
Epileptic Seizure Detection & Classification using MATLAB

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Abstract

Epilepsy is that the tendency to possess seizures that begin within the brain. Basically brain takes electrical signals in use to pass messages between brain cells. If there is a discontinuity in signals, this may cause a seizure. Epilepsy is typically diagnosed once someone has had quite one seizure. These Seizures will have an effect on your feelings, awareness or movement. The manual recognition of given disorder by a medical specialist is pricey and time intense conjointly and there is also loss of precision for the reason of fatigue, computer based techniques etc. This work has projected a way that is very economical and offers correct results over EEG signals for encephalopathy. MATLAB is highly regarded and powerful tool for all-purpose system also commonly it is a broad purpose background for matrix based calculation and computation. The record of the electrical action of the brain from the scalp is referred to electro encephalogram. Electroencephalogram activity is sort of little, measured in micro volts with the main frequencies of interest up to or so 30 Hertz. Some parameters are used to classify EEG signal in Matlab. With the help of Matlab a program has been developed to visualize the situation of the signal whether or not it is healthy.

Keywords

Brain, EEG, Epilepsy, Matlab

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Introduction.

Epilepsy could be an ordinary social and medical disorder or cluster of disorders within distinctive characteristics^[1]. It is established that Epilepsy is typically outlined as an inclination to the repeated seizures, which means that epilepsy is very old and considered to be a social isolation disease in altogether civilization^[2]. This is often derived as so much back as medical records exist. In fact, epilepsy could be considered to be a disorder also that may occur altogether class species, most likely a lot of off times as brains became a lot of advanced. Epilepsy is as well equivalently dispersed round the world. There aren't any racial, geographical or people boundaries. It is also proved that it can happen in each sex, at any age irrespective of socioeconomic demography and in the least ages, particularly in infancy, youth and more and more in mature populations^[3].

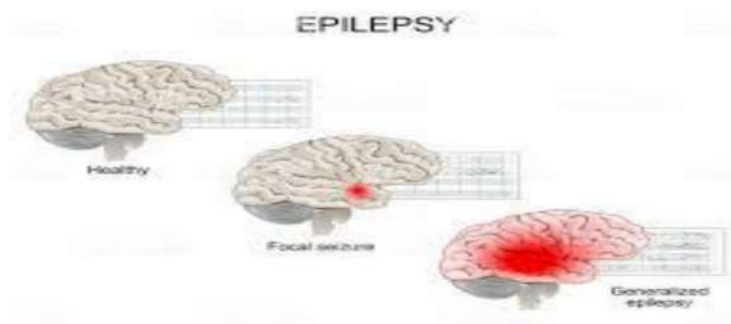


Figure 1. visual condition of brain during seizure.

Figure 1 shows the healthy brain, brain with focal seizure & brain with generalized seizure. Focal seizure is affecting a small portion of the brain and onset is in a single portion, while generalized seizure is affecting a large portion of brain whereas the seizure onset in both side of brain and spread fastly^[4].

Seizure types:

There are various commonly known kinds of seizures. The classification of seizures can be categorized as generalized & focal.

1. Focal seizures

These occur once seizure activity is restricted to a locality of 1 brain hemisphere. There is a focus, within the brain wherever the seizure begins. There focal seizures are of following types:

- A situation of retained awareness along with focal seizure.
- A situation of lack of awareness along with the focal seizure.

2. Generalized Seizures.

These seizures take place once there is extensive seizure movement within the left and right hemispheres of the brain. The generalized seizures are of following types:

- Clonic seizures.

- Tonic seizures.
- Myoclonic seizures.
- Absence seizures (formerly known as petit mal).

Diagnosis.

Accuracy of diagnosing is key. Identification is clinical and may be confirmed by knowledgeable expertly in encephalopathy. EEG might facilitate identification, however is actually required to classify seizure kind and provides a significant forecast. Most medicine studies so far have lacked inquiring facilities within the field, particularly in developing countries^[5]. finding out encephalopathy is beset with difficulties. correct identification and case ascertainment stay major issues, as a result of encephalopathy is just a signal of the many disparate actuating entities. assured identification or exclusion altogether cases of seizures is troublesome as a result of seizure sorts vary, uncommon behaviour and vacant spells might not be acknowledged like seizures, there could also be no concomitant medical specialty signs associated if an watcher account is missing, the identification might not be created in the slightest degree^[6].

