TOWARDS ENCOURAGING THE ATTITUDINAL BEHAVIOUR OF NEUROLOGISTS DURING DIAGNOSIS OF STROKE DISEASE: EEG PERSPECTIVE

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Abstract
The manner and approach our medical practitioners in developing countries such as Nigeria attend to their patients leaves much to be desired. Advanced countries have a better approach when it comes to handling sick people. Neurological ailments like stroke are the worst hit because most of the patients found themselves in situation where they cannot properly describe the nature and history of the disease that is affecting. This paper is providing a new technique that requires the medical practitioners to adopt a computer technology to an extent of its relevance to diagnose and treat stroke disease in Nigeria. This approach is cheap, simple and safer especially in those areas where state of the art machines are not readily available during the acute period of the brain attack.

Keywords: Artificial Neural Network, Attitudinal Behavior, Brain - Computer Interface, Diagnosis, Electroencephalogram, EEG Recording, and Signal Classification.

1 INTRODUCTION

This work is an ongoing research that was geared towards establishing the fact that the electroencephalogram (EEG) signals captured from the human brain can form the basis for diagnosis and treatment of stroke disease. Several new cases of stroke attack are reported in our hospitals and homes especially in developing countries like Nigeria on daily basis. Because it is viewed as a non communicable disease the masses and government cares less about eradicating this dreadful disease. One fact they are forgetting is that stroke affects both the rich and the poor; the young and the old. The economic meltdown in these developing worlds is a contributing factor to the increasing cases as witness today.

The people at the receiving end are the stroke specialists who are at all times engulfed by the overpowering number of stroke patients. There is a need to look for way out in the name of information technology driven solution that can augment the neurologists when attending to patients. Furthermore, the cost of other methods of measuring the brain activity such as Computerized Axial Tomography (CAT), Magnetic Resonance Imaging (MRI), is too expensive for everyone to afford. They are also not easy to access and become a serious problem when the patient's condition has deteriorated and he or she is expected to travel a long distance for any of these scans.

Those suffering from neurological diseases can be vastly paralyzed, but they still have some cognitive abilities. Most efficient way to communicate with their environment is via brain activities [1] (Priyan, Uma, & Prabhu, 2015). Development of technological tools for the disabled will significantly transform their life, because they will carry out their normal daily chores more independently and help in sustaining and including them in the society [2] (Thierry, Matthieu, Guy, & Thierry, 2014).

This study was used to prove that electroencephalography recordings captured from a stroke patient can provide useful information on the state of the alertness of the patient's brain, which will in turn aid diagnosis and treatment. The recording is made possible by the use of EEG machine. This EEG machine is moveable, simple and the cost is cheaper considering the expensive nature of other brain scanning technologies. EEG provides functional [3](Rozado, Duenser, & Howel, 2015) information on the status of the different parts of the brain. It is also a veritable instrument for monitoring oxygen circulation in the blood and heart rhythm. EEG is one of those technologies that exploited the advantages of brain-computer interface, which aim is to supply human subjects with direct control over computer applications without passing the usual muscular pathways [4] (Llera, Gomez, & Kappen, 2014).

This paper is meant to address: (i) Scarce Equipment for efficient diagnosis of stroke diseases (ii) The difficulty of most stroke patients communicating to the neurologists in order to ascertain the level of their consciousness (iii) The challenge of neurologists handling the rising cases of stroke patients especially in developing country such as Nigeria.

The main goal is to prove the relevance of EEG recordings as a handheld tool for diagnosis of stroke disease based on the frequency generation in form of signals coming out of the patient's brain.

