Smart Management of Epilepsy Disease: Review Article

By

Mahy E. Elemam
Computer Science Department
Faculty of Specific Education
Mansoura University

A.F.Elgamal
Computer Science Department
Faculty of Specific Education
Mansoura University

I. Elmenshawi
Neurology Department,
Faculty of medicine,
University of Mansoura

Hanan E. Abdelkader
Computer Science Department
Faculty of Specific Education
Mansoura University

Research Journal Specific Education
Faculty of Specific Education
Mansoura University

ISSUE NO. 75 MAI , 2023

Smart Management of Epilepsy Disease: Review Article

*Mahy E. Elemam** *A.F.Elgamal**

*I. Elmenshawi*** *Hanan E. Abdelkader**

Abstract:

Epilepsy is caused by genetic causes as well as brain infection, stroke, and high temperature. Also educational institutions include some of the students who are likely to have epilepsy, and for fear of exposing them to epileptic seizures in front of their colleagues, we identify and detect the symptoms to anticipate the seizure before it occurs.

Because of the high incidence and harm caused by seizure control failure, it is important to understand the characteristics of epilepsy in order to give an appropriate response for each patient. As a result, epilepsy prediction and early diagnosis are required to give timely preventative measures that allow patients to be free of the detrimental repercussions of epileptic seizures.

Manual analysis of Electroencephalogram (EEG) brain signals for epilepsy detection is a time-consuming and difficult procedure that places a tremendous strain on neurologists. As a result, several automatic approaches based on Artificial Intelligence have been developed to aid neurologists in epilepsy detection. The use of artificial intelligence in the diagnosis of epilepsy and predicts epileptic seizures provides an asset to the medical college students and the less experienced doctors in interpreting the EEG and reduces the diagnostics time.

The current study aims to summarize the most recent updates on epilepsy definitions, kinds, diagnosis, seizure and artificial intelligence role in its detection.

Keywords : Epilepsy, Smart, Seizures, Disease, Electroencephalograms, AI

* Computer Science Department Faculty of Specific Education Mansoura University
** Neurology Department، Faculty of medicine، University of Mansoura

Introduction

Epilepsy has been identified as a serious public health problem by the World Health Organization (WHO) and its partners [1], making it one of the most common noncommunicable diseases, and it is a branch of medicine that deals with the nervous system condition, which is a major cause of disability and death [2]. Epilepsy may affect around 50 million individuals globally, making it one of the most common neurological illnesses [3]. Worldwide, the annual incidence and prevalence of epilepsy may be 50 per 100,000 and 700 per 100,000, respectively [4]. About 80% of the patients live in lowland Middle-income countries [5].

In some ways, our understanding of epilepsy has improved during the last few years. It is a common chronic neurological condition characterized by repeated unprovoked seizures and in which the balance between brain excitability and inhibition is skewed towards uncontrolled excitability [6]. Epilepsy is characterized by neuronal hyperactivity and brain circuits that create excessive and synchronized electrical discharges, which can result in seizures [7].

Epileptic seizures can occur at any time and induce a loss of consciousness, which can result in injuries or even death [8]. A seizure is caused by an imbalance in the brain's excitement and inhibition, which is connected to neuronal firing and excessive action potential discharge. A seizure can begin in one or both hemispheres of the brain (focal seizures) or in a portion of the brain that spans both hemispheres (generalized seizures) [9].

The diagnosis of epilepsy is mostly based on electroencephalograms (EEG) to record pattern of brain waves, computed tomography (CT), magnetic resonance imaging (MRI) and positron emission tomography (PET) and symptomatology [10].

Over the last two decades, machine learning (ML), a sub-branch and cornerstone of artificial intelligence (AI), has made great strides. It is presently commonly employed in the diagnosis of diseases. Machine learning algorithms are being used to anticipate or diagnose a variety of serious illnesses such as epilepsy, cancer, diabetes, heart disease, thyroid disease, and so on [11].

Machine learning has recently revolutionized the identification of epileptic seizures by tackling the tremendous complexity of EEG data. Its technologies facilitate the identification and evaluation of seizure features [12].

Until recent years, Machine learning has been widely employed in epilepsy detection and seizure prediction, but in recent years, research has mostly focused on deep learning algorithms that demonstrate excellent performance in sectors such as computer vision and speech recognition [13].