ELECTROENCEPHALOGRAPH

One of the foremost versatile brain imaging techniques is Electroencephalography. In short: graphical record. Literally, electro-encephalo-graphy suggests that writing of the electrical activity of the brain^[7]. Electroencephalography records electrical activity and brain waves exploitation electrodes fixed over the scalp. For the measurement of electrical movement from brain is beneficial as a result of it reflects however the various totally different neurons within the brain network communicate with one another via electrical impulses^[8]. EEG are the awfully high complicated signal that contains immense data in relevance the person brain practicality and each of the medicine diseases. speech act of convulsion by optical scan of electroencephalogram signal may be a very long time taking method and should be mistaken, principally for protracted recordings. Here tends to measure exploitation this technique for electroencephalogram signal categorization for higher product correctness with less length of your time^[9].

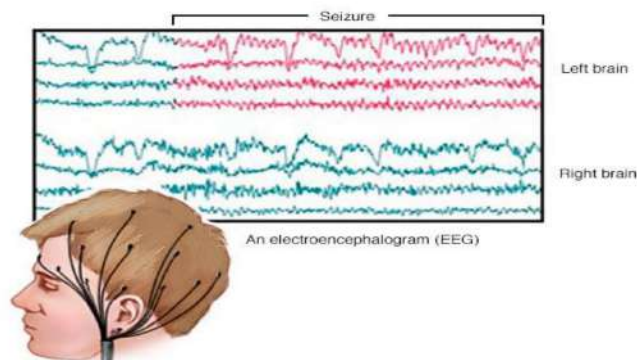


Figure 2. Electroencephalogram

Electroencephalogram facts.

A graph is sometimes described in terms of transients and swinging movement. These of the revenant activities square measure splinted in bands with the help of frequency^[10]. For a number of degrees, these of the frequency bands square measure the substance of language. These of the designations appear due to isosceles actions in some of the frequencies vary were applauded to own associate forward transmission over the scalp. The figure 2 shows that the EEG recording of the electrical signals of the brain where we can see the difference between affected EEG signal and non affected EEG signal^[11]. The Frequency bands square measure typically drawn out victimization spectral ways square measure enforced in graph computer code like EEGLAB. Mostly associate analytical signal recognized within the scalp graph falls within the vary between 1–20 cycle per second^[12]. The waveforms is additionally divided in many bandwidths, that square measure called alpha, beta, gamma, theta and delta to involve the majority of the graph employed in logical study. Some description of further frequency bands-

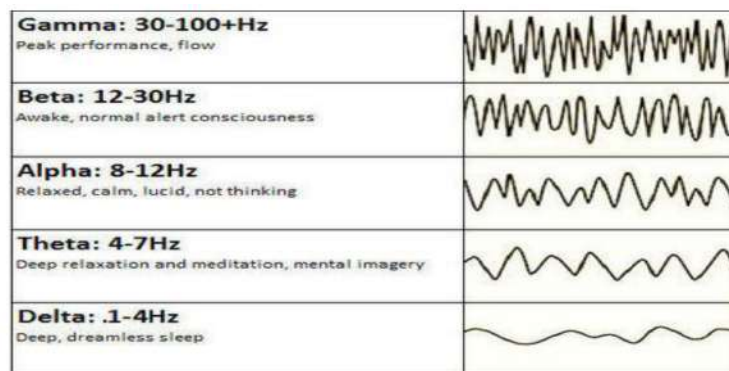


Figure 3. frequency bands of EEG

- ▶ **Delta waves-** Frequencies vary up to four rates are called as delta. That is slowest waves within the highest amplitudes. According to studies:-
 - Sleep and sleep disorders- Bound medical specialty diseases like Parkinson's, dementedness or dementia praecox area unit usually among sleep disorders. Observance graphical record throughout sleep will offer insights into the depth of sleep and potential risks related to sleep disorders^[13].
 - Alcoholism and sleep- Alcohol has robust facet effects on sleep. Significant drinking decreases slow wave sleep and thus delta frequencies necessary for memory consolidation.
- ▶ **Theta waves-** Frequencies falling within the vary four cycles/second to seven cycles/second are called as theta. Theta is determined normally in rising youngsters. These waves may be seen in slowness in rising youngsters and youths. It would be determined in study. According to studies:-
 - Brain observation in operational environments- The theta band activity is mostly monitored in vigilance and observation tasks, for instance in traffic or vessel management, vehicle steering or obstacle dodging^[14].