2 RELAVANCE OF EEG IN TREATMENT OF STROKE

Qiaquinto, Cobianchi, Macera, & Nolfe researched on the usefulness of capturing EEG signals in cases of people that suffered stroke attack. They were of the view that the EEG has been investigated in stroke patients with more emphasizes on the acute phase of the attack. The characteristics appear to differ with the clinical state after recovery. However, they supported that the EEG study in the acute stage could be valuable [5]. EEG can be helpful technology for sensitive discovery and monitoring of the affected tissue [6]. Accurate description of stroke-related structural EEG changes is based on sufficient spatial sampling density. EEG may increase the usefulness of information for clinical and imaging-based outcome predictions. This will improve the selection of patients for treatment [7]. The available evidence supports the view that EEG enhances the value of early diagnosis, outcome prediction, patient selection for treatment, clinical management and neurological examination and imaging studies. Home-based robotic technologies may offer the possibility of self-directed upper limb exercise after stroke as a means of growing the intensity of rehabilitation or treatment [8]. All these suggest that computer technology especially EEG is a veritable technology in the area of medicine particularly in diagnosis and treatment of people suffering from stroke attack.

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In all these studies, it was obvious that EEG technology has been a beneficial tool in monitoring neurological ailment especially during rehabilitation process. The issue is why can't it form the basis for diagnosis/prognosis of stroke disease? The second concern is that the level of EEG usages as pointed out by these studies above is grossly under used in developing economies such as Nigeria. Some tertiary hospitals have EEG machine but doesn't use them. Those that use it restrict it to treatment of other ailments such as epilepsy and never apply it in diagnosis of stroke.

2.1 RESEARCH QUESTION AND HYPOTHESIS

The research question that guided this work is stated thus:

Research Question: How useful is recording brain signals for diagnosis of stroke diseases?

This question led to the formulation of the hypothesis.
H0 (Null hypothesis): Brain Signals Recording is not useful in diagnosis and treatment of stroke.
H1 (Hypothesis 1): Brain Signal Recordings is a useful tool for diagnosis and treatment of stroke.

3 METHODOLOGIES

The primary source of data collection for this research is through the signals acquired using the EEG machine. Also, a questionnaire was designed and used to elicit information from respondents. Ethical approval was obtained from the Ebonyi State University, Research Ethics Committee.
The materials used in capturing EEG signals are: EEG-BCI Machine connected to a Computer System, Methylated Spirit, EEG Cap, Skin Preparation Gel, Amplifier, 25 Electrode Plates, 2 EKG Stickers, Jack Box for Cables, Balanced Chair and Elevated Bed.
Sample signals were obtained from two subjects. The first EEG data was obtained from a male as a control subject. The second EEG data was obtained from female stroke patient in the Federal hospital, Abakaliki, Nigeria. EEG signals were captured at different scalp sites according to the international 10/20 system. The EEG signals were filtered (0.5–40 Hz band-pass filter) and amplified. The signals were digitized. The sampling rate was 60 Hz with the amplitude of 100µV. The EEG signal was analyzed and classified using MATLAB version R2013a /Neural Network Kits (Mathworks Inc., USA).
During the capturing, it was observed that the participants were generating signals in waveform that were displayed on the computer screen. Finally, the data was analyzed and classified according to the frequency each subject generated.

3.1 Questionnaire Analysis and Result

The analysis of the data is among the discussion under data analysis using simple percentages as our descriptive measure.
90 copies of questionnaires were distributed and 81 of them were completed and returned. The gathered data is as shown in the Tables 1 in agreement with the questions asked in the questionnaire.

Table 1: Respondents view on the usefulness of recording brain signals for treatment of stroke.

Opinion	Frequency	Percentages
Strongly Agree	15	18.52
Agree	54	66.67
Neutral	12	14.81
Disagree	0	0.00
Strongly Disagree	0	0.00
Total	81	100

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From the Table 1, 15 respondents representing 18.52 percent strongly agreed that recording brain signals is beneficial in treatment of diseases; 54 respondents representing 66.67 percent agreed; 12 respondents representing 14.81 percent are neutral ; no respondent either disagreed or strongly disagreed.