The purpose of this overview is to provide a review of the updates on epilepsy, addressing the definitions, types, etiological classifications and artificial intelligence role in its detection published in previously selected electronic databases and books on epilepsy. The databases Scientific Electronic Library Online (SCIELO), and Medical Literature Analysis and Retrieval System Online (MEDLINE) were consulted as data source.

History of epilepsy

The term epilepsy is derived from the Latin and Greek words "epilepsia," which meaning "seizure" or "to seize upon." It is a significant neurological condition with distinct features, such as recurring seizures [14]. The background of epilepsy was recorded almost 3000 years ago in a Babylonian medical literature [15].

Epilepsy is a central nervous system (CNS) disorder that produces abnormal brain activity, resulting in seizures, strange behavior, and, in rare cases, loss of consciousness [16]. Epilepsy may afflict people of all ages, genders, and races. The phrases "seizures" and "epilepsy" are not synonymous [17].

SEIZURES

Seizures are isolated occurrences, but epilepsy is a neurological disorder characterized by two or more seizures. Seizures can cause a variety of symptoms. Seizures are not usually connected with uncontrollable body movements [14].

Some people with epilepsy stare at a fixed point for a few seconds during a seizure, while others move their arms or legs unnaturally. Seizures are characterized based on how they start and which part of the brain they impact [16].

There are two main types of seizures, generalized and partial, depending on whether the seizures affect some part or the entire brain region. In generalized seizures, all brain sections are affected; for partial seizures, only an area of the brain is affected [8]. Figure 1 shows a block diagram of different types of seizures [8, 18].

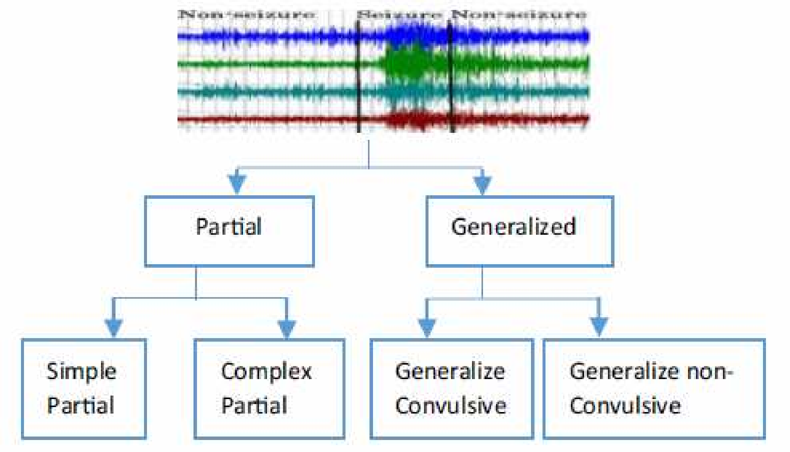

Figure (1) Block diagram of different types of seizures

Symptoms of seizure

The first and most critical stage in diagnosing epilepsy is to take a thorough history from patients and witnesses. The clinical examination of the incident will determine the need for further diagnostic testing such as EEG and MRI [19].Which diagnosis of epilepsy begins with a thorough history, which identifies traits that help separate epileptic seizures from non-epileptic seizures? [1]

Diagnosis of paroxysmal occurrences might be difficult. There is no one clinical sign that identifies whether a seizure is epileptic or not. Given the number of differential diagnoses, understanding the important elements of each paroxysmal occurrence may aid in identifying patterns of symptoms that lead to a clinical diagnosis [20].

Diagnostic studies, such as EEG, MRI, blood tests, or cognitive assessments, will help to confirm the diagnosis of seizures, but they may be normal in epileptic individuals [6].

The table below displays a collection of symptoms that differentiate between actual epileptic seizures and pseudo-seizures [1-6, 19, 20].

