Electroencephalogram (EEG) and Neuro-Signal for Non-Linearity Analysis in Human Brain

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Abstract: **Neuro-reactance in human behavior has visual trait in terms of motor and sensory states such as, eye movement, lip movement, remembrance, hand clenching through signal processing technique that provides understanding of the complex inner mechanisms of the brain. In this paper, external interfaces of MATLAB incorporated API function to depict electrical activity of brain signals; by analyzing and processing electroencephalogram (EEG) signals for nonlinearity tendency in brain structure.**

Keywords: **EEG, Signal Processing, MATLAB, Pattern.**

I. INTRODUCTION

Neuro-reactance in human behaviour has visual trait in terms of motor and sensory states such as, eye movement, lip movement, remembrance, attention, hand clenching etc. These states are related with specific signal frequency which helps to understand functional behavior of complex brain structure.

At the moment, various technologies exist to record brain waves and electroencephalography (EEG) is one of them [1]. The signal processing technique on brain and allows gaining the understanding of the complex inner mechanisms of the brain and abnormal brain waves have been associated with particular brain disorders [2].

Signal processing is the computational power for the generation, transformation, and interpretation of information [3]. With EEG signals it is easy to study the functionalities of brain properly by generating, transforming and interpreting the collected signal. Brain is made up of billions of brain cells called neurons, which use electricity to communicate with each other [4]. The combination of millions of neurons sending signals at once produces an enormous amount of electrical activity in the brain, which can be detected using sensitive medical equipment just like EEG which measures electrical levels [5].

The combination of electrical activity of the brain is commonly called a Brainwave pattern because of its wave-like nature, and the complex inner mechanisms of the brain and abnormal brain waves have shown to be associated with particular brain disorder [6].

The human brain is one of the most complex systems in the universe, because it reacts differently at different stages in time. The analysis of brain waves plays an important role in diagnosis of different brain disorders. Hence, electroencephalogram (EEG) recording for studying functional state of the brain and for diagnosing certain disorders is quite necessary.

This paper aimed to provide experimental analysis for electrical activity of brain signals through; (i) processing of electroencephalogram (EEG) signals to understand functional behavior of complex brain structure, and (ii) visualization of signal frequency for specific states.

II. RELATED LITERATURE

EEG signals contain more relevant information about brain disorders and different types of artifacts. Monitoring the EEG signals according to the placement of electrodes is called montages [7]. EEG signals to recognize and eliminate different disease related artifacts, thus requires signal filtering based on the different types of brainwave frequencies to diagnosis and simulates variety of brain disorders by using MATLAB [8].

The electrodes are placed to the brain by wires and electrical activity of the brain will get recorded to a computer, and to show the activity as a series of wavy lines drawn as an image on the computer screen, as demonstrated in early practices [9]. Patients need to lie down and close their eyes during the recording. The recording may be stopped from time to time to allow the patient for stretching and repositioning. Different things will be done by the patient during the test to record the brain activity at that time; such as taking breathe deeply and rapidly for few minutes and Looking at a bright, flashing light for checking the stimulation.

The EEG can be monitored with either a bipolar montage or a referential one [10]. Bipolar means that just to use two electrodes on the scalp on all the sides and for reference electrode for one side of the brain [11]. The referential montage means only having a common reference electrode in both the side of the brain. Brainwaves pattern may vary according to the placement of electrodes [12].

The electrical activity of the brain is conducted by wires from the scalp and electrodes are placed by using EEG machine. The inputs to the hardware EEG machine are then used to compose a montage, which is a specific arrangement or array of electrodes that display the EEG signal. Each channel basically compares input data taken

based on placement of the two electrodes. Upward deflection of the wave is defined as negative and occurs when the first input data is negative with respect to the second input data or second input data is positive with respect to the first input data [6]. A downward deflection of the brainwave is defined as positive, and occurs when first input data is positive with respect to second input data or when second input data is negative with respect to first input data [9].

