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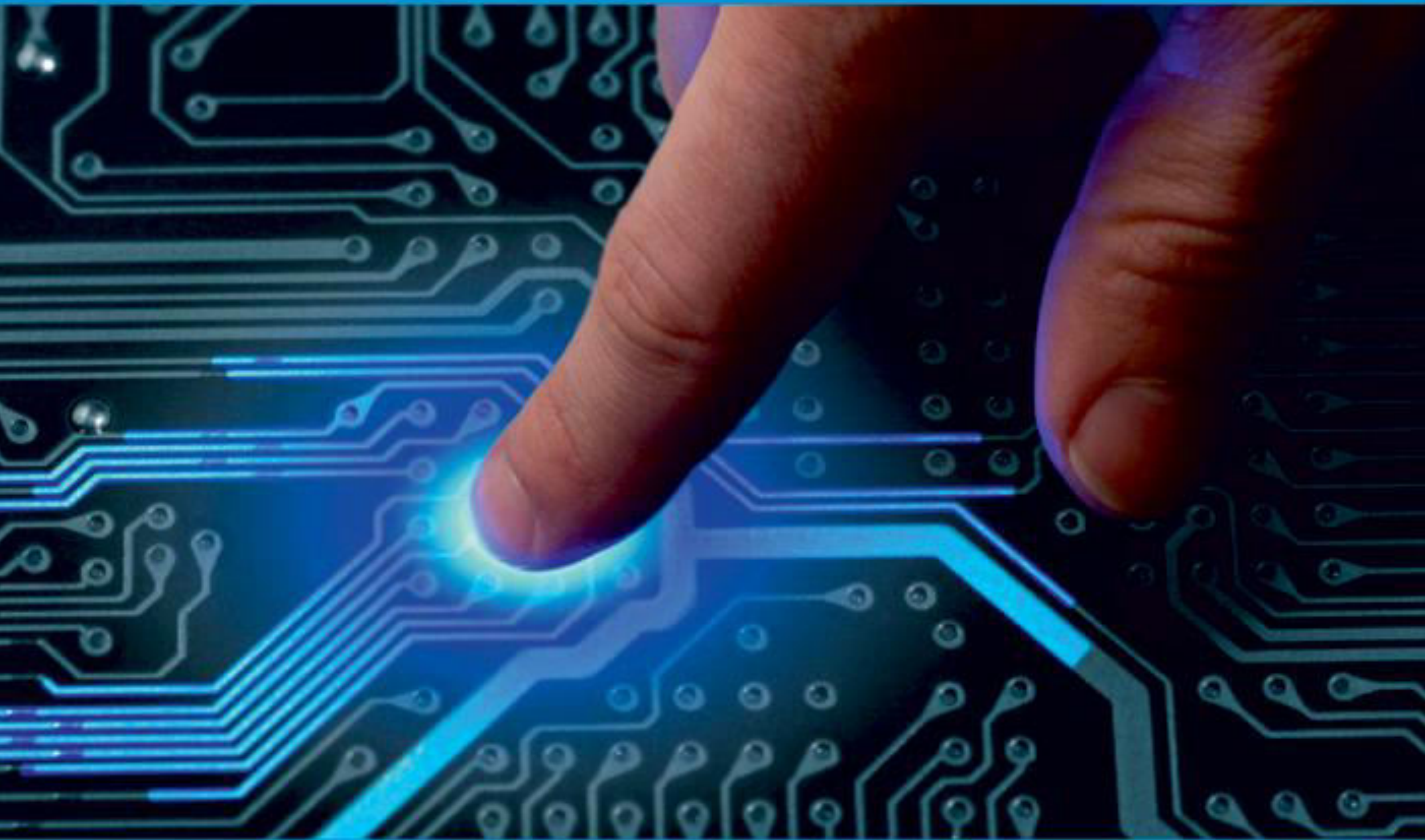

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Diagnosis of Alzheimer's Disease Classification with EEG Signals in A Differential Computational Framework

R. Sathish[1], Dr. R. Muthukumar[2] S. Boobalan[3]

Assistant Professor, Department of EEE, Angel College of Engineering and Technology,Tamilnadu, India

Associate Professor, Department of EEE, Erode Sengunthar Engineering College,Tamilnadu, India