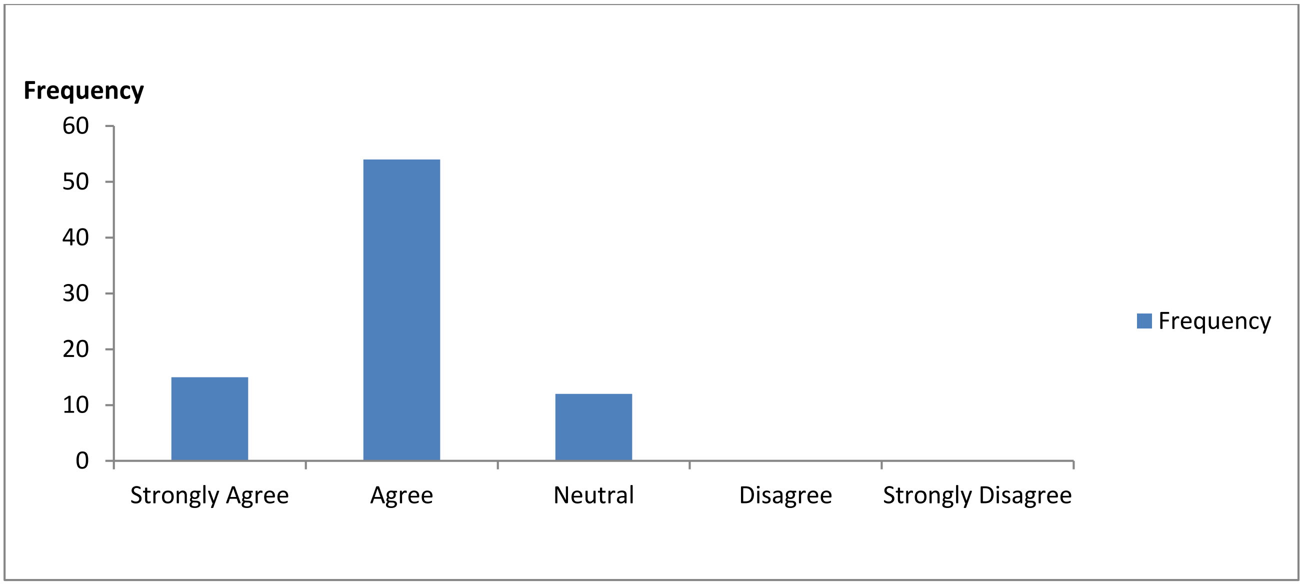

Figure 1: **Respondents view on the usefulness of recording brain signals for treatment of stroke**

The outcome of the questionnaire as illustrated in Table 1 and Figure 1 indicated that over 85 percent , which represent 69 respondents agreed that brain signals is useful for diagnosis and treatment of stroke disease, less than 15% of the respondents (12 respondents) were undecided. No one disagrees with this view. This implies that majority share the opinion that brain signals is useful in diagnosis of stroke.

3.2 Testing of Hypothesis

Table 2: Chi-square Values for Hypothesis 1

Variables	Observed Frequency(O)	Expected Frequency(E)	$(O-E)^2$	$\frac{(O-E)2}{E}$
Agree	69	27	1764	65.333
Disagree	0	27	729	27.000
Neutral	12	27	225	8.333
Total	81	81	2718	100.667

Note: Chi-Square formula is given as follows:

$X^2 = \frac{\sum(O-E)^2}{E}$ where

$\sum = summation$

O = Observed Frequency

E = Expected Frequency

DF = Degree of Freedom = 3 -1 = 2

Alpha Level (Level of Significance) = 0.05

Critical value X^2 based on Chi Square table = 5.991

Computed X^2 value = 100.667

Decision**:**

Due to the fact that the computed value of X^2 value (100.667) is greater than the Critical (Table) value (5.991), the null hypothesis was rejected and hypothesis 1 was accepted, which postulates that: Brain Signal Recordings is a useful tool for diagnosis and treatment of stroke.

