Classification of Human Brain Signal for Diagnosis of Stroke Disease Using Artificial Neural Network

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1. ABSTRACT

The ravaging effect of stroke diseases in Nigeria is growing at an alarming rate. The masses are paying less attention to diagnosis and treatment. Neurologists lack efficient state of the art tools that will aid diagnosis of stroke. Electroencephalograph (EEG) signal records could improve the understanding of the mechanisms of stroke. Artificial neural network (ANN) model was used in classifying Electroencephalograph (EEG) signal report generated by the brain for the diagnosis of stroke. The result obtained agrees with expert's view of the patient's condition.

CCS concepts

• **Computing methodologies → Machine learning → Machine learning approaches → Neural network**

Keywords

Artificial Neural Network; Brain - Computer Interface; Brain Signals; Diagnosis; Electroencephalogram; Signal Classification.

2. PROBLEM STATEMENT

This research is motivated by the following problems.

i. Increasing cases of stroke patients in Nigeria.
ii. Inadequate Equipment for effective diagnosis of stroke.
iii. Lack of good user interface platform for sole purpose of reporting outcome of EEG signal.
iv. Inadequacy of qualified neurologists to handle the increasing number of stroke patients.
v. Inability of most patients to speak to experts so as to ascertain the level of consciousness.

3. RELEVANCE OF STUDY

The benefits of this work are:

i. The analysis of the result gotten from mining the EEG data will lead to sensitization of programmes for causes, prevention and cure of stroke.
ii. It will aid decision making and is going to lessen pressure on the medical experts.
iii. Postgraduate students in computer science and neuroscience will find this research to be a fertile land for further researches.
iv. Nigeria as a country will find the use of EEG and the ability of ANN to classify its reports for correct diagnosis of stroke as an eye opener.

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4. BACKGROUND AND RELATED WORKS

The manner stroke patients are being handled by medical practitioners most times is disturbing. Due to lack of state of the art tools, they most often recommend expensive scans such as CAT, MRI, and PET that are costly to the sufferers. Majority of the patients cannot afford the cost of those scans. EEG signal records can help to improve the understanding of the stroke mechanisms. Functional behavior of the brain based on the EEG signal is an important component in the diagnosis of stroke. EEG is electrical representation and measurement of the electrical activity of the brain [1]. The detectors are worn on the scalp to observe signals; these signals portray the brain movement. The aim of this paper is to use an Artificial Neural Network (ANN) model in classifying Electroencephalograph (EEG) signal report generated by the brain for the diagnosis of stroke. Objectives are to: (i) Survey the awareness and usage of EEG signals for diagnosis of stroke. (ii)Capture EEG signals (iii) Create ANN for classifying the brain signals. (iv) Design software for interpretation of EEG outcome.

Researchers predict stroke disease by comparing the performance of predictive data mining. Data was collected from patients' dataset in hospital about stroke diseases symptoms. Three classification algorithms Decision Tree, Naive Bayes and ANN were used. Observation shows that ANN performance is having more accuracy than decision tree and naïve Bayes' models [2].

A work on ANN in diagnosing thyroid disease was carried out. The purpose is to identify computer technology with high accuracy for diagnosing thyroid disease. Multi-layer Perceptron (MLP) ANN algorithm was used for classification. Result indicated accuracy level of 98.6% performance optimization [3].

Research was also carried on classifying EEG signals for detecting Parkinson disease. Focus was on how to classify EEG signals in normal and abnormal person. Dataset of 10 subjects were used. Two classifiers, Support Vector Machine (SVM) and MLP were used. The result was promising [4].

5. RESEARCH METHODOLOGY

Multilayer Perceptron (MLP) classifier algorithm was used. One stroke patient and one control subject participated. EEG machine captured signals at scalp sites Left Front Parietal (FP1), Right Front Parietal (FP2), Left Front Lobe (F3), Right Front Lobe (F4),

Left Center Lobe (C3), Right Center Lobe (C4), Left Parietal Lobe (P3), Right Parietal Lobe (P4), Left Occipital Lobe (O1), Right Occipital Lobe (O2), Left Frontal Lobe (F7), Right Frontal Lobe (F8), Left Temporal Lobe (T3), Right Temporal Lobe (T4), Mid Left Temporal Lobe (T5), Mid Right Temporal (T6), Center (C) and SPO2 based on international 10/20 system.

