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EEG Brain Signal Processing by Utilizing Matlab and Support Vector Machine Techniques

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ABSTRACT

Brain signals acknowledgment has been an issue that PCs are not productive at. It is hard to locate the fine varieties in the signal on the grounds that the signals are excessively long. Today, proficient brain signal acknowledgment is constrained to discover distinctive brain diseases, for example, epilepsy, tumor, encephalitis, and sleep disorders; utilizing equipment like Electroencephalogram (EEG) wherein the strokes are straightforwardly identified and the brain signals is perceived But on the off chance that you need to change over a brain signal record to computerized content, we need to extricate the EEG signals and then perceive the brain diseases utilizing brain signals. We will indicate distinctive brain signals by contrasting, breaking down and mimicking datasets which is as of now stacked in the MATLAB programming to process the EEG signals. We will likewise depict the Wavelet change is utilized to take the signal in time and additionally frequency domain. To separate highlights of EEG signals, Wavelet Transform is valuable. In light of appropriate highlights of EEG signals, order the EEG signals and foresee results. Support Vector Machine is appropriate to group signals on the premise frequency as an element and to distinguish Alzheimer Disease.

1. Introduction

These days, Population increments with expanding number of diseases Neurogenerative is the real gathering of diseases which influence on the memory of senior individuals Alzheimer's disease is brain issue which influences on memory It is discovered that because of dead brain cells individual lost his memory. By and large, it occurs after the age of 70 years of age. Electroencephalograph (EEG) is a noninvasive strategy which is valuable to record electrical brain movement. In this work, electroencephalograph (EEG) is utilized to identify Alzheimer"s disease. Electroencephalograph (EEG) is catching electrical brain action over the scalp, created by the terminating of neurons in the brain. Electroencephalograph pursues 10-20 standard frameworks. The inspiration for this task, work on EEG signal investigation to improve the understanding of Digital Signal Processing (DSP) and Machine Learning. EEG examination gives an approach to propel this information about the DSP and Machine Learning. Starting at now, there is no framework which portrays the soonest recognition of brain issue.

In this the wavelet change is utilized to speak to EEG signal in time and in addition in frequency domain. Wavelet Transform is a mathematical strategy to understand exceedingly dimensional and non-stationary EEG signal. The wavelet changes having the property of time and also frequency domain numerous specialists chip away at EEG signal arrangement to foresee mental condition of individual. There are numerous machines learning algorithm for order of EEG signals. A few algorithms have been researched for reason or expanding the classification rate and accuracy

1.1 Electroencephalograph (EEG)

Electroencephalograph (EEG) is a non-invasive method which is helpful for distinguishing brain issue. As Electroencephalograph isn't troublesome and complex to utilize this electroencephalograph strategy is valuable in numerous applications like neuro-marketing, social cooperation, human variables and so forth. In any case, proposed work depends on Brain Computer Interface and helpful in clinical analysis. In the technique of location of brain issue present or missing it is basic to understand and to think about the fundamental arrangement designs. In proposed work, performing investigation of EEG signals to distinguish Alzheimer Disease. Numerous frameworks utilize Fourier Transform to take electroencephalograph signal in frequency domain as it were. Likewise, it is helpful to extricate highlights of signals.

Electroencephalogram (EEG) remains a brain signal processing technique that let picking up the energetic about the troublesome inner machines of the brain and unpredictable brain waves guarantees to be associated through specific brain disorders. The examination of brain waves demonstrates a noteworthy part in the finding of divergent brain disorders. MATLAB conveys an agreeable graphical user interface (GUI) letting clients to transparently and intelligently course their high thickness EEG dataset then extra brain signal data unique techniques like independent component analysis (ICA) and time/frequency analysis (TFA). Notwithstanding settled averaging strategies The examination work settle show different brain signals through associating, analyzing then reproducing datasets which is before hampered in the MATLAB programming to rehearse the EEG signals The human brain is one of the best composite structures in the creation. Right now numerous advancements are to record brain waves then electroencephalography (EEG) stays one of them. This remaining parts one of the brain signals processing technique that licenses accomplishment the mindful of the troublesome internal components of the brain and anomalous brain waves have appeared to be related with specific brain disorders.

