International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-4, November 2019

Epilepsy Seizure Detection and Prediction Based on DeviceHive

K. Nanthini, T. Kavitha, D. Sivabalaselvamani, M. Pyingkodi, Gourav Kumar

Abstract*— Unpredictable nature of epilepsy, patients only has more need of awareness about precautions and how to handle the occurrence. Epilepsy belongs to have a recurrent seizures tendency throughout the life. Seizure may happen due to number of reasons like tumor, head injury, pregnancy time, genetic etc. It can be curable with proper diagnosis, incurable but controllable with lifelong medication and remaining are uncontrollable that leads to death. Recording of alert symptoms like auras, prodromes and precipitant factors are helped to self-alert the patient, create positive impact on quality of life and increase the efficacy of treatments. The need of enhancing early seizure detection and developing wearable monitoring product with low cost is used to create fear free environment among the affected people. In this connection, my proposed work reviewed on existing and currently available IOT based seizure detection and alert systems feasibility.

Keywords: Epileptic Seizure, Seizure detection, Seizure Alert, IOT, IONT

I. INTRODUCTION

Uncontrolled electrical disturbance nature in the brain leads to seizure. It can change in movements, feelings, behavior and in levels of consciousness. Recurrent occurrence of seizure leads to Epilepsy disorder. Epilepsy Seizures have many different causes and triggers, still now doctors are also know the exact reason without the number of diagnosis. Seizure classified as two types based on which part of area of the brain is affected by the episode. Potential causes and trigger of seizure includes genetic disorders, head injury, brain tumor, stroke, surgery, Infection, medications etc., Potential triggers includes sleep deprivation, illness, alcohol or drug usage, stress, low blood sugar, etc. All type of seizures has three phases or states to know the signs of the affected person is commonly known as preictal(before), ictal(during) and interictal(after) the occurrence. The following figure states the types and phases of seizure.

Manuscript published on November 30, 2019.
* Correspondence Author

K. Nanthini*, Assistant Professor, Department of Computer Applications, Kongu Engineering College, Tamilnadu, India (E-mail: nanthiniksg@gmail.com)

T. Kavitha, Assistant Professor, Department of Computer Applications, Kongu Engineering College, Tamilnadu, India.

Dr. D. Sivabalaselvamani , Assistant Professor, Department of Computer Applications, Kongu Engineering College, Tamilnadu, India.

M. Pyingkodi, Assistant Professor, Department of Computer Applications, Kongu Engineering College, Tamilnadu, India.

Gourav Kumar, PG Student, Department of Computer Applications, Kongu Engineering College, Tamilnadu, India.

K. Nanthini*, T. Kavitha, Dr. D. Sivabalaselvamani , M. Pyingkodi, Assistant Professor, Department of Computer Applications, Kongu Engineering College, Tamilnadu, India E-mail: nanthiniksg@gmail.com

Gourav Kumar, PG Student, Department of Computer Applications, Kongu Engineering College, Tamilnadu, India