Procedure are (i) Set up the equipment: electrodes ➔ jack box ➔ amplifier ➔ BCI machine ➔ computer system (ii)Radiographer mark scalp area to place electrodes (iii)Rub scalp area with Methylated Spirit (iv) Electrodes fix or wear EEG cap (v) Subject is laid on a bed/sat in comfortable chair [5].

Figure 16 below illustrates the major component stages of the proposed system in detail.

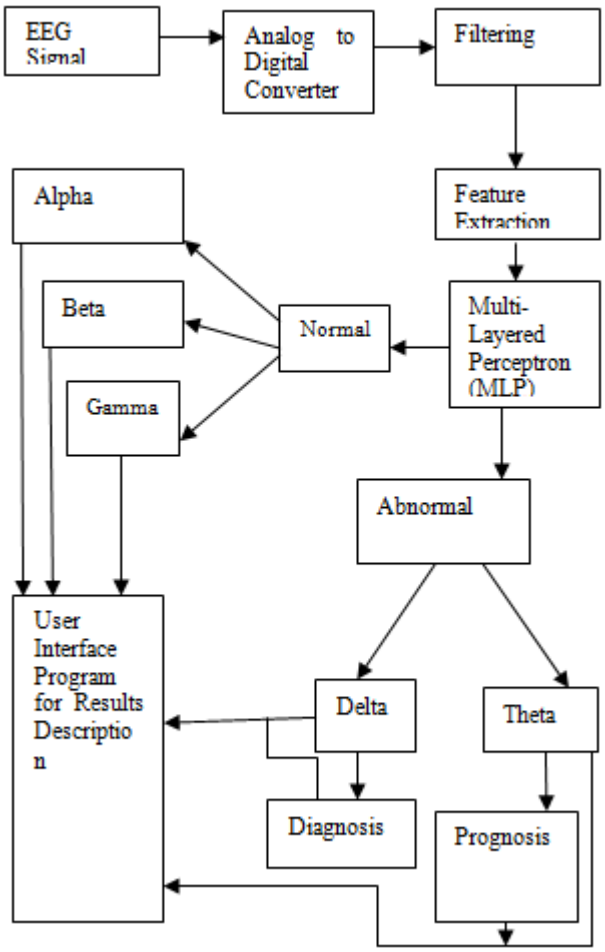

Figure 1. Human Brain Signal Classification for Diagnosis of Stroke Diseases

The EEG signals captured from the stroke patient's brain are first passed through Analog to Digital Converter. The digitized signals are filtered to remove artefacts. Feature extraction is used to obtain the needed signals for further analysis/classification. EEG waves can be delta, theta, alpha, beta and gamma [6]. Depending on the dominant wave observed, the signals may be adjudge to normal or abnormal. Alpha, Beta and Gamma waves in awaked adult indicates normalcy. Observance of Delta and Theta under the same condition implies abnormal case.

See figure 2 for the algorithm deployed in the diagnosis of stroke disease anchored on EEG signals captured. The algorithm creates, train and generate MLP network structure [7].

