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TY-BTech Major Project (SEM-V)

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Automated diagnosis of Schizophrenia using ML techniques

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Problem Statement

To automate the diagnosis of Schizophrenia using ML techniques

Objectives

- To preprocess EEG signals (artifact removal, filtering, normalization).
- To extract features from the data.
- To train and evaluate a machine learning model for accurate classification.
- To assess the model's reliability compared to standard clinical evaluations.

Scope of the Project

- This method could help psychiatrists detect schizophrenia earlier and more objectively.
- It can be used in hospital tools allowing for constant monitoring.
- Neurologists who interpret EEG scans could use this tool to screen for neurophysiological markers associated with schizophrenia

[1]

What is Schizophrenia?

- Schizophrenia is a chronic brain disorder that affects how a person thinks, feels, and perceives reality.
- Characterized by distorted thoughts, hallucinations (hearing/seeing things), delusions (false beliefs), and disorganized behavior.
- It is not split personality, but a disorder of disrupted brain communication and perception.

Fig.1. Symptoms of Schizophrenia

[2][3][4]

Why do we need to automate the diagnosis of Schizophrenia?

- Symptom overlap with depression, bipolar disorder, and drug-induced psychosis leads to frequent misdiagnosis.
- Current diagnosis depends on subjective interviews and observation.
- EEG provides objective biomarkers that can improve reliability.
- Shortage of psychiatrists, especially in rural areas, causes delays and long waiting times.

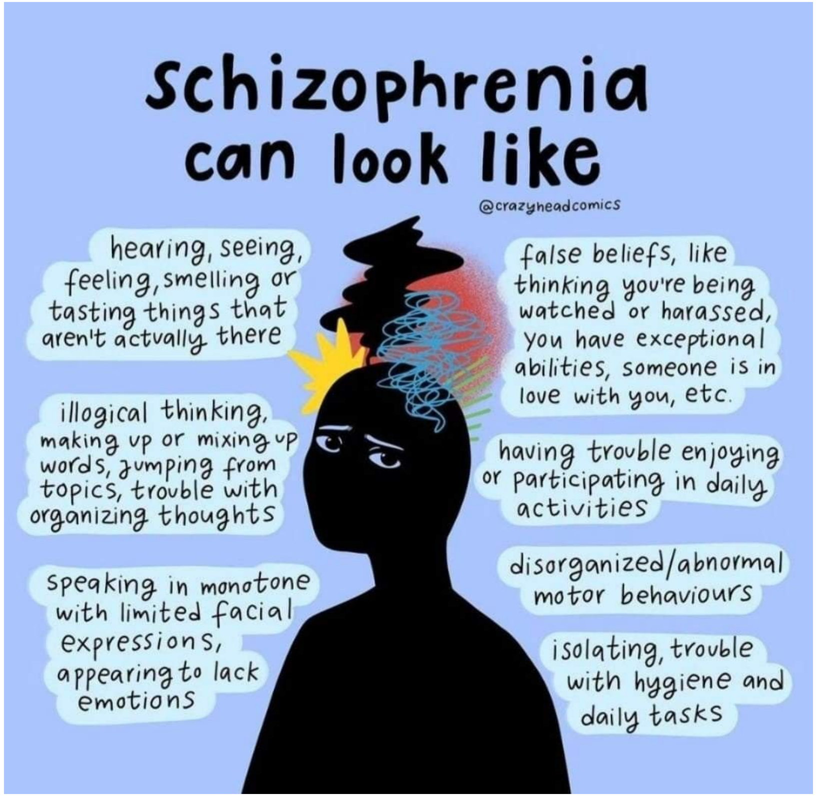


Fig.2. What goes through the brain

Literature Survey

Sl. No.	Authors and Year	Title of Paper/Article	Objective	Methodology/ Approach	Key Findings	Limitations/ Gaps	Future Scope
1	Heda et al. (2024) [7]	miRNA-Based Diagnosis of Schizophrenia Using Machine Learning	To use miRNA biomarkers and ML to create a more reliable diagnostic tool for schizophrenia.	Integrates miRNA and EEG data. Utilizes advanced feature extraction (CNNs) and emphasizes Explainable AI (XAI) for clinical trust.	High accuracy (90-98%) can be achieved with deep learning on EEG data. Combining biological markers (miRNA) with ML is a highly promising approach.	Symptom heterogeneity, small/noisy datasets, and a lack of large, standardized studies limit model generalizability.	Combine multimodal data (miRNA, EEG, MRI), develop interpretable AI models for clinical use, and conduct large-scale longitudinal studies.
2	Vyškovský et al. (2022) [8]	Structural MRI-Based Schizophrenia Classification Using Autoencoders and 3D Convolutional Neural Networks...	To test if deep learning models (SAE and 3D CNNs) can classify schizophrenia using structural MRI data and evaluate different preprocessing techniques.	Used sMRI from 104 subjects with various preprocessing (VBM, DBM). Trained Stacked Autoencoders (SAE) on selected features and 3D CNNs on whole images.	Stacked Autoencoders on VBM-processed data performed best (~70% accuracy). 3D CNNs were less effective, and combining features did not help, likely due to the small dataset.	Very small dataset (N=104) limits the use of complex models like CNNs. Lack of external validation and model interpretability.	Use larger, multi-center datasets. Focus on model interpretability and integrate multimodal data (e.g., MRI + EEG) for better accuracy.
3	Thilagavathi et al. (2024) [9]	Schizophrenia Detection Using Machine Learning Approach	To use a Support Vector Machine (SVM) on extracted EEG features to differentiate schizophrenia patients from healthy controls.	Analyzed EEG data from a small cohort (14 patients, 14 controls). Extracted spectral and entropy features and fed them into an SVM classifier.	The SVM model showed high accuracy, demonstrating that standard ML can effectively classify schizophrenia on small, balanced datasets, serving as a supplementary diagnostic tool.	Extremely small dataset (N=28) severely limits the generalizability of the results. Medication effects were not controlled for.	Validate the approach on larger, more diverse datasets to confirm its effectiveness and test its robustness for real-world application.