III. METHODOLOGY

Amplitude is the magnitude of the EEG activity which is measured in microvolts (μV). It is determined by measuring the brainwave deflection in millimeters (mm) at specified machine sensitivity (μV /mm). Few EEG signals were collected as dataset for processing in MATLAB. Specific features were selected and extracted for EEG signals, so as to classify the chosen features which sensitivity and filtering as data sample as shown in table 1.

Table 1: Selected Data Sample for EEG Signal

Sensitivity	5.7083843e-001	9.9685021e-001	5.5354157e-001
	5.7161573e-001	1.2218915e-001	6.7116623e-001
Filtering	1.5194708e-001	3.9710884e-001	3.7472247e-001
	8.8665840e-002	8.3825559e-001	5.8471862e-001

Thereafter, the variation of different brain waves based on their characteristics was checked for possible changes in different brainwave pattern. Selection of channels for viewing more detailed waveforms was considered as well; fixing the sensitivity values of the collected EEG data by setting filtering range for high frequency (50 - 70 Hz) or for low frequency (0.1 - 1 Hz).

IV. SIMULATION AND RESULTS

Independent component analysis (ICA) and/or time/frequency analysis (TFA) techniques were applied in MATLAB depicted brain signals by visualizing functional states and interpretation.

MATLAB provides an interactive graphic user interface (GUI) allowing users to flexibly and interactively process their high-density EEG dataset, as well as standard averaging methods.