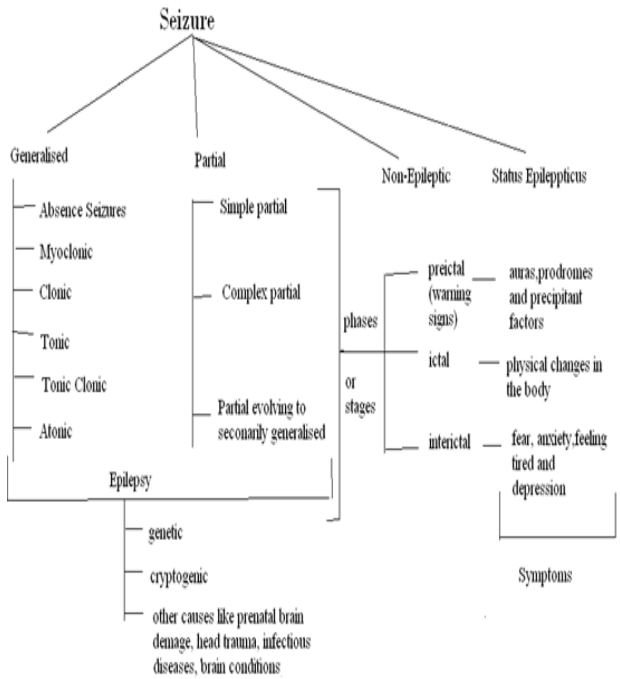

Fig. 1.1 seizure types and phases

A. Purpose of EEG patterns

The main purpose of EEG is to evaluate patients with known seizures to permit an accurate diagnosis of the seizure type and epilepsy disorder. The abnormal brain waves can be recorded by specific technique like flashing light of deep breathing.EEG only focuses on current brain activity during the test. During the time of EEG test, patient aren't having a seizure, there may be chances of recording usual brain waves. The period of a seizure only brain generates abnormal electrical activity. After that period, the brain proceeds to normal in most individuals. When an EEG is done several hours or even days later, it misses the changes in electrical activity that occurred during the actual seizure. Epilepsy waves confirm the diagnosis and may identify the type of seizure disorder.

Sleep deficiency can increase the chance "epilepsy waves" will be recorded, because an EEG while you are asleep may give extra information.

B. Diagnose Procedure

The patient should explain the context about seizure during onset by using questionnaires and answer pattern, then only doctor analyze the seizure belongs to epilepsy or not. The following pieces of information will be needed, including the EEG test, blood test, brain imaging test, and medical history. This detail gives the impression of the electrical activity of the brain, brain shape and possible causes of seizures. Most importantly, the person kept seizure activity diary and record all the changes felt in between the day of diagnosis. This may help the doctor to treat the person in proper direction. Another important thing is to keep in touch with your doctors and health care team and let them know if new problems arise and if your seizures are not responding to treatment.

II. EPILEPTIC SEIZURE FORECAST: STATE-OF-THE-ART

Most of the seizure prediction and detection approaches aims on onset seizure. Intervention before the onset of seizure symptoms could be envisaged with accurate seizure forecasting [1]. The existing system mostly focused on seizure prediction using available dataset and smart seizure detection devices using IoT during ictal state. The diagnosis procedures of seizure are also in need of patient monitoring system for proper and better treatment. The problem of present epilepsy control products involves inappropriate follow-up on the number of seizures, the effectiveness of anti-epileptic drugs, and real-time analysis of changes in the patient body [22]. The advancements in nano-biotechnology have made the real-time analysis of epileptic patients possible, using wearable devices with advanced nano-enabled sensors [30-33]. In this review paper, the main focus is predestined on the existing IoT related work,

appropriate biosensor and nanotechnology inference in the field of seizure prediction and detection. The studies are combined and make a novel prototype model of signal acquisition and alert using Internet of Nano Things and Artificial Intelligence based preictal state data analytics both are leads to develop a smart early seizure detection product for epileptic patients.

III. LATEST REVIEWS IN SEIZURE DETECTION AND PREDICTION

[10] This review provides a guide platform those who are for point-of-care (PoC) applications. The following things are discussed in this paper: Schematics of biomarkers for the

prediction of the epilepsy, Listed 25 categories of available products and sensors in the United State market, Different

types of seizures and related changes in biomarkers, Sensitivity of individual and multimodal systems for the