In like manner, EEG signals connote the blend of waveforms, and remain normally grouped by their:

- Frequency (speed)
- Amplitude (power)
- Wave morphology (shape)
- Spatial circulation (geology)
- Reactivity (social state)

1.2 Brain signal processing

Signal processing is the empowering innovation for the generation, transformation, and understanding of data. At various phases of time our brain responds in an unexpected way. These brain signals utilized for different purposes so it is conceivable to examine the functionalities of brain legitimately by creating, changing and deciphering the gathered signal This procedure is known as brain signal processing.

The examination of brain waves assumes an essential job in determination of various brain disorders. Brain is comprised of billions of brain cells called neurons, which use power to speak with one another. The combination of a great many neurons sending signals on the double delivers a colossal measure of electrical activity in the brain, which can be identified utilizing delicate restorative gear, for example, an EEG which estimates electrical dimensions over zones of the scalp.

The electroencephalogram (EEG) recording is a helpful apparatus for concentrate the practical condition of the brain and for diagnosing certain disorders. The mix of electrical movement of the brain is regularly called a Brainwave pattern as a result of its wave-like nature.

1.3 Overall Detail of the System

The different highlights .Such as EEG montages - Montage implies the situation of the anodes is examined in this paper. The EEG can be observed with either a bipolar montage or a referential one. Bipolar implies that just to utilize two terminals on the scalp on every one of the sides and for reference anode for one side of the brain. The referential montage implies just having a typical reference anode in both the side of the brain. In this part we will indicate how brainwaves will differ as per the arrangement of electrodes.

➢ **EEG Channels**

The electrical movement of the brain is directed by wires from the scalp and electrodes are set by utilizing EEG machine. The contributions to the hardware EEG machine are then used to create a montage, which is an explicit course of action or exhibit of electrodes that show the EEG signal. In our undertaking we are managing essentially 20 channels of the brain since EEG hardware machine manages just till 20 channels of the brain.

➢ **Sensitivity**

Amplitude is the magnitude of the EEG action which is estimated in micro-volts (µV). It is controlled by estimating the brainwave diversion in millimeters (mm) at determined machine sensitivity (µV/mm). We have broke down the brainwaves as indicated by the gathered affectability estimations of the patients, EEG strategies are performed at an affectability rate of 7 µV/mm, with the end goal that a 10 mm redirection of waves implies amplitude of 70 µV.

➢ **Filtering**

Low-pass separating is utilized for smoothening the brainwaves and high-pass sifting is utilized for honing the brainwaves so as to make the signals all the more unmistakably to the watcher. As per the patients EEG hardware information gathered we have appeared in our task two kinds of separating technique choices, for example, – Low – pass frequency channels and High-pass frequency channels.

➢ **Frequency Sweeping**

Sweeping fundamentally lessens the multifaceted nature towards breaking down the brainwaves for EEG signal processing. Finally we will sweep the signal to decrease the multifaceted nature for the perception of the brainwaves. In this we will utilize linear frequency sweeping and it has a settled rate of frequency per time. Fundamentally it is estimated as Hz/sec.

2. Review of literature

Shooshtari et al (2006) - detailed that ordinarily for a clearer investigation it is important to dispose of the reasons for ancient rarities previously EEG estimation methods and also to decrease the rest of the relic signals by applying suitable channels. the focal brain parts, which stay progressively enlightened in relations of what data can be resultant after a bit of them

Subasi (2006) - detailed that Electrophysiological chronicles are considered as a dependable technique for surveying an individual's alertness. EEG signals were disintegrated into the frequency sub bands utilizing wavelet change and statistical parameters are extricated from the sub bands to speak to the dissemination of wavelet coefficients. At that point these statistical parameters were utilized as contribution to a counterfeit neural system to distinguish the alertness of the individual, for example, alert, drowsy and sleep. The goal is to stay away from potential mishaps generated by drives.

Srinivasan et al (2007) - revealed that the EEG traditionally examines each signal of the brain and dependent on current information brain signal, the digital signal processing is readied. The changeover stays till a pre-characterized EEG brain signal is contacted. The 28 last EEG signals that are come to choose what the brain disease is this is actually that the works do with the digital signal information record containing the EEG brain signals. We examine separately signal stake at that point made on the structure so far filtered and the current brain signal stake. The equivalent extent is gotten ready for the various pre-prepared protracted brain signals. Vulnerability an equivalent is observed to be sufficiently commendable, and then the acknowledgment is readied.