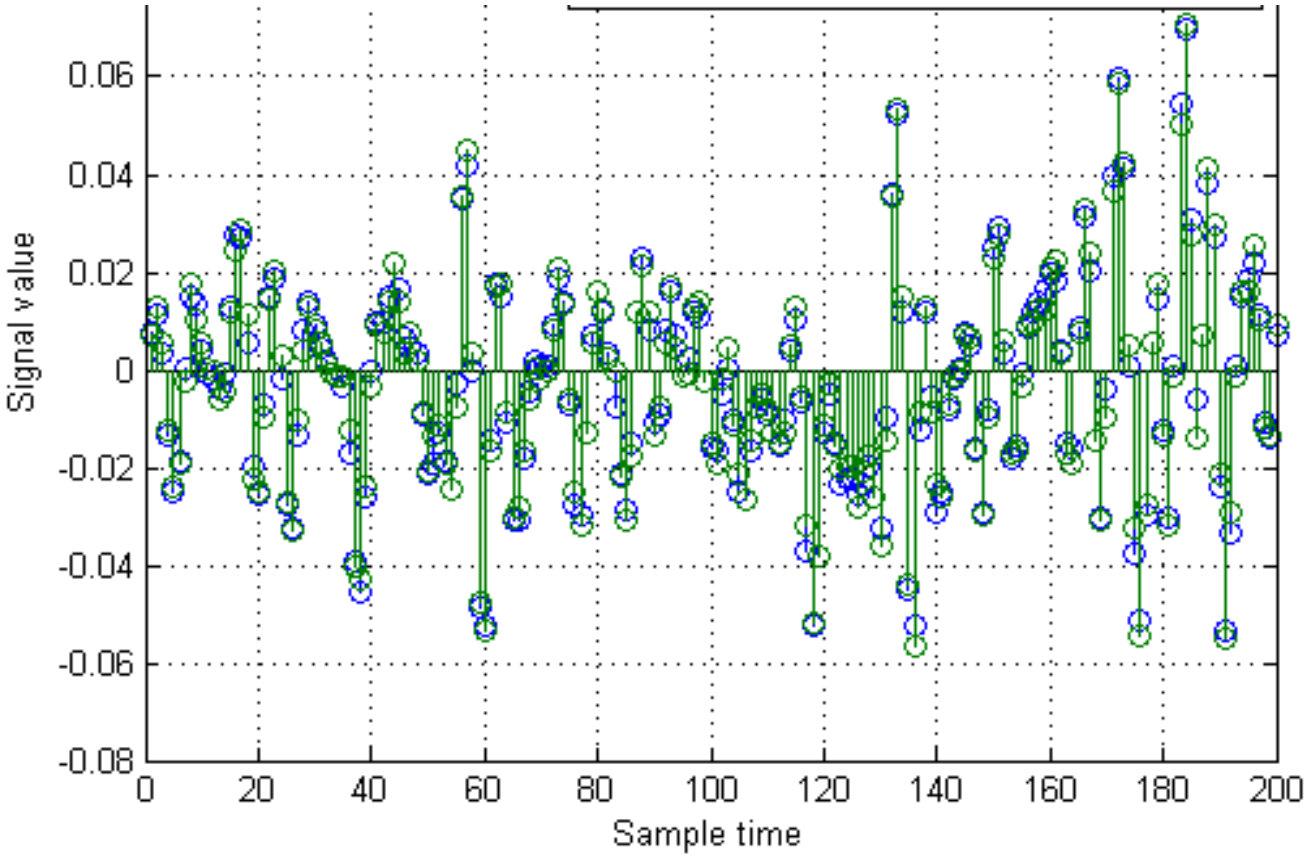

Fig. 1: Time Frequency / Signal Plot

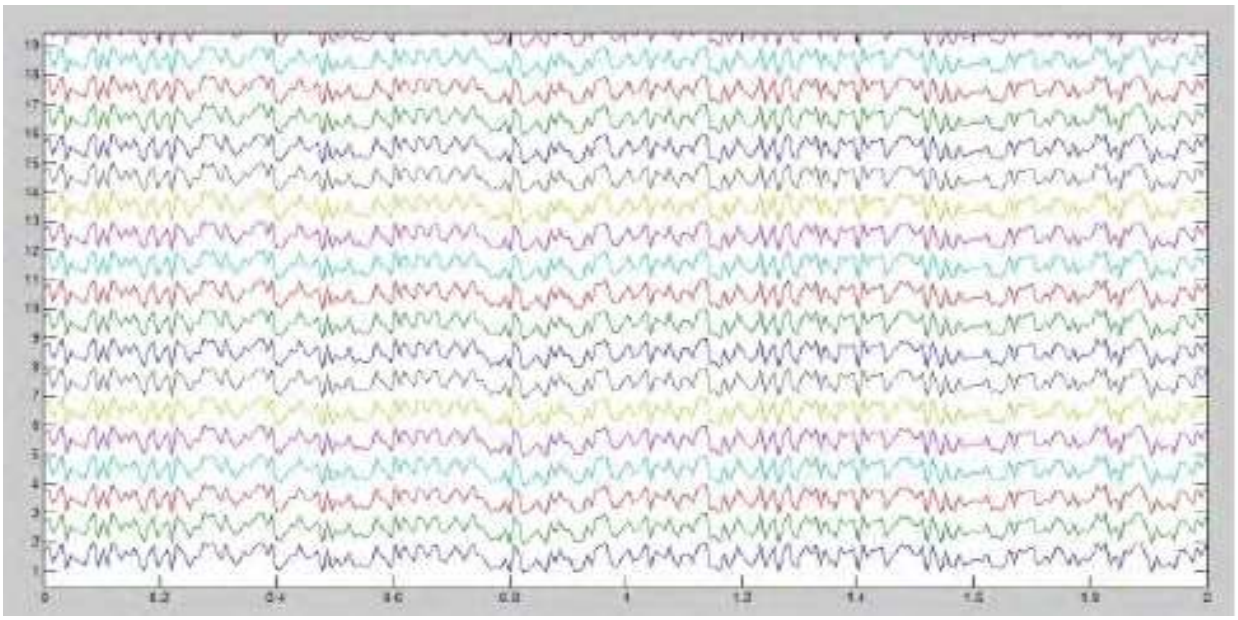

Fig. 2: Brainwave Signal Pattern

V. CONCLUSION

Analysis of brain waves and signal pattern through MATLAB toolbox, described in detail the functional procedure in the modeling of EEG signals and neuron-complexity. EEG is brain signal processing technique that allows gaining the understanding of the complex inner mechanisms of the brain, by which abnormality and its associated disorders can be discovered. The analysis of brain waves plays an important role in diagnosis of different brain disorders. MATLAB provides interactive graphic user interface (GUI) allowing flexibly to process high-density EEG dataset.

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