specific types of seizures aiming to develop a smart bio-sensing system to detect and monitor epilepsy. In the future, the advancements in wearable device, by the use of nanotechnology to detect and diagnose epilepsy for real-time analysis enhance proper management of epilepsy. [14] Most of the machines learning algorithms were implemented to detect the seizure onset and before few minutes back. This review also highlighted the importance and need of research in the field to be improved for early detection of self-alert closed loop system with low cost management service. [16] This study, decomposition of EEG signal into wavelet coefficients is carried out at initial stage and important features are extracted. Later on, classifiers i.e. SVM, ANN, RNN etc. have been used for the classification of extracted features. In future, the early seizure detection techniques can be used to provide an alert to the epileptic patient so that an effective diagnosis can be done before the occurrence of seizure onset. [1] A review of signal processing techniques and classification methods assessed in seizure prediction studies New databases, higher sampling frequencies, adequate preprocessing, electrode selection, and machine-learning considerations may increase seizure forecasting capabilities. [27] This paper presents a review of recent efforts and journal articles on seizure prediction. And also emphasized some new prototype based ideas using machine learning and deep neural network. [25] Evaluated performance of devices and algorithms to detect generalized tonic-clonic seizures in a clinical setting. This paper concluded the essential of research for all types of epilepsy seizures. Because the existing invention stated low detection rate and increase the false alarms. [26] Tabulated number of devices and applications were existed in real world. The performance of evaluated methods with result and closed loop system architecture were highlighted.

In the past five years of reviews are focused the future research in the area of epilepsy seizure detection and prediction is early detection of closed loop warning systems for any type of seizure i.e. generalized and partial seizures.

IV. LITERATURE REVIEW ON IOT BASED SEIZURE DETECTION WORK IN THE LAST DECADE

[3] Monitor vital signs like brain electrical activity, heart rate, blood pressure, the physical activity and posture of the patient. Wearable Jacket provides flexibility for the patients and sends notification to caretaker and robot. The performance of the system was not tested with epileptic patients. [11] Alerting a doctor or caregiver's mobile phone, a few minutes in advance using wireless communication with help of GSM modem. [13] The field study demonstrates the applicability and usability of the wearable accelerometer device for detecting bilateral tonic-clonic seizures. [6] Seizure monitoring and notification proof-of-concept wearable prototype that can detect specific seizure activity, namely generalized tonic-clonic seizures and designing a robust and computationally low intensive real-time seizure detection algorithm, and utilization of a scalable cloud-based data management system to record, analyze, and visualize the received seizure data. [7] The service APP connected to the cloud so that the patients' health condition can be recorded and then referenced by doctors for further diagnosis or research process. The only channel FP2-F8 for seizure detection to avoid using conductive adhesive. Therefore, only generalized onset seizure can be detected. [8]

Retrieval Number: D5320118419/2019©BEIESP
DOI:10.35940/ijrte.D5320.118419
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

This work compared the performance of wrist-worn PPG device and wearable ECG. The result was stated that the performance was good by using wearable EEG. [9] This research achieved an in-depth analysis of the main factors and provides the solutions for tonic-clonic epileptic detection and monitoring. [5] Instead of accelerometer, the use of other combination of sensors like heart rate, oxygen Instead of accelerometer, the use of other combination of sensors like heart rate, oxygen saturation, or muscle twitches/signals were provided good accuracy of result. [12] Evaluated the experimental consistency of a wrist-worn, wireless accelerometer sensor for detecting generalized tonic-clonic seizures. [4] Tonic clonic seizures to be alerted to caregivers of people. Smart watch is not applicable for partial seizures detection.

All the previous work related to seizure detection and prediction based IOT is mainly concentrated generalized type of tonic clonic seizures during onset and few minutes in advance [11]. The closed loop system functionalities are based on device-cloud-mobile configuration setup. Mainly accelerometer, EEG, ECG and oxygen saturation sensors are utilized for the product development.

All the sensors are monitored and give the intimation to the caregivers on onset. The future works will be focused, monitoring and reporting system for all types of seizures. Especially low cost early reporting and monitoring system will be developed to create fear free environment for the seizure affected people. In India there is no product for seizure alert is not recommended by the doctor.

Till now the patient and caregivers only take care of all manually. The main reasons are lack of awareness and cost of the product is not affordable for the developing country people.