UG Scholar, Department of EEE, Angel College of Engineering and Technology,Tamilnadu, India

ABSTRACT: The application of Brain-Computer-Interface (BCI) system has to be effectively improved to make more popular in the field of biomedical. Biomedical industry plays a significant role due to accurate and efficient diagnosis of patients using digital signal processing and wireless sensor network technology. Alzheimer's disease (AD) is an irreversible neurodegenerative disease. This disease is characterized by speedy loss of memory and behavioral characteristics changes. There is no proper AD detection in early and precise identification may assist to stop the disease spread. Accurate and efficient AD identification and classification of AD directs to improve dominance of life and improved life hope for patients. The state-of-the-art deep learning technique is proved over conventional machine learning techniques in classification of complicated configuration in composite elevated dimensional information, mainly in the field of digital signal processing. The deep learning application for early identification and precision classification of AD can be proposed for neuron-signal approach in large scale information. In this project, intelligent decision-making system (IDMS) is proposed for detection and classification of AD and persistence monitoring of patients using associated wearable devices. To detect and classify AD, neural synchrony quantity measurement approaches are proposed.

KEYWORDS: Brain-Computer-Interface (BCI), Alzheimer's disease (AD), Intelligent Decision-Making System (IDMS), Digital Signal Processing (DSP), PCA, ICA, EMD, DCNN, IoT.

I. INTRODUCTION

The Principle Component Analysis (PCA) and Independent Component Analysis (ICA) are basic and useful feature extraction technique both are subjected for estimation of various features on EEG signal. The Fast Fourier Transform (FFT) is the frequency domain technique that can be subjected on EEG signal to estimate frequency domain features. EEG signal is decomposed as a sequence of narrow band signals with using Hilbert–Huang Transform (HHT) has become popular and HHT is used to estimate features of EEG signal further the sub-band signal is decomposed with empirical mode decomposition (EMD) to collect a stationary spatial sequence that are known as Inherent Mode Function (IMF).

The suitable IMF for EEG signal feature extraction is chosen. The estimated entropy value of the EEG signal can be estimated as the corresponding feature vector from IMF. We should college more number of EEG signal from healthy people and disease patients for analysing signals. All the features are collected and stored as database during training phase of deep learning. The equivalent spectrum of energy and secondary spectrum are estimated to categorize the signals based on the features.

The large size of database is created for improving efficiency of IDMS. By integrating frequency, time and other channel information from EEG signal are given the Deep Convolution Neural Network (DCNN) for training purpose. The DCNN will train all the database features and make the IDMS system for testing and EEG real time signal. The EEG real time signal of any patient can be given to DCNN testing phase. The real time EEG testingsignal is undergone for all of our novel phases such as filtering, enhancement and feature extraction. The testing features are estimated and stored in DCNN. The testing features are compared with DCNN training phases. Based on the comparison, the IDMS will make decision as EEG signal is normal or abnormal. All the information of patients is given in Graphical User Interface (GUI) that will be feed to Internet of Things (IoT). The security algorithm will be developed for patient information to ensure confidential of data in the cloud using IoT.

The Health Security System (HSS) plays a significant role in the medical domain for IoT cloud storage. In the medical domain, Confidential Health Information (CHI) is an increasing patient-centric system of health information exchange that is often outsourced to be kept at the server of a third party. In medical domain, where opinions are frequently focused on saving someone's life, preserving data access to interconnection and network systems that keep confidential information like health records is also a necessary aspect to consider. Therefore, there may be different privacy and security problems as CHI has a risk of being compromised to the unrecognized third parties. Information security controls access to the confidential medical data by permitting free and simple permission to those who are authorized to access that data

The primary aim is to provide a comprehensive framework for the early diagnosis of AD and classify medical data for different phases of the illness. This study applies a deep learning strategy, in particular, a CNN. Multiple categories can be used to describe the first four AD phases. On top of that, every pairing of AD stages is classified using a different binary brain tumour detection classification system. Medical image classification and Alzheimer's disease detection employ two different approaches. The first approach uses 2D and 3D convolution using basic CNN architectures to deal with anatomical brain imaging in 2D and 3D from the Alzheimer's dataset.