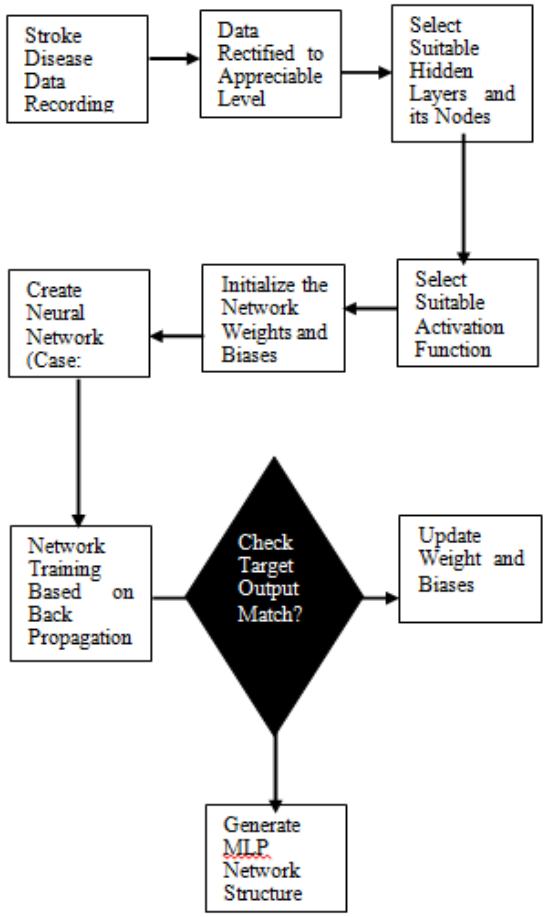

Figure 2: Algorithm for Diagnosis of Stroke Diseases (case: MLP)

6. RESULT

The outcomes of this research are itemized below:

(i)The survey conducted suggested need for creating more awareness on the ravaging effect of stroke diseases and on the use of EEG in aiding diagnosis of stroke.

(ii)EEG signals were successfully captured from both stroke patient and control subject.

(iii) ANN was created and trained using MATLAB 2013a

(iv) Captured Signals were classified into distinct bands of delta, theta, alpha, beta and gamma. (v)EEG recordings were interpreted using VB.NET IDE (see figure 3).

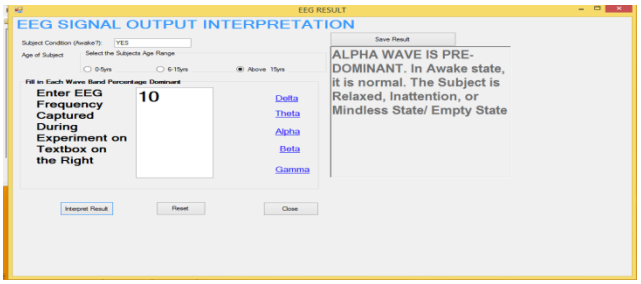

Figure 3: Interpretation of EEG Recording using VB.NET IDE

Also figure 4 demonstrates the classification of EEG result in MATLAB environment.

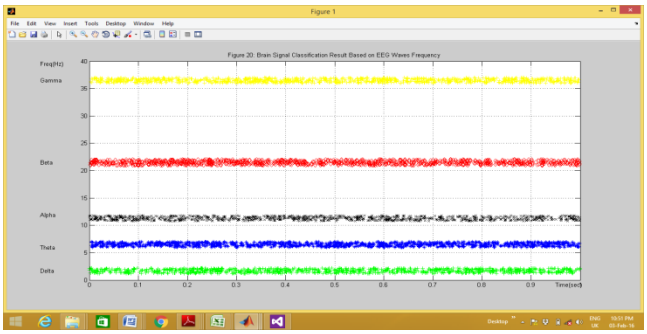

Figure 4: Classification of EEG Signals into Five Distinct Frequency Waves

7. EVALUATION PLAN

Brain Hub Research Team was established in Ebonyi State University to nurture and evaluate the success of this project in the future. It is team made up of the principal researcher (computer scientist), System analyst, Neurologist, Computer Engineer, and Radiographer. A publication in international reputable journals at a rate of two per year is our expected goal.

8. EXPECTED CONTRIBUTION TO KNOWLEDGE

(i) Survey will aid stroke diagnosis and help to raise the awareness level of the ravaging effect of stroke in Nigeria.

(ii) The software developed will support and further describes the outcome of EEG experiment to those with little knowledge of radiography.

(iii) This is the first time someone will be using ANN with EEG signal as a data to aid diagnosis of stroke ailment to best of our knowledge.

9. REFLECTIONS

There is a need to capture EEG signals from more patients to collaborate our results. Also, an innovative EEG based technology (hardware) should be developed with sole aim of diagnosing stroke diseases. This will help to raise the acceptance rate of the EEG technology among the medical practitioners.

10. REFERENCES

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