V. LITERATURE REVIEW ON EARLY SEIZURE DETECTION IDEAS IN THE LAST DECADE & RESULTS

[28] Achieved the goals of maintaining and economically Improving – high – quality care with minimizing costs in

respective of patients, caregivers and medical team. [29] Machine learning methods using intracranial electroencephalographic (iEEG) measures have shown promise. A machine-learning-based pipeline was developed to process iEEG recordings and generates seizure warnings. Results support the ability to forecast seizures at rates greater than a Poisson Random Predictor for all feature sets and machine learning algorithms were tested. Subject-specific neurophysiologic changes in multiple features are reported preceding lead seizures, providing evidence supporting the existence of a distinct and identifiable preictal state. [21] This paper summarized the seizure forecasting ideas in reality. [2] Non-pharmalogical strategies like preictal state detection for self-control of epileptic seizures. [25] Many unmet needs are discussed as similar as addressing the burden of epilepsy. [30] This work presented an intelligent method for preprocessing in neurological disorders. The work was related to obtain more accurate results by removing artifacts of vital signals. This method is applicable for early diagnosis of neurological and cardiovascular disorders. [19] This paper covered about biomarkers for understanding the domain knowledge of epilepsy.

The improvement of this area to be directed towards effective signal acquisition techniques, identifying smart methods to eliminate relics of vital signals, monitoring preictal phase of data analytics to assess the symptoms, Internet of nano things based closed loop system which is applicable to make a product to be comfortable, wearable, cost reasonable and early detectable.

VI. PROPOSED PROTOTYPE

Wukong, Opensource DeviceHive etc., Framework provides a rock-hard foundation and building blocks to create any

IoT/M2M solution, bridging the gap between embedded device - cloud - big data and client applications. Our proposed work intends to integrate the multimodal device based on EEG,ECG, blood pressure and oxygen saturation measure nano sensors with the Internet of Things framework "DeviceHive" to control external applications, such as turning lights on/off, vibration and alarm alert etc.,

EEG sensor which capture eSense signals, defined as attention and meditation signals. Different patterns are built based on the attention or meditation signal values. The main part of work will depend on EEG for emotional detection and classification before the seizure. Along with the result the remaining sensors values are taken into consideration for alerting mechanism. The data processing with the Artificial Intelligence techniques for signal acquisition, Feature Extraction and Pattern Recognition will improve the result.

Implementation Steps for Proposed Prototype Modal:

1. Multimodal Nano enabled biosensor Device (IONT) (EEG|ECG|BP|Oxygen Saturation)
2. Integrated with Device Hive Framework for AI Data Processing
   - ✓ Cloud Configuration (Signal Data Storage)
   - ✓ Signal Acquisition
   - ✓ Feature Extraction
   - ✓ Emotional Pattern detection and Learning
3. Based on Emotional learning – Preictal Pattern Recognition in real time (Before Seizure)
4. Warning Sign Emotional Classification
5. Alerting Mechanism (Self and caretaker Alert)

VII. CONCLUSION

As a result of this review gives a future focus towards intervention of IONT-EPI CARE MONITORING (ECM) system for self-protection and effective treatment management with affordable cost service. This paper reviewed the possibilities, the improvement, existing problems and applications in the field of epileptic seizure detection.

REFERENCES

1. Elie Bou Assi, Dang K.Nguyen, Sandy Rihana, Mohamad Sawan, Towards accurate prediction of epileptic seizures: A review, Biomedical Signal Processing and Control 34 (2017)144-157.
2. Iliana Kotwas, Aileen McGonigal, Agnes Trebuchon, Mireille Bastien-Toniazzo,Yokonagai, Fabrice Bartolomei, Jean-Arthur Micoulaud-Franchi, Self-control of epileptic seizures by nonpharmacological strategies, Epilepsy & Behavior 55 (2016) 157-164.