Manisha Chandani (2018) - Electroencephalogram (EEG) involves profitable subtleties identified with the distinctive physiological condition of the brain. In this paper, a structure is offered for identifying the epileptic seizures from EEG information recorded from typical subjects and epileptic patients. This system depends on a discrete wavelet transform (DWT) investigation of EEG signals utilizing linear and nonlinear classifiers. The execution of the diverse blends of two-class epilepsy location is considered utilizing Support Vector Machine (SVM) and neural system examination (NNA)

classifiers for the got statistical highlights from DWT. In this new methodology initially parse EEG signals to sub-bands in various classifications with the assistance of discrete wavelet transform (DWT) and then we infer statistical highlights, for example, Mean, Median, Standard Deviation, Kurtosis, Entropy, Skewness for each subband. These highlights, removed from subtleties and estimate coefficients of DWT sub-bands, are utilized as contribution to Principal Component Analysis (PCA).

3. Objectives of the study

1. To describe the EEG brain signal and various reviews based on it.
2. To define the overall system of the brain signal using sensitivity, filtering, EEG channels and frequency sweeping
3. To analyze the EEG signal processing technique using MATLAB
4. To experiment the EEG Signal Using Support Vector Machine for Alzheimer Disease
5. To evaluate the performance of classifier

4. Research methodology

4.1 EEG signal processing technique using MATLAB

- **Experimental procedure**
  - ✓ Different EEG signals are gathered as a type of dataset in the MATLAB;
  - ✓ Load the information into the software for brain signal processing;
  - ✓ Process the datasets;
  - ✓ Extract and select the specific features for various EEG datasets;
  - ✓ Classify the datasets as per the item highlights, for example, montages, channels, affectability, separating and sweeping
  - ✓ Check the variety of various brain waves dependent on their qualities,
  - ✓ Select the explicit montages, for example, – left side montage, right side montage or both side montages to check change in various brainwaves.
  - ✓ Then select the channels out of 20 channels for review increasingly definite waveforms.
  - ✓ By settling the affectability estimations of the gathered EEG information we will set separating scope of the signals for high frequency (50 - 70 Hz) or for low frequency (0.1 - 1 Hz); we will change the benefits of sweeping additionally as indicated by the information.
  - ✓ At last we will get the last EEG signal in waveform.

4.2 Data collection

i. **Right Montages**: Patient data has collected by electrodes are put in the right half of the brain, so it will demonstrate the waves identified with the right half of the brain dependent on time-frequency examination.

ii. **Left Montages:** Patient data has collected by electrodes are set in the left half of the brain, so it will demonstrate the waves identified with the right half of the brain dependent on time-frequency investigation.

iii. **Both Side Montages:** Patient data has collected by electrodes are put in the left and right half of the brain, so it will demonstrate the waves identified with the right half of the brain dependent on time-frequency investigation.

- **Implementation**

Figure 1 Welcome page

This is the welcome page of our GUI which prompts the sort of choice of the following segment by choosing the 'click here' button.

Figure 2 Sample results and other records page

This page is loaded in the wake of choosing the 'click here' button of the main page. In this page two choices are referenced. For checking the leaving patient's records select the main alternative and for determination of various brainwaves forms select the second choice.

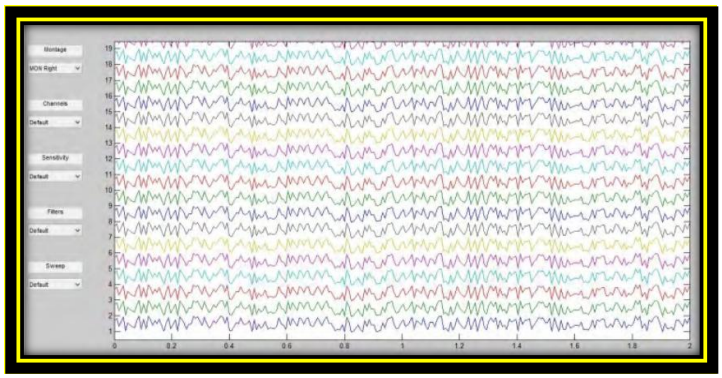

Figure 3 Brainwaves pattern

The above is the outcome acquired by the changes made in montage module just by choosing right montage of the brain and diverse frequencies of brainwaves can be effectively decided.

4.3 EEG Signal Using Support Vector Machine for Alzheimer Disease

- **Data Acquisition -** Silver/Silver chloride (Ag/AgCl) electrodes are utilized to record brain exercises

utilizing EEG top. By associating these electrodes on the scalp, electrical brain exercises are recorded.

