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Schizophrenia Detection Using Deep Learning Techniques

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Abstract: *A severe mental illness called schizophrenia affects, 1 percent of people worldwide. Early detection is essential for effective treatment and management of this disease. Deep learning methods have shown the potential to detect and diagnose, multiple illnesses, including schizophrenia. For example, convolutional neural networks (CNN) are deep learning techniques that researchers have used in recent years to analyze magnetic resonance imaging (MRI) images of the brain to find patterns suggestive of schizophrenia. These techniques can detect small changes in brain anatomy that cannot be detected by the naked eye. Using deep learning techniques to detect schizophrenia offers the opportunity to improve the early detection and diagnosis of this debilitating condition, potentially leading to better treatment and management of its sufferers. This article provides an overview of the various techniques used to detect schizophrenia.*

Keywords: Schizophrenia, EEG, CNN, SPWVD-CNN

I. INTRODUCTION

A persistent and severe mental illness called schizophrenia (SZ) affects 20 million individuals globally. It is a severe, pro- tracted brain illness that manifests in a variety of symptoms, such as hallucinations and delusions. SZ causes considerable handicap that has an impact on healthcare expenses globally. Due to curable physical conditions such as cardiovascular disease, metabolic disorders, and infections, the projected mortality rate for SZ patients is two to three times higher than that of healthy individuals. Thus, there is a growing need to create an effective diagnosis method for differentiating healthy control (HC) individuals from SZ patients early on. EEG is a biosignal that monitors changes in brain activityby recording it on the scalp. EEG can therefore be used to make a preliminary diagnosis of neurological illnesses like schizophrenia. A few studies investigated electromyo- gram (EMG) and electrocardiogram (ECG) data to identify schizophrenia. However, because there is less of a correlation between these signals and schizophrenia, the performance of these studies is constrained.This work uses the state-of-the-art CNN method to classify data from EEG signals associated with schizophrenia and normal EEG signals.

Since its capacity for automatic deep feature extraction and categorization, CNN is a Deep Learning technique that has gained popularity. Instead of multiplying matrices, CNN convolutionally finds many characteristics to distinguish one class from another. An intricate network of interconnected neurons makes up the CNN. These neurons have been taught to identify and extract the features. Input, hidden, and output layers make up CNN's fundamental architecture. The hidden layer is made up of several pooling, fully connected, and convolutional layers. Deep feature extraction is done by the convolutional and pooling layers, while classification is done by a fully connected layer. Four convolutional layers, two pooling layers, a dropout layer, and two fully linked layers make up the proposed CNN.

II. LITERATURE SURVEY

This section discusses many methods for detecting schizophrenia.

A SPWVD-CNN automated technique for schizophreniadetection was proposed by S. K. Khare, V. Bajaj, and U. R. Acharya in 2021 [1]. The effectiveness of several time- frequency techniques and CNN-based models is proposed in this paper. To differentiate between SZ patients and healthy participants, three conditions have been tested. When com- pared to the other two scenarios, the classification of SZ and HC was more accurate after pressing the button. Compar-ing SPWVD to STFT and CWT techniques, we found that SPWVD produced greater accuracy. In comparison

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to other CNN-based networks, the suggested CNN model with four convolutional layers not only had the highest accuracy butalso was computationally quick and efficient.

Siuly Siuly et al. introduces an EMD-based method for automatically identifying SZ patients from EEG signals in 2020[2]. Since the signal processing system demands stationarity ofthe signal to uncover significant information pertaining to the temporal domain, the EMD transforms the non-linear and non- stationary EEG- signal to a finite number of stationary IMF. Thereafter, the KW test was used to assess the discriminative power of the five statistical characteristics that were retrieved from each of the IMFs. The effectiveness of the generated feature matrix was subsequently assessed using a number of well-known machine-learning techniques. The EBT classifier outperformed other classifiers in differentiating between SZ and HC, demonstrating the value of brain activity response as a biomarker. The proposed methodology provides the path for developing a new robust and consistent method for the automated analysis and identification of SZ in EEG signals.

Nebras Sobahi et al. have created a precise method for effectively detecting SZ in EEG data [3]. The channels and rhythms of the EEG signals are used to determine the pro- posed approach. This paper develops a novel signal-to-image mapping method, and the results of the experiments showhow effective it is. The ResNet50 model fared better than the ResNet101 model during the experiments. Data augmentation was found to be crucial for achieving high. It was shown that the suggested mapping method outperformed more established time-frequency transformation methods in terms of results. It can be shown that the suggested method performed better thanthe alternatives.

Seifedine Kadry et al. proposed using an automated methodto identify schizophrenia using T1W axial-view brain MRI slices[4]. The well-known deep-learning technique VGG16 with a binary classification was used in this study. The learned-features (1x1x1024) and SMA-optimized features are used to categorise the test images that are being taken into consideration (1x1x614). The best value of the achieved resultis adopted for validation in this study, which implements a 10-fold cross validation. The experimental results of this method demonstrate that VGG-classification Cubic's accuracy outperforms alternative methods. The suggested method is effective for diagnosing the condition using brain MRI, andin the future, it might be thought to look at the clinicallygathered real-time images.