Table (1): Differences between Pseudo seizures and Epileptic Seizures

Clinical Features	Pseudo seizures	Epileptic Seizures
Duration	Prolonged	Briefer (usually <5 min)
Clinical features during episode	Fluctuating	Stereotypic
Time of day	Usually during wakefulness in the presence of an audience	May occur in sleep whether or not
Consciousness	Preserved even with generalized motor activity	Usually altered (exception is supplementary motor area seizures)
Onset	Gradual, with slow escalation in intensity	Abrupt
Head movements	More frequently side-to-side	Usually unilaterally turned, with staring expression
Extremity	Out-of-phase movements, unusual posturing	In-phase movements, rhythmic muscle contractions
Vocalizations	Emotional (crying) in the middle or end of episode	Cry at the onset of episode
Eyes	Closed during the episode	May be open during the episode
Pelvic thrusting	Forward direction	Retrograde direction
Incontinence	Rare	May be present
Related injury	Inconsistent with fall	Consistent with fall
Tongue bite	Occasional (usually at the tip)	Common (at the side)
Postictal change	None or brief, even after prolonged generalized convulsive event	Prolonged, with confusion and exhaustion (although maybe absent after frontal lobe seizures)

5. Diagnosis

A variety of methods have been developed to determine the kind of epilepsy in an individual. As indicated as follows:

5.1. EEG monitoring

Electroencephalography (EEG) is a monitoring technique used in biomedical and computer science to study brain activity [21]. The neurophysiological assessment of electrical activity in the brain as measured by electrodes implanted on the scalp or, in certain circumstances, subs dually or in the cerebral cortex is also included [22]. EEG is becoming more significant in the detection and treatment of neurodegenerative disorders and abnormalities of the mind and brain [23].

5.2. Brain scan

It is a critical diagnostic technique for detecting brain tumours, cysts, and other structural abnormalities in the brain. CT (computed tomography), PET (positron emission tomography), and MRI (magnetic resonance imaging) are the most widely utilised brain scans, followed by SPECT (single photon emission computed tomography) and MRS (magnetic resonance spectroscopy) [24].

CT and MRI scans reveal the brain's structure. PET and MRI can be used to monitor and diagnose anomalies in the brain's activity. The SPECT scan is also used to find seizure foci in the brain [25]. The magnetic impulses generated by neurons are detected using MEG (magneto encephalogram). MRS can reveal anomalies in the metabolic processes of the brain [26].

5.3. Medical history

Medical history, including symptoms and duration of seizures, aids in diagnosing epilepsy and the kind of seizures present in the individual.

5.4. Blood tests

Seizures can be caused by an acute underlying toxic or metabolic disease, in which case appropriate medication should be addressed at the specific anomaly, such as hypocalcaemia [27]. Blood samples are frequently examined for metabolic or genetic abnormalities that may be linked to seizures [28]. Blood samples are also detected signs of infections, genetic conditions or other conditions that may be associated with seizures or triggering the seizure [29].

6. Automatic seizure detection

At the present time, Artificial Intelligence (AI) technology has achieved breakthrough development and has been applied to many fields, especially in biomedicine, which can assist doctors in diagnosing diseases [30]. The most often applied classifiers in automated epilepsy detection systems are machine learning methods. Handcrafted feature extraction methods are used to extract features to statistically analyses, rank, and choose data that is then fed into machine learning algorithm classifiers [8].

Several researchers have created algorithms to detect epileptic EEG data. Existing approaches for identifying seizures include nonlinear signal analysis, the time domain, the time-frequency domain, and the frequency domain, as well as hand-designed algorithms for feature extraction within EEG data [31].

EEG signals are commonly used because they are inexpensive, portable, and exhibit distinct frequency domain rhythms [32].

They must be recorded for an extended period of time in order to detect epileptic seizures, which complicate the analysis. This will make it difficult for doctors to detect epileptic episodes using noisy EEG readings. To address these issues, much research is being conducted to identify and forecast epileptic seizures using EEG modalities and other methods such as MRI combined with AI algorithms [33]. In the field of epileptic seizure detection, AI systems have used traditional machine learning and deep learning methods [34].

The EEG classification can be implemented based on classification methods of machine leaning [35]. Most often used classifiers are K nearest neighbors (KNN) [36], Neural Networks (NN) [37], Support Vector Machine (SVM) [38], [39], [40], and decision trees [41]. The classification accuracy for all of these classifiers is determined mostly by the initial data (numerical samples) formed at the step of the preliminary transformation [42].

Therefore, the output of the signal preprocessing is very important for signal classification [43]. This can be illustrated by the studies of EEG signal classification based on SVM. In this case, it has been shown that different procedures of feature extraction [39], dimensionality reduction [38], and specific procedures of signal preprocessing based on fuzzy approximate entropy [36] influence classification accuracy.

The use of machine learning in the categorization of epilepsy diagnosis is attracting an increasing number of scholars, so several classification techniques have been proposed in the literature. The following table showed a list of some studies using machine learning algorithms with different feature extraction techniques [44],[8].

