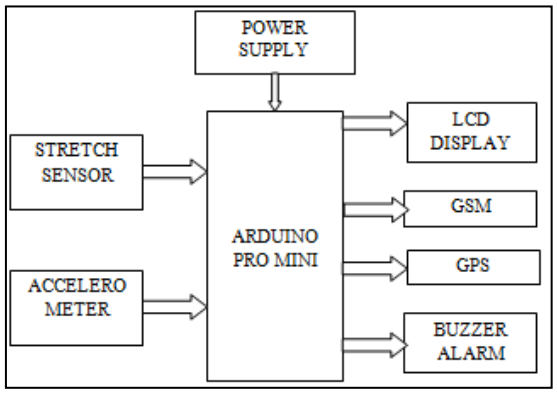

Fig. 1: Block diagram of wearable epilepsy monitor

The system design consists of both hardware and software sections. The hardware used are Stretch sensor, accelerometer, arduino, GSM module and GPS. The software section includes arduino IDE.

B. Working Operation

The Wearable Epilepsy monitor consists of Arduino Pro Mini as the microcontroller board. The stretch sensor for measuring the respiration rate which is a mandatory parameter in detection of seizures during occurrence of epilepsy is connected to the microcontroller. Another parameter for seizure detection is detecting the patient's movements. Hence accelerometer is used to find the three-dimensional axial position in which a person is currently in.

Additionally Global Positioning System (GPS) module is connected to the circuit to find the exact location of the patient. Also a Global System for Mobile communication (GSM) module is also connected in order to send the details of occurrence of epilepsy to the patient's caretakers and physician. The text message is sent immediately after the buzzer rings. It also contains the location data of the patient.

A Liquid Crystal Display (LCD) is also connected to the chest/abdomen belt. It displays the respiration and motion data on the screen. The whole circuit is powered by a battery.

The arduino codes are uploaded into the microcontroller. Initially the stretch and accelerometer readings are taken for the patient in normal condition. Threshold limits are set for seizure detection. The epilepsy monitor is then worn on the patient's chest or abdomen. The patient's condition is then continuously monitored by the belt and it displays readings throughout.

III. Conclusion

A real time wearable, multi-sensor device which is helpful in detecting seizure in out-patients is developed using stretch sensor and accelerometer and the location of the patient is accessed using Global Positioning System (GPS). The data thus collected is transferred to the caregivers using Global System for Mobile communication (GSM) module. By further reducing the battery size the system will be made more compatible.

References

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