In order to achieve SCZ/HC classification, Jin Liu et al. have suggested an MKL framework that combines the node and edge characteristics of distinct hierarchical networks with the cortical thickness patterns from structural MRI images[5]. To create node and edge features, we first build unique hierarchical networks for each subject. mRMR and SVM-RFE are applied separately to the node and edge features in a two- step feature selection technique in order to choose the discriminative features that are useful for SCZ/HC classification. Then, using SVMRBF, the chosen node and edge features are used independently for SCZ/HC classification. The results of the comparison experiments demonstrate that edge features are more suited to depict anomalies in SCZ.

In order to categorize the results of the Gamma band synchronization test, Ming-Hsien Hiesh et al. developed a system created with the Wavelet Transform (WT), Genetic Algorithm(GA), and Support Vector Machine (SVM)[6]. There are four steps in this system:(1) Preprocessing of the data, (2) Finding of features, (3) Choosing of features, and (4) Classification. Following 40Hz auditory stimulation of the participants, the input data are divided into 2-second segments of brain waves, followed by a 4th-order WT. In this step, we calculate the maximum, minimum, mean, and standard deviation for all of the nodes in the segments. The statistical properties of the total variation, standard deviation, sample entropy, skewness, and energy will then be extracted using these numbers.

N V Swati and Dr. Indiramma M came to the conclusion that a model would be required to accurately identify patients with schizophrenia, regardless of external factors like lifestyle, climate, or environmental factors, by detecting several poten- tial markers[7]. A hybrid deep learning model that can use and analyze data from many sources (eye movement, fMRI, and retinal imaging) and combine the results to produce clear results is needed to create such a model. Such a techniquemay be used to identify further mental illnesses such as megalomania, panic disorder, OCD, etc.

An approach to identify schizophrenia based on electroen- cephalograms using support vector machines was put out by Ivan Kurnia Laksono and Elly Matul Imah[8]. The best accu- racy for classifying normal EEG signal data and schizophrenia patients using CNN was 0.76; SVM had a better accuracy score of 0.03 points higher than CNN. The SVM results are biassed towards one class, and CNN with Alexnet design still has gaps that are prone to errors, therefore the outcomes of both algorithms still need to be improved.CNN cannot compare to the training time of the

SVM network. CNN received an average time of 145.18 seconds, compared to 0.77 seconds for SVM.

A method for diagnosing schizophrenia based on a person's eye movements was presented by Juraj Sˇkunda et al.[9]. A straightforward convolutional neural network was utilised to classify a clinical sample.The suggested approach might be used during the psycho diagnostic preclinical examination, but it would still require the supervision of a specialist in diagnosing cognitive problems. The overburdened healthcare systems in many nations could be improved and the danger of error reduced by the use of entirely or semi-automatic medicaldiagnostic instruments.

The model was presented by Yan-Jia Huang et al. to assess positive and negative symptoms of cognitive, language and communication difficulties in patients with schizophrenia [10].A subset of TLC and PANSS experts representing related disorders and symptoms serve as predictors.The approach uses both text and audio information to predict conversations between schizophrenic patients and interviewers. Unlike some related works, the model incorporates multiple pretrained transformer-based models, ie. BERT, ELECTRA and TERA, to extract semantic,syntactic and acoustic features. These works also tried to evaluate schizophrenic patients based on text or acoustic speech.

Kandala. N V P S Rajesh and T. Sunil Kumar presentedan automatic approach based on symmetrically weighted lo- cal binary patterns (SLBP) for the detection of schizophre-nia in young people using electroencephalogram (EEG) sig- nals[11].The histogram based on SLBP are extracted fromeach EEG channel. The CFS algorithm is used to shorten the length of the feature vector. The CFS algorithm significantly improved the performance of the approach by reducing the length of the feature vectors. Finally, the resulting featurevector is fed into LogitBoost classifiers, which are used to distinguish between schizophrenia and healthy EEG signals.

J. Cacur et al. presented an approach based on the Rorschach Inkblot test and an eye-tracking system to detect schizophrenic disorders[12]. The method extracts and estimates the total time in the specified regions and passes individual scans through the image. This is achieved by expressing the image scan-ning process using a Markov chain, which is a well-known, easily implemented and mathematically tractable model. The final probability vectors and transition matrices are important features used in later processing. The extracted features are then classified into positive (schizophrenic disorder) and neg- ative (healthy individuals) categories. A non-parametric KNN method with multiple strategies and free tuning was used forclassification.

III. CONCLUSION

This paper provides a summary of the various techniquesfor diagnosing schizophrenia. Schizophrenia detection and classification is a challenging issue. Effective schizophrenia detection and categorization depend on accurate machine-learning models. The electroencephalogram (EEG) signals offer a crucial method for schizophrenia diagnosis. EEG data decoding manually may lead to incorrect classification.

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