Table (2): list of some studies using machine learning algorithms with different feature extraction techniques

Author	Year	Features	Classifier	Accuracy
Naser et.al[45]	2019	DWT and approximation and abe entropies	SVM	98.08%
Lamhiri et.al[46]	2019	Hurst exponent	K-NN	100%
Raghu et.al[47]	2019	Sigmoid entropy	SVM	100%
Wang et.al[48]	2019	Symlet wavelet processing, and grid search optimizer	Gradient Boosting Machine	96.10%
Bose et.al[49]	2019	Multifractal detrended fluctuation analysis	SVM	100%
Dalal et al. [50]	2019	FAWT and FD	RELS-TSVM	90.20%
Osman et.al[51]	2019	SOM	RBFNN	97.47%
Fasil O.K. et.al[52]	2019	Time domain	Exponential Energy	99.50%
Saminu et al. [53]	2019	DWT, Entropies, Energy	SVM, FFANN	99.00%
Mahjoub et.al[54]	2020	TQWT, IMFs, MEMD	SVM	98.78%
Raluca et.al[55]	2020	DWT	ANN	91.10%
Ozlem et.al[56]	2020	Ensemble EMD	KNN	97.00%
Khaled et.al[57]	2020	NA	Random Forest	97.08%
Rabcan, J et.al[58]	2021	FDT, Fuzzy random forest (FRF	fuzzy classifier	99.3%
Rabby, M.K.M et.al[59]	2021	Wavelet transform Singular value decomposition entropy	ANN	99%
Omidvar, M et.al[60]	2021	DWT 5 level and statistical calculations.	SVM & ANN	98.7%

Continue Table (2): list of some studies using machine learning algorithms with different feature extraction techniques

Author	Year	Features	Classifier	Accuracy
Gulshan Kumar et.al[61]	2022	variational mode decomposition (VMD) and Hilbert transform (HT)	neural network (NN)	99%
Xiaoyan Wei et.al[62]	2022	multidimensional input	Multidimensional CNN	94%
Deepa B et.al[63]	2022	Min Max Scaler normalization	Bidirectional Long Short Term Memory (BiLSTM)	99.55%
Chunjiao Dong et.al[64]	2022	Time, frequency	two-layer ensemble model	93.9%
Athar A. Ein Shoka et.al[65]	2023	Arnold Transform algorithms &Transfer Learning (TL)	CNN	86.11 %
Zhengdao Li et.al[66]	2023	graph-generative neural network (GGN)	convolutional neural network (CNN)& graph neural networks (GNN)	82%
Muayed S AL-HUSEINY ,et.al[67]	2023	random forest	decision tree & AdaBoost algorithm	96.93%
Puja Dhar, ,et.al[68]	2023	PSO and WOA optimizations.	DenseNet201 and LSTM	89.02%

Conclusion

Epileptic seizures are classified as a category of neurological illnesses, and early detection is critical for expert physicians and neurologists. Several techniques for detecting epileptic seizures have been proposed up to this point. When compared to other neuroimaging modalities, EEG is the most important to specialist physicians.

EEG signals, while extremely valuable, are not without drawbacks and can generate complications for expert physicians. Long-term recording, several EEG channels, diverse disturbances in EEG signals, and so on are some of the challenges that physicians face when properly and swiftly identifying epileptic seizures.

Various AI methods for detecting epileptic seizures have been proposed thus far, with the goal of assisting specialist physicians in the rapid diagnosis of epileptic seizures based on EEG signals. Previously, researchers primarily used ML methods to diagnose epileptic seizures. The most significant shortcomings of these approaches include inefficiency in huge volumes of input data, method complexity, and the requirement for extensive understanding to apply ML methods in detecting epileptic seizures, and so on.

To solve this issue, in recent years, DL techniques with adequate efficiency and performance for detecting various disorders, including epileptic seizures, using a vast quantity of input data have been presented.

References

[1] Haleema Anwar,et.al,(2020)," Epileptic seizures ",discoveries journals, Vol.8 , NO .2.

[2] Asif Bilal,et .al ,(2021) ," Epilepsy: A Systematic Review ", JOJ Pub Health ,Vol.6.

[3] Edward Molina,et.al,(2020)," Intelligent Telehealth System To Support Epilepsy Diagnosis ", Journal of Multidisciplinary Healthcare ,Vol.13 ,pp. 433–445.