3. Ali Hayek, Samer Telawi, Josef Borcsok, Roy Abi Zeid Daou, Nashaat Halabi, Smart wearable system for safety-related medical IoT application:case of epileptic patient working in industrial environment, Health and Technology (2019).
4. Juliana Lockman, Robert S. Fisher, Donald M. Olson, Detection of seizure-like movements using a wrist accelerometer, Epilepsy & Behavior 20 (2011) 638–641.
5. Anup D. Patel, RobertMoss, Steven W. Rust, Jeremy Patterson , Robert Strouse , Satyanarayana Gedela, Jesse Haines, Simon M. Lin, Patient-centered design criteria for wearable seizure detection devices, Epilepsy & Behavior 64 (2016) 116–121.
6. Aaron Marquez, Michael Dunn, Jaime Ciriaco, and Farid Farahmand, iSeiz: A Low-Cost Real-Time Seizure Detection System Utilizing Cloud Computing, IEEE (2017).
7. Shih-Kai Lin, Istiqomah, Li-Chun Wang, (Fellow, Ieee), Chin-Yew Lin, And Herming Chiueh, (Member, IEEE), An Ultra-Low Power Smart Headband for Real-Time Epileptic Seizure Detection Wearable Sensors and Health Monitoring Systems (2017) Digital Object Identifier 10.1109/JTEHM.2018.2861882.
8. Kaat Vandecasteele , Thomas De Cooman, Ying Gu, Evy Cleeren , Kasper Claes ,Wim Van Paesschen, Sabine Van Huffel and Borbála Hunyadi, Automated Epileptic Seizure Detection Based on Wearable ECG and PPG in a Hospital Environment,SENSORS(2017)
9. Paula M. Vergara, Enrique de la Cal, José R. Villar,Víctor M. González, and Javier Sedano, An IoT Platform for Epilepsy Monitoring and Supervising, Journal of Sensors(2017).
10. Shivani Tiwari, Varsha Sharma, Mubarak Mujawar, Yogendra Kumar Mishra, Ajeet Kaushik and Anujit Ghosal, Biosensors for Epilepsy Management: State-of-Art and Future Aspects, sensors(2019).
11. Mehta, D.; Deshmukh, T.; Sundaresan, Y.B.; Kumaresan, P. Continuous Monitoring and Detection of Epileptic Seizures Using Wearable Device. In Smart Innovations in Communication and Computational Sciences; Springer: Singapore, 2019.
12. Beniczky, S.; Polster, T.; Kjaer, T.W.; Hjalgrim, H. Detection of generalized tonic–clonic seizures by a wireless wrist accelerometer: A prospective, multicenter study. Epilepsia 2013, 54, e58–e61.
13. Meritam, P.; Ryvlin, P.; Beniczky, S. User-based evaluation of applicability and usability of a wearable accelerometer device for detecting bilateral tonic–clonic seizures: A field study. Epilepsia 2018, 59, 48–52.
14. Zhao, X.; Lhatoo, S.D. Seizure detection: Do current devices work? And when can they be useful? Curr. Neurol. Neurosci. Rep. 2018, 18, 40.
15. Binder, D.K.; Haut, S.R. Toward new paradigms of seizure detection. Epilepsy Behav. 2013, 26, 247–252.
16. Kaur, M.; Prakash, N.R.; Kalra, P. Early Seizure Detection Techniques: A Review. Indian J. Sci. Technol. 2018,11, 1–8.
17. Elger, C.E.; Hoppe, C. Diagnostic challenges in epilepsy: Seizure under-reporting and seizure detection.Lancet Neurol. 2018, 17, 279–288.
18. Dorsey, E.R.; Glidden, A.M.; Holloway, M.R.; Birbeck, G.L.; Schwamm, L.H. Teleneurology and mobile technologies: The future of neurological care. Nat. Rev. Neurol. 2018, 14, 285.