4 EEG MODEL FOR DIAGNOSIS OF STROKE

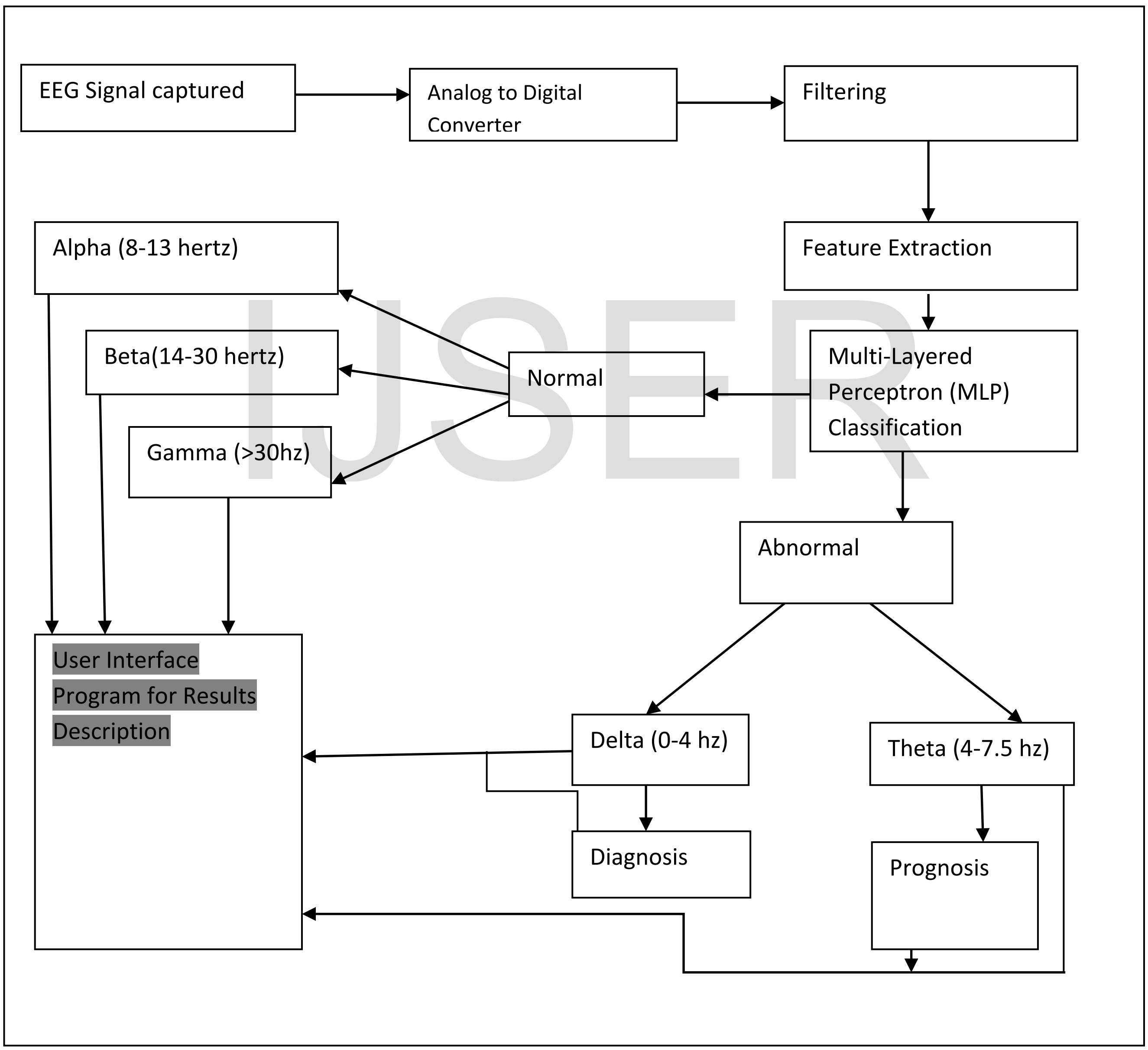

Figure 2: EEG Model for Diagnosis of Stroke Disease

The process model starts by capturing of the brain signal as shown in Figure 2. The analogous signal is then converted to digital signal by passing it through Analog to Digital Converter (ADC). The signal

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after amplification is filtered and relevant features extracted. The signal is then classified using Multi-Layered Perceptron classifier into delta, theta, alpha, beta and gamma waves. Interpretation of the result obtained by the EEG machine is done using a software platform user interface.