[4] Eugen Trinka,et.al,(2019)," Epilepsy in Asia: Disease burden, management barriers, and challenges ", Epilepsia , Vol 60(S1) ,PP.7–21.

[5] KUO-KAI SHYU,et.al,(2023)," A Low Complexity Estimation Method of Entropy for Real-Time Seizure Detection",IEEE Access,Vol.11

[6] Hirak Kumar Mukhopadhyay,et.al,(2012)," Epilepsy and its Management: A Review", Journal of PharmaSciTech ,Vol. 1,No.1,pp.20-26.

[7] Lílian Lúcia de Oliveira Costa,et.al,(2020)," Update on epilepsy: literature review", Rev Med (São Paulo), Vol.99,No.2,pp.170-81.

[8] Sani Saminu,et.al,(2022)," Applications of Artificial Intelligence in Automatic Detection of Epileptic Seizures Using EEG Signals: A Review",Artificial Intelligence and Application , Vol. 1,pp. 11–25

[9] Pravin Shende,et.al,(2021)," Nanotheranostics in epilepsy: A perspective for multimodal diagnosis and strategic management", Nano Select ,Vol.2,pp.1277–1290.

[10] Wanlin Lai,et.al,(2022)," Metabolomics Provides Novel Insights into Epilepsy Diagnosis and Treatment: A Review", Neurochemical Research ,Vol. 47,pp.844–859.

[11] Shamriz NAHZAT,et.al,(2021),"Classification of Epileptic Seizure Dataset Using Different Machine Learning Algorithms and PCA Feature Reduction Technique", Journal of Investigations on Engineering & Technology Volume 4, Issue 2, 47-6

[12] Afef Saidi,et.al,(2021)," A novel epileptic seizure detection system using scalp EEG signals based on hybrid CNN-SVM classifier" ,Research Gate, 10.1109

[13] Sanguk Ryu,et.al(2021)," A Hybrid DenseNet-LSTM Model for Epileptic Seizure Prediction ", Appl. Sci.,Vol. 11, 7661

[14] Mohammad Khubeb Siddiqui,et.al,(2020)," A review of epileptic seizure detection using machine learning classifiers" , Brain Informatics,Vol.7,No.5.

[15] Anis Malekzadeh,et.al,(2021)," Epileptic Seizures Detection in EEG Signals Using Fusion Handcrafted and Deep Learning Features",Sensors , Vol, 21, 7710

[16] W. K. Abdelbasset,et.al,(2022)," Treatment of pilocarpine-induced epileptic seizures in adult male mice ",Brazilian Journal of Biology, vol. 84

[17] PACK, et.al,(2019)," Epilepsy overview and revised classification of seizures and epilepsies. CONTINUUM", Lifelong Learning in Neurology, vol. 25, no. 2.

[18] Fisher, R. S. (2017). "The new classification of seizures by the international league against epilepsy". Current Neurology and Neuroscience Reports, Vol.17,No. 48.

[19] Hema Patel,et.al,(2017)," Psychogenic Nonepileptic Seizures (Pseudo seizures) ", neurology Vol.32 No.6.

[20] Annette Leibetseder,et.al,(2020)," How to distinguish seizures from non-epileptic manifestations",Epileptic Disord ,Vol. 22 No.6,pp. 716-38

[21] Venkata Phanikrishna,et.al,(2021)," A Brief Review on EEG Signal Pre-processing Techniques for Real-Time Brain-Computer Interface Applications" , techrxiv, DOI: 10.36227

[22] Hend Nooreldeen,et.al,(2021)," EEG Signal Analysis Based Brain-Computer Interface ",Menoufia J.of electric engineering research,Vol.30,No.2

[23] Kislay RAJ,et.al,(2023)," Understanding EEG signals for subject-wise Definition of Armoni Activities ", arXiv preprint arXiv:2301.00948 ,Vol.3

[24] Karin Trimmel,et.al,(2018)," Left temporal lobe language network connectivity in temporal lobe epilepsy", BRAIN ,Vol. 141,pp. 2406–2418

[25] Enas A. Mohamed Abdel-Gawad,et.al,(2020)" Role of Volumetric Magnetic Resonance Imaging in Evaluation of Nonlesional Childhood Epilepsy ", MJMR, Vol. 31, No. 3, pp. 142-146.

