International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.04, March 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Enabling epilepsy patients to drive using Fog computing

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ABSTRACT

Fog computing is a latest area of research and has been predicted as the future of the Internet of Things. Fog computing is proposing to provide the cloud computing services like compute, network, storage etc closer to the IoT devices (end devices) where the data is being generated. Fog computing is expected to compliment the cloud computing and mitigate some of the challenges in the field of cloud computing. This paper emphasizes the benefits of fog computing in a particular health area, namely Epilepsy, whose patients` quality of life is affected. Fog computing can enable epilepsy patients to live a free life without any constraint which may be imposed by the epilepsy. Fog computing can not only predict the epilepsy seizures but also help to mitigate its affects on the life of a person.

Keywords: Cloud Computing, Epilepsy, Fog computing, Internet of Things, Seizures

I. INTRODUCTION

Epilepsy is the neurological disorder of the human brain characterized by epileptic seizure or epileptic fit which affects many people in the world [1]. Epileptic seizures are events of vigorous shaking whose duration can vary from few seconds to more than 5 minutes [2]. The outward affects of epileptic seizure can take different forms including uncontrolled shaking of the body, blank stare, momentarily loss of awareness, odd sensations or convolutions etc. Epileptic seizures may also result in physical injury and in rare cases may lead to fracture also [3]. Epilepsy is a common medical condition with 1 in every 12 people experiencing epileptic seizures in their lifetime [3] and the chances of experiencing another seizure ranges between 40-50% [4]. It is more common in children and elderly and 5-10% of the people have experienced seizure by the age of 80 [5].

Seizures may not always indicate epilepsy as seizures can also be caused by low levels of oxygen, brain trauma, high body temperature and drug use. There are a number of other conditions that resemble epileptic seizure but are not. 25% of the people who suffer from seizures actually have epilepsy. The cause of the epilepsy is unknown in 70% of the cases [3] and its association with the genetic factors has also been ruled out. However certain events which can affect the working of the brain may cause epileptic seizures like head injuries, stroke or problems in the development of the brain before birth [6]. The seizure can also be stimulated in photosensitive people by flickering lights at a certain speed and brightness.

People with epilepsy experience varying degree of social stigma in some areas of the world because of their condition [6]. Although they exhibit same range of intelligence as the general population [1] but they experience a range of emotions like depression, frustration, anger etc. Epilepsy can also have sensory, cognitive and psychological effects. Epileptic seizures need to be addressed quickly because a person with epileptic seizure, if left unattended, can prove fatal in extreme cases.

II. EPILEPSY AND DRIVING

Epilepsy can affect the quality of the life and smooth social interactions. People with epilepsy suffer from slowed processing speed, memory loss or attentional difficulties which can further aggravate their quality of social life [7]. Driving forms an important part of our everyday life and the restrictions imposed on epilepsy patients can add significant burden to such people [8]. People with uncontrolled epilepsy are not allowed to drive and may be allowed only after certain seizure free period which varies from country to country. Restricting such people from driving can severely affect their job opportunities and they may not be able to keep their job if it depends on their ability to drive. People with epilepsy have also reported bias during employment, sports and access to education, recreational and other activities.

The cause of the epilepsy is unknown in most of the cases and there is no known cure for the epilepsy as well. The main objective of the epilepsy treatment is to prevent seizures and the treatments may include antiepileptic medication, surgery, vagus nerve stimulation and in children the ketogenic diet [3]. About 70% of the people have their seizures controlled by medication [3]. But even with these treatments, people with epilepsy may not be allowed to drive unless the person has been off seizure medication and seizure free for a certain period of time. This time period varies from country to country and can range from 3 months to 5 years. In United States people with epilepsy are provided commercial driving license only when they have been off seizure medication and seizure free for at least 10 years [9].