It is at this point that deduction is made on whether the signal is within normal or abnormal range. The interpretation is that a frequency range from 0 to 4 hertz is classified as delta wave and it denotes that the individual is under coma. This is abnormal in adult. It implies he/she has lost consciousness and is a sign of having physical defect in the brain. Frequency range 4 to 7.5 hertz is classified as theta wave and it depicts the state of depression and total confusion. It is also abnormal wave in an awaked adult. Observance of dominant signals from 8 to 13 hertz is grouped as alpha wave. It is a normal wave for an adult that is calm without much mental exercise. The same goes for beta wave that represents a frequency wave between 13.5 to 30 hertz. It indicates a state of activeness and serious mental activity. The frequency above 30 hertz is called gamma wave. It is also considered as normal wave in adult unusual mental meditation.

4.1 How the System Works

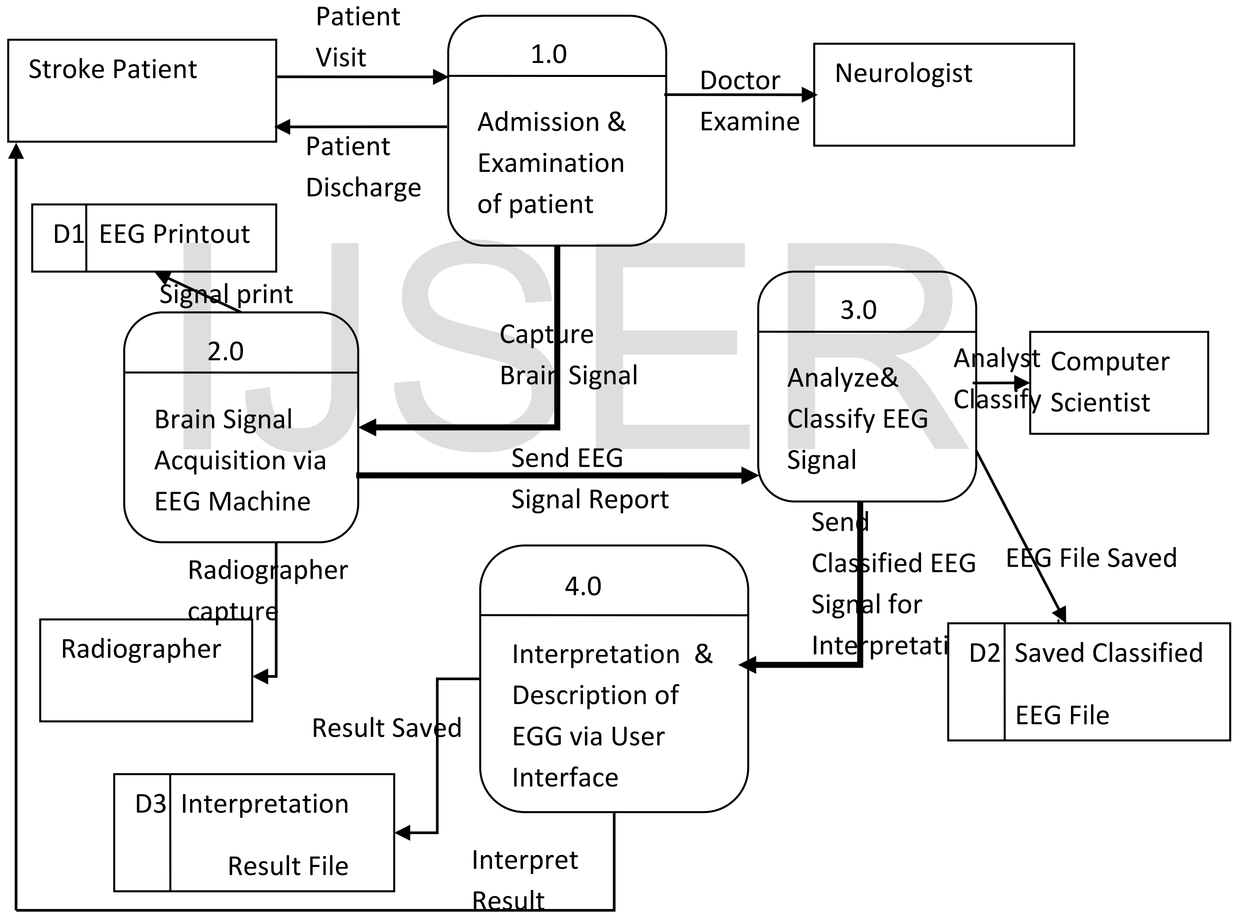

Figure 3: Data Flow Diagram of EEG Technology for Diagnosis of Stroke

The patient visits the doctor in the hospital. The doctor after physical examination refers the patient to the EEG radiographer, who captures the brain signals. The EEG report is printed out. The report is analyzed and classified into distinct wave forms by a system analyst (computer scientist). This is followed by interpretation and storage of the result.

4.2 Neural Network Architectural Design of EEG Model for Diagnosis of Stroke

The neural network is made up of four layers; one input, two hidden layers and one output layer. The input layer consists of two neurons for accepting the brain signals as shown in Figure 4. The first hidden layer has four neurons, while the second hidden layer is made up of three neurons. The output layer consists of five neurons that denotes the five brain wave frequencies of delta, theta, alpha, beta and gamma.