[26] Emad AbdulAzem Tiba,et.al,(2019)," Advanced MR Imaging Techniques in The Diagnosis of Epilepsy ", Benha Medical Journal, Vol. 36, Issue 3.

[27] Banote RK, et.al,(2021)," Quantitative proteomic analysis to identify differentially expressed proteins in patients with epilepsy", Epilepsy Res,174:106674.

[28] Fiona Sutton,et.al,(2020)," Testing blood and CSFin people with epilepsy:a practical guide ", Epileptic Disord ,Vol. 22 ,No. 4,pp. 381-98

[29] Rakesh Kumar Banote,et.al,(2022) ," Blood biomarkers in epilepsy", Acta Neurol Scand ,146:362–368

[30] Y. H. Liu ,et al.,(2022)," Epilepsy detection with artificial neural network based on as-fabricated neuromorphic chip platform", AIP Advances ,Vol.12

[31] Omaima Ouichka,et.al,(2022)," Deep Learning Models for Predicting Epileptic Seizures Using iEEG Signals ", Electronics,Vol. 11, No.605

[32] Shoeibi, A,et.al,(2021)," A comprehensive comparison of handcrafted features and convolutional autoencoders for epileptic seizures detection in EEG signals", Expert Syst ,Vol.163, 113788.

[33] Romaine, J,et.al,(2021)," EEG—Single-Channel Envelope Synchronisation and Classification for Seizure Detection and Prediction", Brain Sci, Vol.11,No. 516.

[34] Tang, X,et.al,(2020),"Conditional adversarial domain adaptation neural network for motor imagery EEG decoding", Entropy, Vol.22,No. 96.

[35] Khosla, P. Khandnor and T. Chand, (2020),"A comparative analysis of signal processing and classification methods for different applications based on EEG signals," Biocybernetics and Biomedical Engineering, vol.40, no.2, pp.649-690

[36] Y. Yuan, G. Xun, K. Jia and A. Zhang,(2019), "A Multi-View Deep Learning Framework for EEG Seizure Detection," IEEE Journal of Biomedical and Health Informatics, vol. 23, no. 1, pp. 83-94.

[37] M.K. Siddiqui, et.al,(2020), "A review of epileptic seizure detection using machine learning classifiers." Brain informatics vol. 7, no.1, 5

[38] Y. Kumar, et.al,(2014) "Epileptic seizure detection using DWT based fuzzy approximate entropy and support vector machine," Neurocomputing, vol. 133, pp. 271–279.

[39] P. Potapov,(2017), "On the loss of information in PCA of spectrum-images," Ultramicroscopy, vol. 182, pp. 191–194.

[40] J. Rabcan, et.al,(2020), "Review of Methods for EEG Signal Classification and Development of New Fuzzy Classification-Based Approach," in IEEE Access, vol. 8, pp. 189720-189734.

[41] P. Y. Zhou and K. C. C. Chan,(2018), "Fuzzy feature extraction for multichannel EEG classification," IEEE Transactions on Cognitive and Developmental Systems, vol. 10, no. 2, pp. 267–279.

[42] R. Sharma, et.al,(2017), "Decision support system for focal EEG signals using tunable-Q wavelet transform," Journal of Computational Science, vol. 20, pp. 52–60, May 2017.

[43] J. Jia, et.al,(2017), "Automated identification of epileptic seizures in EEG signals based on phase space representation and statistical features in the CEEMD domain," Biomedical Signal Processing and Control, vol. 38, pp. 148–157.

[44] Guangda Liu,et.al,(2021)," Mini review of Epilepsy Detection Techniques Based on Electroencephalogram Signals ", Front. Syst. Neurosci,Vol. 15:685387

[45] Naser, A,et.al (2019)," M. Detecting epileptic seizures using abe entropy, line length and SVM classifier.", In Proceedings of the International Conference on Advanced Machine Learning Technologies and Applications, pp. 169–178.

[46] Lahmiri, ,et.al,(2019),"Accurate classification of seizure and seizure-free intervals of intracranial EEG signals from epileptic patients", IEEE Trans Instrum. Meas.,Vol. 68,pp. 791–796.

[47] Raghu, S,et.al,(2019), " Performance evaluation of DWT-based sigmoid entropy in time and frequency domains for automated detection of epileptic seizures using SVM classifier.", Comput. Biol. Med., Vol.110, pp.127–143.