- **Signal Processing -** After chronicle the EEG signals which contain the commotion and ancient rarity. So that there is have to clean them. In this progression, noise and artifacts are evacuated i.e. clean these EEG signal.
- **Feature Extraction** - In this progression, extricate EEG signal's features as qualities utilizing wavelet transform
- **Classification** - In this progression, important properties of EEG signals are ordered to distinguish mental state (typical or abnormal).As there are numerous classification algorithms in machine adapting yet here we talk about the SVM classifier.
- **Detection of brain issue** - In location step, frequency >30Hz that individual is "normal". In the event that frequency

✓ **Feature Extraction:** In Feature Extraction, Wavelet transform is utilized to extract features of EEG signals. To appear or speak to EEG signals in the time domain is the fairly tedious errand. While Wavelet Transform is utilized for feature extraction of signal and to appear or speak to it in time and also frequency domain. The wavelet transform is the general mathematical technique for EEG signal processing in much Brain Computer Interface application. The principle function of the Wavelet transform is go about as curio evacuation which partitions the signals into frequency band according to necessities. Wavelet transform comprising of two functions wavelet function and scaling function which appears beneath

$$f(t) = \sum 2^{\frac{j}{2}} c(k).\Phi(2^j t - k) + 2^{\frac{j}{2}} d(k).\Psi(2^j t - k) \quad (1)$$

Where Φ (2^jt – k) and Ψ (2^jt – k) are scaling and wavelet function. In above condition, the primary term demonstrates estimate f (t) in light of index j (0) which is the index of scale. The second term includes more detail utilizing the smoother scale. Scaling and Wavelet coefficients are determined as underneath:

$$c^j(k) = \int f(t).\Phi(2^j t - k).dt \quad (2)$$

$$d^j(k) = \int f(t).\Psi(2^j t - k).dt \quad (3)$$

Where φ (t) & ψ (t) are separately, the scaling (approximation) and wavelet (detail) coefficient in the DWT The frequency pivot is isolated into interims towards the lower frequencies while the bandwidth-length diminishes exponentially. The arrangement of wavelet characterized an exceptional channel bank which can be utilized for signal part investigation and coming about wavelet transform coefficient can be additionally connected signal features for its classification.

✓ **Classification: -** As features extracted from the signal, at that point arrange signals as indicated by frequency bands and identify the normal and abnormal individual. Classification can be performed by utilizing machine learning classification algorithms.

✓ **Support Vector Machine**: - The hyper-plane is utilized by Support Vector Machine to distinguish or anticipate the class. As SVM chooses hyper-plane which one maximizes the margins i.e. separate from nearest prepared information? This classifier has been connected with progress to BCI issues. It can make nonlinear choice limits by utilizing piece type. It comprises in verifiably mapping the information to another space, for the most part of a lot higher dimensionality, utilizing kernel function K(x,y).The bit commonly utilized in BCI examine is Radial Basis Function bit.

$$k(x,y) = \exp\left(-\frac{||x-y||^2}{2\sigma^2}\right) \quad (4)$$

5. Data analysis and result

5.1 EEG signal processing technique using MATLAB

Table 1 Different Patient's Data of Montages

5.6014109e-001	6.9510397e-004	2.5127513e-001	4.3194860e-001	4.3065287e-001
8.8967125e-001	2.3849760e-002	1.2872483e-001	7.4064020e-001	3.9102021e-001

Table 2 different patient's data of brain channels

4.8976380e-001	1.9324533e-001	8.9589157e-001	9.9089650e-002
3.4878481e-001	4.5134058e-001	2.4090500e-001	7.1504501e-001

Table 3 different patient's data of brain sensitivity

5.7083843e-001	9.9685021e-001	5.5354157e-001	5.1545845e-001
5.7161573e-001	1.2218915e-001	6.7116623e-001	5.9958555e-001

Table 4 different patient's data of signal filtering

1.5194708e-001	3.9710884e-001	3.7472247e-001	1.3111471e-001
8.8665840e-002	8.3825559e-001	5.8471862e-001	9.4810874e-001

Table 5 different patient's data of signal sweeping

4.3390472e-002	6.9162515e-001	9.7898547e-001	2.8326790e-001
2.6296403e-001	6.8056620e-001	2.3365315e-001	4.5642536e-001

The general research work comprises of five modules which were finished in their particular time span. The implementation and functionalities methods appeared an overwhelming undertaking, however were effectively finished to

accomplish the ideal goal. After the fruitful execution of test outcomes, this examination work can be appropriate for observing alertness, trance state and brain passing; testing drug impacts; exploring sleep disorders; investigating mental disorders; locating regions of harm following head damage, stroke and tumor and Monitoring the brain advancement.