Literature Survey

Sl. No.	Author(s) and Year	Title of Paper/Article	Objective	Methodology/ Approach	Key Findings	Limitations/ Gaps	Future Scope
4	Yamashita et al. (2021) [10]	Three-Dimensional Convolutional Autoencoder Extracts Features of Structural Brain Images With a 'Diagnostic Label-Free' Approach...	To use a 3D convolutional autoencoder (3D-CAE) to extract features from sMRI scans without using diagnostic labels during the learning phase.	Trained a 3D-CAE on two separate MRI datasets (Kyoto and COBRE). Used the extracted features to predict clinical severity and medication dosage via regression.	The label-free 3D-CAE approach successfully extracted features that were highly predictive of clinical variables (symptoms, medication). It outperformed traditional methods.	The model's architecture was not fully optimized. The approach needs testing on other psychiatric disorders and with longitudinal data.	Extend to other disorders, incorporate longitudinal and multimodal data (EEG, genetics), and improve model interpretability for clinical use.
5	Uhlhaas & Singer (2010) [5]	Abnormal Neural Oscillations and Synchrony in Schizophrenia	To review and synthesize evidence linking neural oscillation abnormalities across different frequency bands to the cognitive deficits seen in schizophrenia.	A narrative literature review summarizing findings from human electrophysiology (EEG/MEG) and animal model studies to build a conceptual framework.	Schizophrenia is associated with widespread dysregulation of both high (gamma) and low-frequency oscillations. Disrupted cross-frequency coupling is likely a key mechanism behind cognitive dysfunction.	Findings across the literature are often contradictory and difficult to compare due to varying methodologies. The review can only infer, not establish, causal links.	Systematically study cross-frequency interactions, use mechanistic models to understand the neurobiological basis (e.g., GABA dysfunction), and standardize methods for biomarker development.

Difference in EEG Signals between a normal person and a schizophrenic person [5]

	Normal Person	Schizophrenic Person
Delta(< 4 Hz)	Deep sleep; rare when awake	Elevated during wakefulness; altered sleep delta
Theta(4–8 Hz)	Drowsiness, meditation	Elevated resting/task-related theta
Alpha(8–12 Hz)	Relaxed wakefulness (eyes closed)	Reduced alpha power and coherence, especially in medicated patients; associated with negative symptoms.
Beta(12–30 Hz)	Active thinking, alertness	Mixed often elevated in resting, eyes open
Gamma(>30 Hz)	Cognitive integration, memory	Dysregulated: power and synchrony abnormalities. Reduced gamma power and synchronization during tasks (sensory gating, working memory); sometimes increased at rest.

EEG Database

- There are two EEG data archives for two groups of subjects. The subjects were adolescents who had been screened by psychiatrist and divided into two groups: healthy (n = 39) and with symptoms of schizophrenia (n = 45).
- Each file contains EEG data for one subject, with samples from 16 channels listed sequentially, where each value represents an EEG amplitude in microvolts
- First 7680 samples represent 1st channel, then 7680 - 2nd channel, ets. The sampling rate is 128 Hz, thus 7680 samples refer to 1 minute of EEG record.

1 - F7	**9 - T4**
2 - F3	**10 - T5**
3 - F4	**11 - P3**
4 - F8	**12 - Pz**
5 - T3	**13 - P4**
6 - C3	**14 - T6**
7 - Cz	**15 - O1**
8 - C4	**16 - O2**