[48] Wang, X,et.al,(2019), "Automated recognition of epileptic EEG states using a combination of symlet wavelet processing, gradient boosting machine, and grid search optimizer", Sensors, Vol.19,pp. 219.

[49] Bose, R,et.al,(2019), "Detection of epileptic seizure employing a novel set of features extracted from a multifractal spectrum of electroencephalogram signals.", IET Signal Process., Vol.13, pp.157–164.

[50] Dalal, M,et.al,(2019)," Machine Intelligence and Signal Analysis", Springer: Singapore.

[51] Osman, A.H,et.al,(2019), "New approach for automated epileptic disease diagnosis using an integrated self-organization map and radial basis function neural network algorithm", IEEE Vol. 7, pp.4741–4747.

[52] Fasil, O.K,et.al,(2019)," Time-domain exponential energy for epileptic EEG signal classification. Neurosci", Lett, Vol.694, pp.1–8.

[53] Saminu, S,et.al,(2019) ," Epilepsy detection and classification for smart IoT devices using hybrid technique." In Proceedings of the 15th International Conference on Electronics, Computer and Computation (ICECCO), pp. 1–6.

[54] Mahjoub, C,et.al,(2020) ," Epileptic seizure detection on EEG signals using machine learning techniques and advanced preprocessing methods", Biomed. Eng , Vol.65, pp.33–50.

[55] Raluca, M.A ,et.al,(2020) ," EEG-brain activity monitoring and predictive analysis of signals using artificial neural Networks", Sensors ,Vol. 20, 3346.

[56] Ozlem, K.C,et.al,(2020), "Epileptic seizure classifications using empirical mode decomposition and its derivative" , BioMed Eng,Vol. 19, No.10.

[57] Khaled, M.A.,(2020)," Classification of epileptic seizure dataset using different machine learning algorithms", Inform. Med., Vol.21, 100444.

[58] Rabcan, J.; Levashenko, V.; Zaitseva, E.; Kvassay, M. EEG Signal Classification Based On Fuzzy Classifiers. IEEE Trans. Ind. Inform. 2021, 18, 757–766

[59] Rabby, M.K.M,et.al,(2021), "Wavelet transform-based feature extraction approach for epileptic seizure classification", In Proceedings of the 2021 ACM Southeast Conference, , pp. 164–169.

[60] Omidvar, M et.al,(2021), "EEG signal processing for epilepsy seizure detection using 5-level Db4 discrete wavelet transform, GA-based feature

selection and ANN/SVM classifiers.", J. Ambient. Intell. Humaniz. Comput., Vol.12, pp.10395–10403.

[61] Gulshan Kumar,et.al,(2022)," An intelligent epilepsy seizure detection system using adaptive mode decomposition of EEG signals",Physical and Engineering Sciences in Medicine ,Vol. 45,pp.261–272

[62] Xiaoyan Weiet.al,(2022)," Epileptic seizure detection from multivariate sequential signals using Multidimensional convolution network",Reasearc Square,doi.10.21203

[63] Deepa, B., et.al, (2022)," Epileptic seizure detection using deep learning through min max scaler normalization", International Journal of Health Sciences,Vol. 6(S1), 10981–10996.

[64] Chunjiao Dong et.al,(2022)," A Two-Layer Ensemble Method for Detecting Epileptic Seizures Using a Self-Annotation Bracelet With Motor Sensors",IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, VOL. 71

[65] Athar A. Ein Shoka et.al,(2023)," An efficient CNN based epileptic seizures detection framework using encrypted EEG signals for secure telemedicine applications",Alexandria Engineering Journal,Vol.6,pp.399-412

[66] Zhengdao Li ,et.al,(2023)," Graph-generative neural network for EEG-based epileptic seizure detection via discovery of dynamic brain functional connectivity",Scientifc Reports ,Vol. 12:18998

[67] Muayed S AL-HUSEINY ,et.al,(2023)," DETECTION OF EPILEPTIC SEIZURES IN EEG BY USING MACHINE LEARNING TECHNIQUES",DIAGNOSTYKA, Vol. 24, No. 1

[68] Puja Dhar, ,et.al,(2023)," Hybrid RNN(Long Short-TermMemory) with CNN (Densenet201)model using EEG signals in detecting epileptic seizure in a human being",Journal of Survey in Fisheries Sciences ,Vol.10(4S) ,pp.2249-2251