II. LITERATURE SURVEY

Within body sensor networks many study groups and independent labs around the world are active and suggested a mental health monitoring personal atmosphere (PAM)initiative. The goal of the initiative is the monitoring of bipolar condition signatures (BP) patients. The PAM consists of two levels: a personal ambient management system (PAM-I) and a specific technology framework for environmental monitoring (PAM-A). Health monitors are installed in the home environment and on the body of an individual. The Bluetooth protocol is used to link body sensors and mobile telephones; the mobile and personal computers are linked via Bluetooth. While writers are mainly worried about applications for wireless surveillance of mental health where the secrecy of patients is a requirement for these applications, they do not discuss the privacy of patients.

Recently, the new system developed for tracking patients in hospitals and in emergency situations at Johns Hopkins University, called MEDiSN, has been reported [2]. This contains multiple clinical devices (so-called "PMs"), battery-based motes and medical indicators used to gather patient information regarding physiology (e.g. blood oxygenation, pulsation rate, pulse rate, etc.). Moreover, only authorized customers can access and monitor the backend controller sensor network, but undisclosed is the authenticated username. As a result, author's knowledge on their security mechanisms has not been given in depth from a security perspective.

Designed and created, together with the University of Illinois and the University of Virginia, a wearable personal monitoring service called SATIRE. SATIRE allows users to monitor their daily routine tasks (for instance, determined by two motion and position sensors) in a personalized, searchable manner. A man who sports a SATIRE jacket that records normal daily life. If a person, i.e. a jacket, enters the neighborhood of an access mote (i.e. linked to a personal computer), the recorded information can be reliably uploaded to the private depot of the person involved. These data can subsequently be used to recreate the person's experiences and locations. While authors correctly tackle security and privacy concerns in SATIRE, for sensitive physiological details, they have not enforced any security or privacy.

Implementing the medical image segmentation system using the histogram dependent technique. The technique analyzes the threshold value of the image by using the p- tile method and the edged information obtained by applying the edge maximization technique. Based on the threshold value, the regions are segmented from the satellite image which is used to analyze the tumor present in the image with effective manner.

Developing the image segmentation system by using the genetic algorithm based adaptive thresholding approach. The method analyzes the image window size based on the entropy features. From the entropy feature the images are segmented into different regions by applying the parallel genetic algorithm. The algorithm selects the segmentation according to the selection, mutation and crossover function. The operator based segmentation process segments the image in an efficient manner when compared to the huang' sphramidal window merging approach. Eventually, the device output is evaluated in relation to the consistency and error rating using experimental results and explanation.

Improvement of the brain tumor detection cycle by suppressing speculation in the MRI image. In order to improve the image's quality by reducing the image noise quality, the author employs numerous filter strategies such as the medium-length, average filter and Wiener filter and wavelet methods. The approach removes noise during the noise removal process without affecting the quality of the edges because the edges have only information on the actual tumor. Ultimately, the output is measured using the high signal-to-noise ratio criteria for the proposed device capacity.

Brain tumors are studied with different medical pictures such as MRI, CT, X rays and ultrasound. Some of the noise that removes the entire system output impact these images. The noise is therefore generated by using the different filters, and the wavelet converts and extracts the noise without impacting the knowledge on the edges. Afterwards the quality photos are used for the isolation of the tumors in the next step which ensures full precision.

Segmenting effective tumor region from the MRI image using the different preprocessing methods. Placing the different filters, which eliminate noise with three different series such as T1, T2 and DWI, are used to preprocess captured images. Different features thatare fed into the classifiers to effectively examine the tumor are extracted from the pre- processed image. Then the system's efficiency is correlated with the specific statistical techniques.

[9, 10] Use the MRI picture to establish the tumor detection system. The pictures obtained are improved by using Gaussian laws by the Gabor filter. Then the tumor region is segmented by applying the Otsu thresholding techniques based on the threshold value. From the segmented region, various normal features are extracted which is used to determine the normal and abnormal images from the dataset. The machine output is then contrasted with the sound image and several traditional methods of segmentation.

III. EXPECTED OUTPUT AND OUTCOME OF THE RESEARCH

The expected output and outcome are hardware and software integrated prototype for detection and recognition of AD and persistence monitoring of patients using IDMS. For EEG signal acquisition, the integrated wireless sensor with association of software will be developed. The acquired analog EEG signal has to be converted to digital format for storing purpose. The noisy EEG signal is filtered using digital filter. The digital filter can be designed and developed in order to filter various noise content present in EEG signal. The DSP processor is used for designing the filter. The filtering parameters are calculated for justifying the filter performance. The EEG signal is further applied to DSP enhancement algorithm for improving the quality of signal. The appropriate feature is estimated and presented for classification purpose. The decision making for IDMS can be obtained using DCNN for classifying given real time EEG signal is affected by AD or not.