- **Alpha waves-** Frequencies falling within the vary seven Hz to thirteen Hz are called as Alpha. Hans Berger coined ‘alpha waves’ once he ascertained the primary activity of electroencephalogram signal. According to studies:-
 - Meditation- Basically alpha reflects sensory inhibition, relaxation, meditation studies compare alpha levels of knowledgeable about and novice meditators^[15].
 - Biofeedback training- The alpha band power is monitored for trace the relief level of a respondent. Hyperbolic levels of alpha power are taken as deeper relaxation. That is often significantly helpful in rehabilitation eventualities or for clinical populations, as an example youngsters laid low with minimal brain dysfunction.
- **Beta waves-** The frequency spectrum from fourteen rates to thirty rates are called as Beta waves. It is discovered typically on one and different aspect insure division and conjointly. This is most able to be seen directly. According to studies:-
 - Motor control- Studies on motor control sometimes need the respondent to succeed in towards or grasp objects that area unit either physically aware or simulated on screen or virtually^[16].
 - Stimulant-induced alertness- Beta frequencies are usually monitored throughout stimulation with extreme light-weight / sound stimuli and psychostimulants modifying levels of alertness and basic cognitive process processing.
- **Gamma waves-** Gamma band (above twenty five Hz) At the instant, gamma frequencies are the black holes of graph analysis because it remains unclear wherever specifically within the brain gamma frequencies are generated and what these oscillations shows. According to studies:-
 - Microsaccade studies:- In this high-speed analysis eye trailing is combined with high-speed electroencephalogram signals to research however delicate eye movements have an effect on EEG gamma frequencies. Stimuli area unit largely screen-based, with fixation targets showing on totally different screen positions^[17].

Data attainment from the subjects.

A dataset is essentially a bunch of knowledge. Graphical record segments utilized in this work area unit which are collect by WWW.physionet.org. There is a complete of 150 graphical record signals during this dataset. Information may be a single graphical record signal with length of ten seconds. During which we have got a hundred signals of epileptic subjects and 50 signals of healthy subjects.

Parameters used:-

1. Kurtosis
2. Form factor

Kurtosis: Kurtosis is a calculation for the degree of peakedness in the variable distribution.

$$\text{Kurt}[x] = \frac{[(X - \mu)^3]}{[(X - \mu)^2]^2} \quad (1)$$

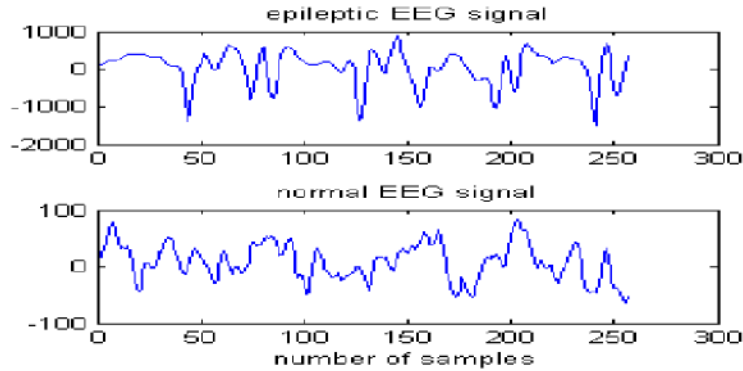


Figure 4. Sample epileptic and normal EEG signal

Form factor: In physics or electrical the form factor of electricity undulation (signal) is that the magnitude relation of the RMS (root mean square) worth to the average value. (mathematical mean of absolute values)

$$\text{Form factor} = \frac{rms}{avg} \quad (2)$$

Methodology:

This methodology constitutes of the subsequent major stages, which are as follows:

1. Data attainment.
2. Parameter study
3. Classification with the help of MATLAB.

In the following analysis, several parameters have been used for analyzing EEG signals; those signals were both healthy and non healthy signal. The following parameters which have been used are kurtosis and form factor. A program has been developed in Matlab to ascertain the state of signal whether or not this is healthy or non healthy. Foremost verify the kurtosis & form factor of each signal which are reaching to classify. Then some criteria are mounted by reassuring the average of various healthy signals for every parameter to ensure whether the signal is healthy or non healthy. These criteria are assured once the analysis of various healthy EEG signals. This method conjointly indicates the share of unwellness in a very unhealthy subject; this also shows the percentage error of unhealthy subjects on the basis of kurtosis.

Flow chart-

Flowchart of the proposed system has been shown in figure 4 ahead, showing various functional aspects.

Flow chart explanation-

Firstly the proper epileptic subjects data has been collected and checked in Matlab to analyze the waveforms correctly then find out the kurtosis and Form factor of the following given signal which is

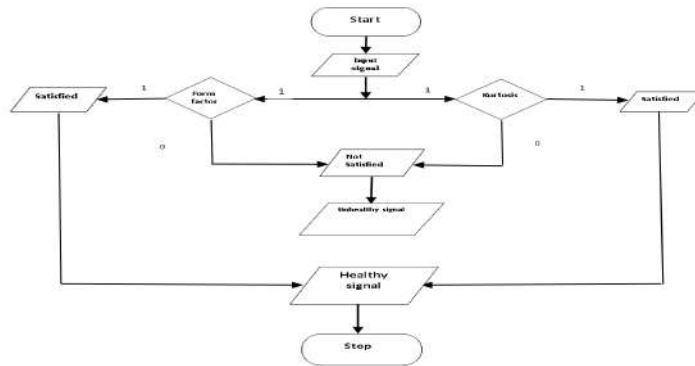


Figure 5. Flowchart of Signal Flow for Illness Identification

included in the algorithm. The program which is developed will run over the fixed criteria. This has been fixed after analyzing the average of various healthy subjects.

After running the program it will seen that if the given signal parameters are coming in that criteria then it will give 1 else 0 which will decide whether the signal is healthy or unhealthy. And the deviation between fixed criteria and parameters results of unhealthy subject will decide the percentage of illness in unhealthy subjects.

Condition for the results.

Table 1. conditions

Stages	Kurtosis	Form Factor	Results
Stage 1	Satisfied	Satisfied	Healthy signal
Stage 2	Not satisfied	Satisfied	Unhealthy signal
Stage 3	Satisfied	Not satisfied	Unhealthy signal
Stage 4	Not satisfied	Not Satisfied	Unhealthy signal

Table 2: shows the stages, parameters, conditions and result respectively. It can be seen that there is 4 types of signals given whose parameters calculation results are absolutely different.

- In the condition 1; both parameters are coming in the selected criteria hence these are showing the result; satisfied. Means when all the parameters will be satisfied, the signal will be declared as healthy signal.
- In the condition 2; both parameters are not coming in the selected criteria hence these are showing the result; not satisfied and satisfied. Here the entire parameters signal are not satisfied, hence the signal is declared as unhealthy signal.
- In the condition 3; both parameters are not coming in the selected criteria hence these are showing the result; satisfied and not satisfied. Here the entire parameters signal are not satisfied, hence the signal is declared as unhealthy signal.

- ## Results.

[illegible]

Figure 6. MATLAB Editor output

As this image shows, the condition of signal has found. Form factor characteristic is not satisfied; because the parameter does not exist in selected criteria. Kurtosis characteristic is also not satisfied as well. Hence the given signal is declared as unhealthy signal. With the help of kurtosis characteristics the percentage of error is also justified.

All the conclusions are supported the parameters delineated within the previous headings. We have got ascertained one hundred healthy signals and fifty unhealthy signals and it absolutely was seen that every healthy signals have close relation in their kurtosis & form factor, whereas the unhealthy signals have immense variations within the values of given parameters. Visual classification between a healthy signal and unhealthy signal depends on human issue which cannot have precise exactitude rather classification through this this technique generates higher classification that is a smaller amount keen about human issue. With the help of this technique convulsion (epileptic seizure) can be detected at its early stages.

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