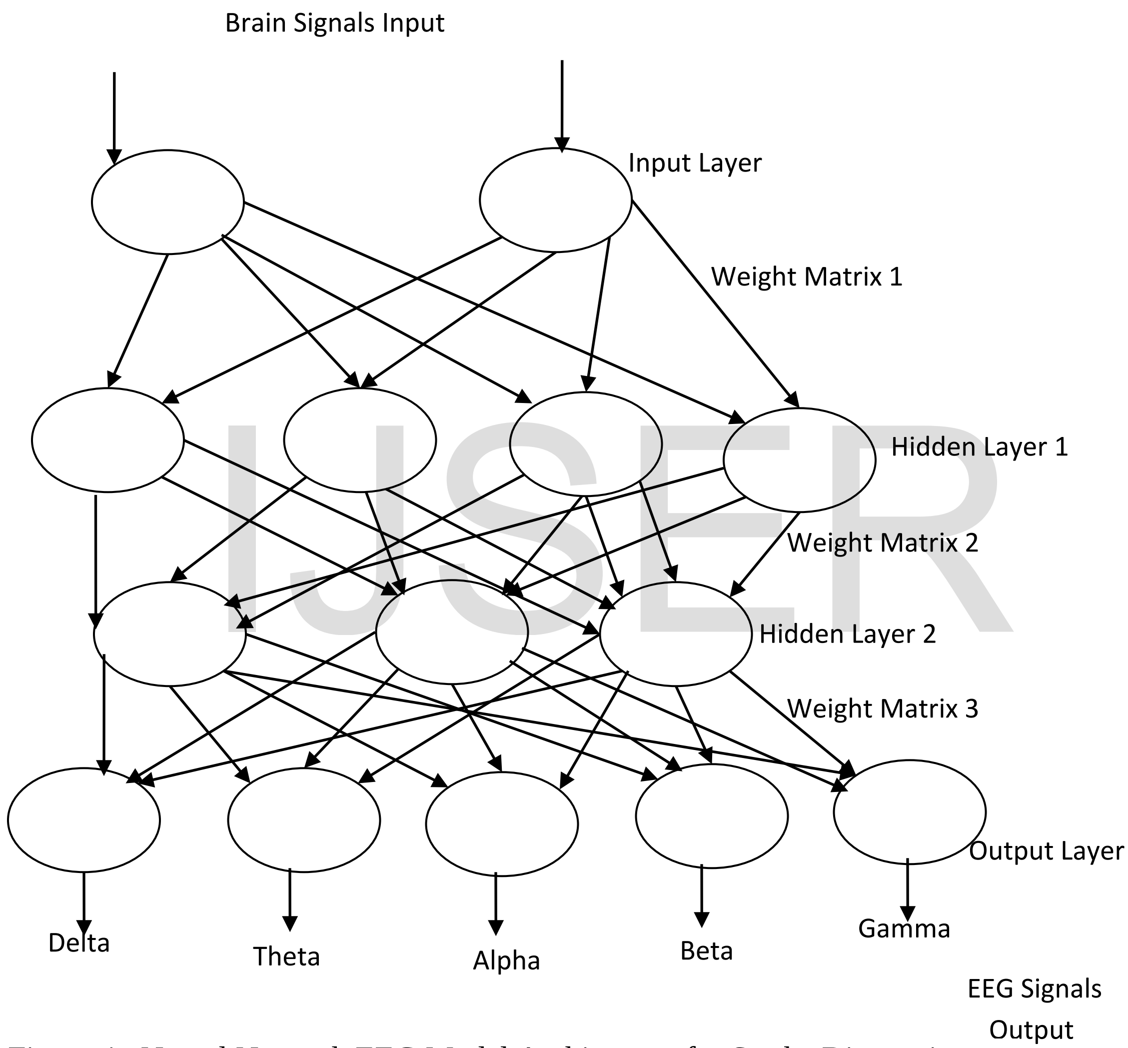

Figure 4: Neural Network EEG Model Architecture for Stroke Diagnosis

5 RESULTS AND DISCUSSION

The result is of two stages. The first was based on the outcome of the neural network design. It was possible to classify the input into five distinct wave bands using MATLAB 2013a platform using Multilayer Perceptron Feed Forward algorithm. The EEG classification is demonstrated in Figure 5.

The second output of this research is that the signal frequency captured using BCI-EEG machine can be further interpreted to make more meaning to EEG recording untrained eyes. This is illustrated in Figure 6. The interpretation is based on the dominant frequency during the brain signal recording. For instance, if the dominant frequency falls within 8 – 13, 13.5-30 and above 30, they are interpreted as normal

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cases. Abnormal cases occur when the dominant frequency falls within 0 – 4 and 4.5 – 7.5. This interpretation result can be saved within the computer system for future references.