5.2 EEG Signal Using Support Vector Machine for Alzheimer Disease

In this work, we caught EEG signals of typical and Alzheimer's disease's individual so as to distinguish Alzheimer Disease. EEG signal chronicle was partitioned into sub frequency band, for example, alpha, beta, delta, theta utilizing Wavelet Transform. At that point this frequency sub-band group by utilizing Support Vector Machine

Dataset: - The dataset of EEG signal utilized for this framework is collected from UCI archive which contains typical and AD individual, by utilizing 8 channels EEG caps. That implies EEG signal recorded utilizing 8 channels. This dataset contains 8 channels information for every individual and each channel comprises of 256 samples with its amplitude.

5.3 Performance evaluation of classifiers

Table 6 Performance of classifier

Sample	Accuracy
22	86%
32	91%
33	91.552%
35	91.896%

Table 7 Evaluation of classifier

No. of trained Signal	No. of tested Signal	Correctly classified	Misclassified	Accuracy
35	35	32	3	91.045%

It very well may be effectively spoken to Support Vector Machine accomplish the most astounding accuracy (91.04%).Support Vector Machine gives adjusted classification.

Table 8 Classifier Performance

Classifier	Accuracy
SLP	84%
GENTREE	87.20
MLP	91
Naivebayes	86%
SVM	91.04

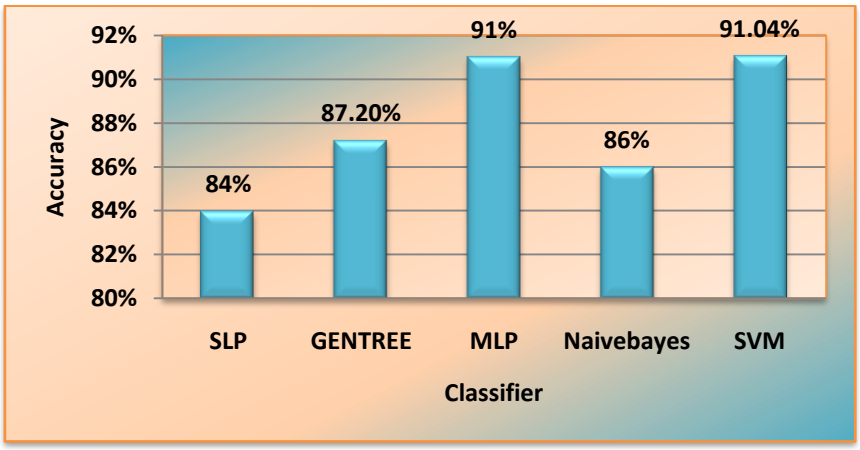

Figure 4 Classifier Performance

6. Conclusion

The previously mentioned task has unmistakably demonstrated the ideas about open source modules, running under the platform MATLAB condition and its capacity to process biophysical information by various path, for example, - utilizing straightforwardness of its command line language or utilizing the numerous MATLAB functions and the strategy identified with the investigation of the brain signal processing through MATLAB software tool stash. It has been depicted in detail the system in the demonstrating of EEG signals and knowledge brain signals recorded amid surgery. In Brain-Computer Interface, EEG is the noninvasive technique which will be valuable in clinical conclusion by recognizing dead brain cells and helpful for society. In the brain-computer interface, EEG is the basic and sensible technique for interfacing among brain and computer. EEG signals dependent on the frequency, the signal can be ordered into various bands of frequency. In the proposed strategy the Wavelet transform is utilized for the feature extraction, in light of the benefits of this on time and additionally frequency domain investigation. In proposed strategy, Alzheimer disease is recognized based on frequency bands by utilizing classification algorithm in machine learning

algorithm. We tried outcomes for recognition of Alzheimer Disease by utilizing Support Vector Machine. In this proposed work, 8 channel EEG signal framework is utilized for the brain-computer interface. This procedure can turn out to be simple and progressively accurate if more channels framework is utilized e.g. 16 channels for examination and execution. Likewise, it tends to be performed by utilizing 4 channel EEG frameworks.

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