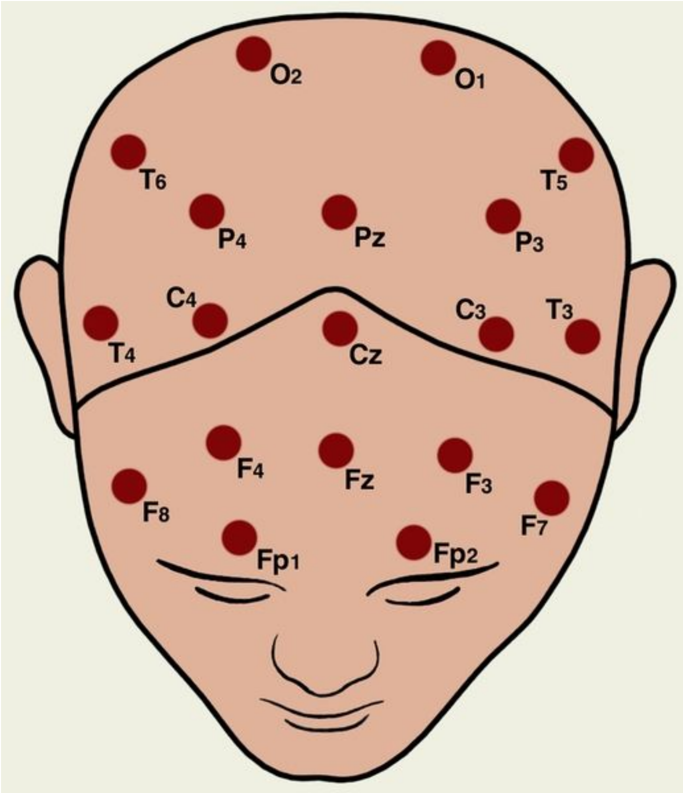
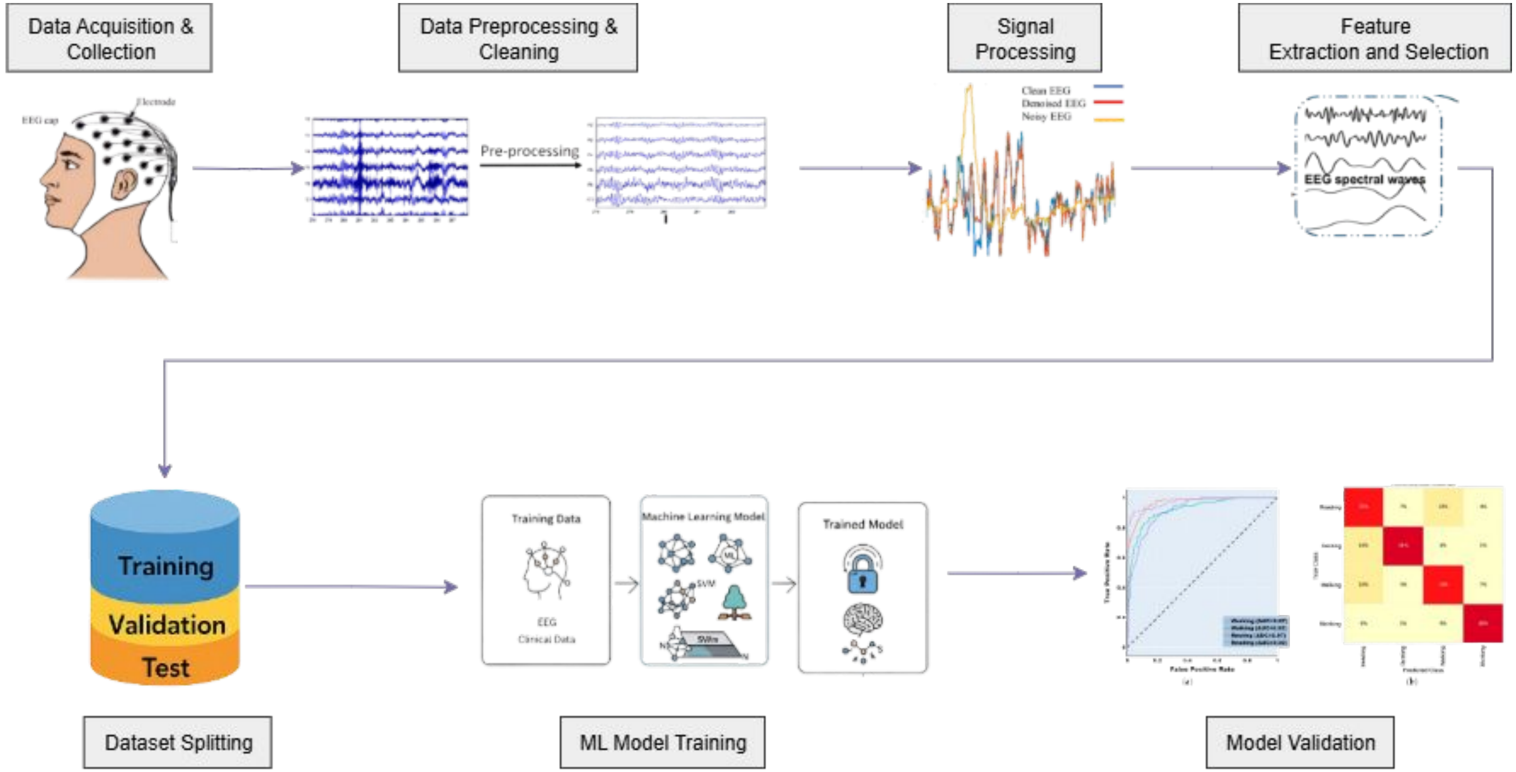


Fig.3. Electrode Placement System

Block Diagram



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