19. Engel, J., Jr.; Pitkänen, A.; Loeb, J.A.; Dudek, F.E.; Bertram, E.H., III; Cole, A.J.; Moshé, S.L.; Wiebe, S.;Jensen, F.E.; Mody, I. Epilepsy biomarkers. Epilepsia 2013, 54, 61–69.
20. Fisher, R.S.; Cross, J.H.; D'souza, C.; French, J.A.; Haut, S.R.; Higurashi, N.; Hirsch, E.; Jansen, F.E.; Lagae, L.;Moshé, S.L. Instruction manual for the ILAE 2017 operational classification of seizure types. Epilepsia 2017,58, 531–542.
21. Dumanis, S.B.; French, J.A.; Bernard, C.; Worrell, G.A.; Fureman, B.E. Seizure forecasting from idea to reality. Outcomes of the seizure gauge epilepsy innovation institute workshop. eNeuro 2017, 4.
22. Fisher, R.S. Bad information in epilepsy care. Epilepsy Behav. 2017, 67, 133–134.
23. Beghi, E. Addressing the burden of epilepsy: Many unmet needs. Pharmacol. Res. 2016, 107, 79–84.
24. . Van Andel J, Thijs RD, de Weerd A, Arends J, Leijten F, Non-EEG based ambulatory seizure detection designed for home use: What is available and how will it influence epilepsy care?Epilepsy Behav. 2016, Apr;57(Pt A):82-89
25. Ramgopal S, Thome-Souza S, Jackson M, Kadish NE, Sánchez Fernández I, Klehm J, Bosl W, Reinsberger C, Schachter S, Loddenkemper T. Seizure detection, seizure prediction, and closed-loop warning systems in epilepsy, Epilepsy Behav. (2014) Aug; 37:291-307
26. . Acharya UR, Hagiwara Y, Adeli H, Automated seizure prediction, Epilepsy Behav. 2018 Nov;88:251-261
27. Leviton A, Oppenheimer J, Chiujdea M, Antonetty A, Ojo Ow, Garcia S, Weas S, Fleegler E, Chan E, Loddenkemper The Characteristics Of Future Models Of Integrated Outpatient Care Healthcare (Basel). 2019 Apr 27;7(2)
28. *varatharajah y, iyer rk, berry bm, worrell ga, brinkmann bh, seizure forecasting and the preictal state in canine epilepsy,int j neural syst. 2017 feb;27(1)*
29. *javadpour a, mohammadi a, implementing a smart method to eliminate artifacts of vital signals,j biomed phys eng. 2015 dec 1;5(4):199-206*
30. Manickam, P.; Kaushik, A.; Karunakaran, C.; Bhansali, S. Recent advances in cytochrome c biosensing technologies. Biosens. Bioelectron. 2017, 87, 654–668.
31. . Kaushik, A.; Vabbina, P.K.; Atluri, V.; Shah, P.; Vashist, A.; Jayant, R.D.; Yandart, A.; Nair, M. Electrochemical monitoring-on-chip (E-MoC) of HIV-infection in presence of cocaine and therapeutics. Biosens. Bioelectron.2016, 86, 426–431.
32. Gray, M.; Meehan, J.; Ward, C.; Langdon, S.P.; Kunkler, I.H.; Murray, A.; Argyle, D. Implantable biosensors and their contribution to the future of precision medicine. Vet. J. 2018, 239, 21–29.
33. Jamieson, B.; Bigelow, M.E.G. In Vivo Biosensor. US Patent No. 9,883,826, 6 February 2018.
34. www.epilepsy.com
35. . www.mayoclinic.org

AUTHORS PROFILE

Mrs. K.Nanthini, Assistant Professor Department of Computer Applications, Kongu Engineering College Perundurai.

Mrs.T.Kavitha, Assistant Professor, Department of Computer Applications, Kongu Engineering College Perundurai.

Dr. D.Sivabalaselvamani, Assistant Professor , Department of Computer Applications, Kongu Engineering College Perundurai.

Mrs.M.Pyingkodi, Assistant Professor Department of Computer Applications, Kongu Engineering College Perundurai.