The automated and integrated IDMS system can be developed based on the features that are stored as a database. The database is more important for signal classification using deep learning. The automated and integrated intelligent decision-making system can be presented for presence of AD. The Graphical User Interface using python has to be presented to monitor brain activities. The IoT cloud storage system can be established for storing all information such as acquisition, processing and creation of database. The associated data encryption and decryption is possible for keeping privacy and security on IoT cloud storage.

IV. ORIGIN OF THE RESEARCH

The human brain generated electrical signal is called as electroencephalograph (EEG). Alzheimer's disease (AD) is a medical disorder which produces loss of memory and cognitive impairment by the killing of brain cells. A degenerative form of Alzheimer, the condition begins slightly, and is slowly becoming worse. Limited hospitals, however, are typically unable to obtain enough materials for rigorous identification training. Although the exchange of information in scientific research is growing, it is unclear if a system based on one database is very well adapted for other resources. Compared to a system based on the initial limited dataset, the accuracy improved by around 20 per cent.

The results showed that the proposed solution is an innovative and efficient method of BCI in clinics only with limited data set for learning. Continuous work is under way to accurately diagnose Alzheimer's disease (AD) focused on conventional deep learning methods, and deep learning-related strategies have become a common alternative for AD diagnostics. The Cognitive Impairment (CI) is described by blight storage of memory condition of human brain possibly leads to AD. Because of various characteristics of AD, neocortical disconnection syndrome is occurred. The historical statistics report that 6-25 % of CI is converted to AD per annum and 0.2-4% through normal people to AD, disclose the detail that CI is a conversion level of AD. Loss of coordination and integration among cortical and hippocampus has been a significant subject in research to investigate the origin in cognitive impairment in AD. To order to analyze neural interaction, quantitative evaluation of interconnectivity between time series reported from various areas of the brain is called "functional connectivity". The human brain revelation as a composite system has led for obtaining away the aspects that could be the best recognize practical disease in human brain.EEG signal is reflected functional instances to estimate cognitive disorder and an investigative tool, particularly an analytical uncertainty subsists even following the preliminary medical measures.

Deep learning techniques have recently been implemented to the EEG-based BCI scheme, as they are very difficult to implement to the creation of a complete EEG classification process due to different effect factors such as noise, channel differentiation and high-dimensional EEG details. An optimal classification system would involve a stage of data processing, where signals are decreased in dimensional space and are interpreted by new data without substantial loss of data. The next stage of this process-that is, the system architecture- is after data processing, where functional features of the inputs are all removed. Given manyof the above-mentioned difficulties, efficient application of deep learning approaches for classifying EEG signals is indeed a success.

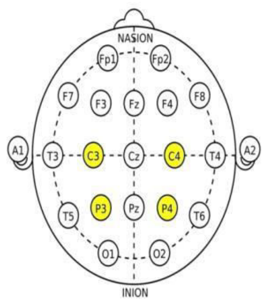

Figure 1: Electrode location in scalp

The figure 1 shows the electrode location in scalp. As described above, the positions 'C3' and 'C4' are positioned over the counter-lateral cerebral areas and these are essential for the motions of the limbs, particularly the motions of the hands. They are both related to motor planning and execution, whereas the 'P3' and 'P4' reflect the posterior parietal areas connected to the sensory details. The pursuing of 'C3', 'C4,' 'P3' and 'P4' has been triggered by their position over similar cortical regions. Of example, the most often used regions are the 'C3' and'C4' for both illustration and actual activity, the electrodes from the parietal areas (like 'P3' and'P4') are less widely utilized, but their placement is often very valuable for the detection of illustration and actual motions.