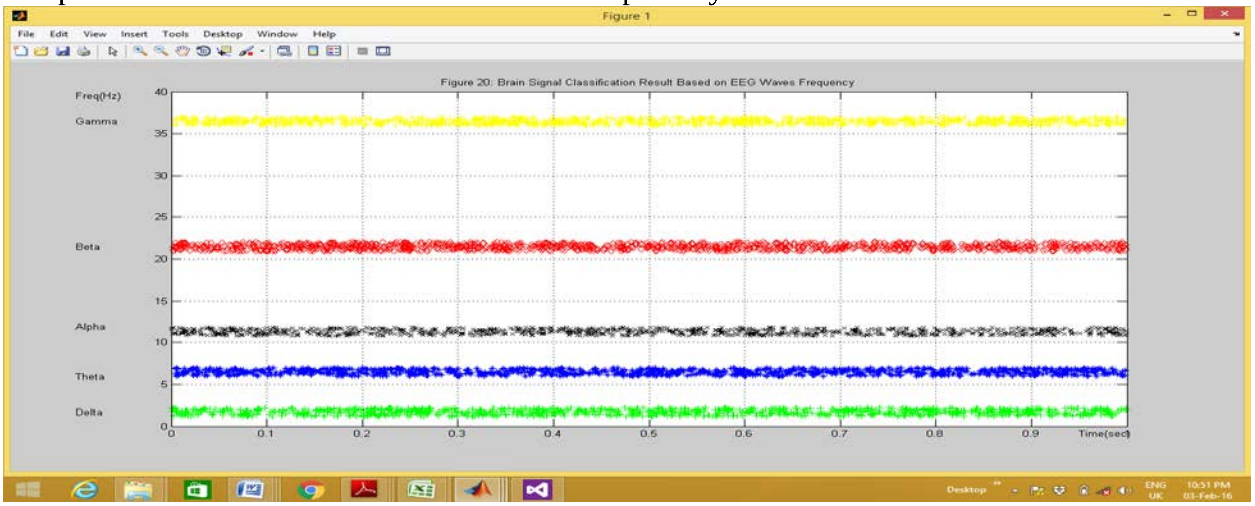

Figure 5: EEG Signal Classification into Five Distinct Brain Waves

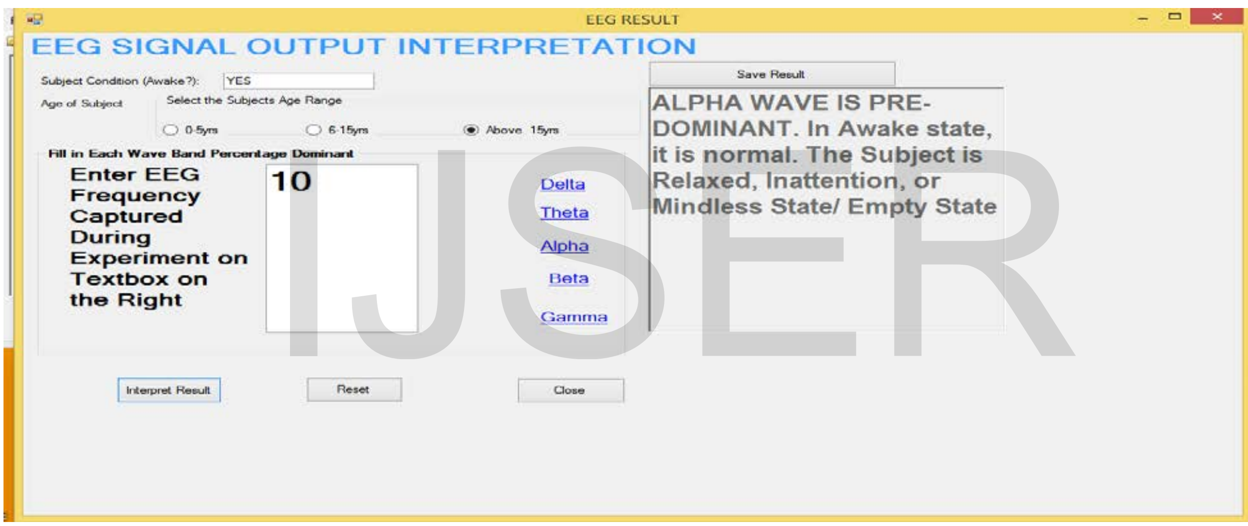

Figure 6: EEG Signal Interpretation Using VB.NET 2012 Platform

6 CONCLUSIONS

The use of EEG technology in diagnosing stroke provides more accessible means for the sufferers. This is because it is a portable tool. Another benefit is that the cost of capturing the EEG signal is far cheaper when compared to other brain scanning techniques. EEG usage eliminates the communication difficulty experienced by neurologists while eliciting information from those under stroke attacks. Finally, EEG facilitates and complements the neurologist for more effective diagnosis.

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