III. EPILEPTIC SEIZURE PREDICTION

For the last 4 decades, neuroscientists were of the opinion that the epileptic seizures began abruptly. However there has been mounting evidence that seizures developed minutes to hours before clinical attacks. Prediction of seizure predictions has spread over multiple fields like medical, engineering and patent publications [10]. Seizure prediction can enable to issue warnings of impending seizures to the patients to avert seizure associated injuries, timely administration of appropriate stimulus etc, ultimately enabling them to lead a normal life by minimizing the effects of epilepsy on their lives [11]. Developments in the field of seizure prediction and other related areas like Internet of Things, Fog computing and wearable technology promises to give rise to implantable devices capable of warning

about the impending seizures. These warnings could be used to trigger treatments such as electrical stimulation or infusion of anti epileptic drugs [11].

IV. HOW FOG COMPUTING CAN HELP?

Fog computing is an emergent architecture which extends the cloud services like storage, compute, network etc closer to the end users along the cloud-to-things continuum [12]. Fog computing was proposed to overcome some of the challenges in the field of cloud computing especially latency and bandwidth constraints. It proposes to use the computational power available in the local network instead of using cloud capabilities which can ensure lower latency and bandwidth requirements, energy efficiency and work in a resource constrained environment.

Fog computing combined with seizure prediction could be used as a valuable tool to almost completely remove the affects of the epilepsy on its patients. Use of implantable or wearable devices to predict the impending seizures have already been mentioned in the literature. Seizures are often preceded by certain experiences called as "aura" [13]. Many wearable sensors can be used to detect aura and in turn helping to predict the seizures.

Internet of Things enables us to use sensors to collect information regarding various environmental parameters. Different sensors are available which can be used to monitor the brain wave signals and predict the occurrence of seizures. A wearable device can act as a sink device which will collect the information from the sensors, process it and use the data for prediction of seizures. An electroencephalogram (EEG) is used to monitor the brain activity to detect the abnormal patterns of brain waves [14].

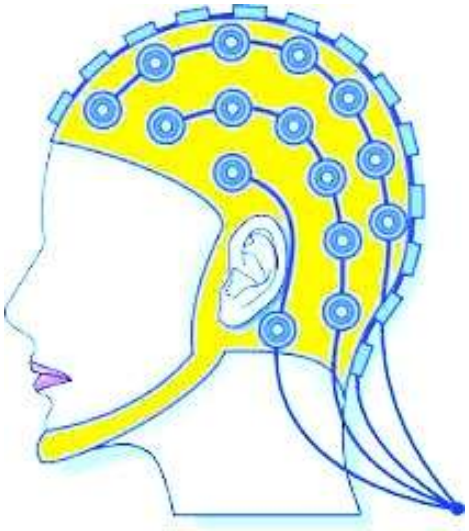

Figure 1: Electroencephalogram (EEG)

Once the data is collected from the sensors it could be sent to the cloud for processing, cloud being the only architectural model available for processing the data. Fog computing proposes to process the same data on a local

machine which will not only reduce the latency to few milli seconds but also reduce the network traffic and ensure privacy of the data. Quick response by fog computing for prediction of seizures allows to automatically trigger therapy or infuse anti-epileptic drugs to minimize its effects and which in turn could help people with epilepsy to drive properly even during epileptic seizures. Delay of few milli-seconds in the initialization of the treatment in case of a seizure means epileptic patients can carry out their daily activities normally. Further experimental work may be carried out to prove the proposed idea and of the results are satisfactory, people with epilepsy may soon be allowed to drive as well and remove the various constraints put on their daily activities.

V. CONCLUSION

Although fog computing is a new research area and not much has been done in this field till now but it continues to grow exponentially and has been predicted as the future of the Internet of Things. It can be useful in various areas and one of its possible applications has been given in this paper which could allow the epilepsy patients to lead a normal life without their medical condition affecting them. Generally epilepsy patients are not allowed to drive and need to have certain seizure free period before they can be allowed to drive. This paper includes the solution for this problem enabling the patients to drive normally. However further experimental work is required to prove the efficiency of the proposed idea.

VI. ACKNOWLEDGEMENT

We would like to express deepest gratitude to Dr. Ifrah Kitab for her continuous support and valuable inputs in improving the quality of the paper.

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