V. METHODOLOGY

In this work, a novel methodology is proposed for the Intelligent Decision-Making System (IDMS) for detection and recognition of Alzheimer Disease (AD) and persistence monitoring of patients. The primary aim is to provide a comprehensive framework for the early diagnosis of AD and classify medical data for different phases of the illness. This study applies a deep learning strategy, in particular, a CNN. Multiple categories can be used to describe the first four AD phases. On top of that, every pairing of AD stages is classified using a different binary brain tumour detection classification system. Medical image classification and Alzheimer's disease detection employ two different approaches. The first approach uses 2D and 3D convolution using basic CNN architectures to deal with anatomical brain imaging in 2D and 3D from the Alzheimer's dataset. A web application for checking for Alzheimer's is recommended using the ultimate qualifying planned designs. Remote monitoring of AD is helpful for both doctors and patients. Additionally, it analyses the patient's symptoms to establish where on the AD spectrum they now fall and provides recommendations accordingly.

1. EEG signal Acquisition

Figure 2 shows the block diagram of EEG signal acquisition. We design and develop alightweight, battery-powered, EEG signal acquisition system package that will be controlled with wireless sensors at the top of patient's head. The introduction of this novel, functionally fold able system allows the EEG scaling issue to be addressed by essentially re configuring equipment for devices that are limited or more complicated. Implementation of the device that have the capacity to obtain 16 to 64 EEG channels at sample frequencies from 250 Hz to 1000 Hz and transmit the raw EEG signal via a Bluetooth or Wi-Fi network.

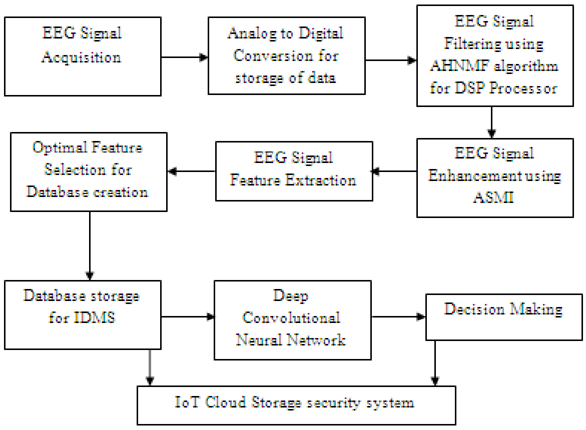

Figure 2: Architecture diagram of proposed methodology

2. IoT data security

All the information of patients is given in Graphical User Interface (GUI) that will be feed to Internet of Things (IoT). The security algorithm will be developed for patient information to ensure confidential of data in the cloud using IoT. The Health Security System (HSS) plays a significant role in the medical domain for IoT cloud storage. In the medical domain, Confidential Health Information (CHI) is an increasing patient-centric system of health information exchange that is often outsourced to be kept at the server of a third party. In medical domain, where opinions are frequently focused on saving someone’s life, preserving data access to interconnection and network systems that keep confidential information like health records is also a necessary aspect to consider. The major constraint of S-Box is that it is static during the occurrence of a security algorithm.

The constraint is successfully solved by applying dynamic and random variance of S- Box algorithm while providing security to the EEG data of the patient. We have proposed a dynamic and random S-Box method and compared with other S-Boxes proposed in the projectusing S-Box characteristics that are necessary for secured S-Box construction viz. nonlinearity, bit independence criteria-nonlinearity (BIC-nonlinearity), strict Avalanche criterion (SAC) and bit independence criteria-strict Avalanche criterion (BIC-SAC).To guarantee safe storage and access of information in the cloud using IoT, Two-Fish algorithmis proposed for providing encryption and decryption during transmission and reception of healthcare data.

VI. CONCLUSION

A novel methodology is proposed for the security threat detection and information recovery model for preserving confidential information by applying Dynamic and Random S Box model with the Two-Fish encryption algorithm. The major constraint of S-Box is that it isstatic during the occurrence of a security algorithm. The constraint is successfully solved by applying dynamic and random variance of S-Box algorithm while providing security to the EEG data of the patient. We have proposed a dynamic and random S-Box method and compared with other S-Boxes proposed in the project using S-Box characteristics that are necessary for secured S-Box construction viz. nonlinearity, bit independence criteria- nonlinearity (BIC-nonlinearity), strict Avalanche criterion (SAC) and bit independence criteria-strict Avalanche criterion (BIC-SAC).To guarantee safe storage and access of information in the cloud using IoT, Two-Fish algorithm is proposed for providing encryption and decryption during transmission and reception of healthcare data.

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