Report for

**Generating the Automated Voice Response for Mute Person Using Machine Learning and Brain Computer Interface technology.**

Submitted in Phase I project

evaluation for the degree of

**MTech (Computer Engineering with**

**Specialization in Software Engineering)**

By

**Aniket Raut**

**[162190018]**

2017-18

Under the Guidance of

**Dr. V. B. Nikam**



Department of Computer Engineering & Information Technology,

Veermata Jijabai Technological Institute,

Mumbai - 400019

(An Autonomous Institute affiliated to University of Mumbai)

2017-18

**CERTIFICATE**

This Report entitled “**Generating the automated voice Response for mute person using Machine Learning and Brain Computer Interface technology.**” by Aniket Rajiv Raut [162190018] is found to be satisfactory.

|  |  |
| --- | --- |
| **Project Guide**  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **Dr. V B Nikam**,  Head of Department of Computer Engineering  And Information Technology,  V. J. T. I.  Mumbai | **Head of Department**  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **Dr. V B Nikam**,  Head of Department of Computer Engineering  And Information Technology,  V. J. T. I.  Mumbai |

**Date: \_\_/\_\_/2017**

**Place: V. J. T. I., Mumbai**

**STATEMENT OF CANDIDATE**

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources.

I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea / data / fact / source in my submission.

I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Signature

Aniket Raut (162190018)

Date: \_\_/\_\_/2017

**Table of Content**

|  |  |
| --- | --- |
| 1. Problem Statement ……………………………………………… 2. Feasibility Analysis……………………………………………… 3. Literature Survey………………………………………………… 4. System Input……………………………..……………………… 5. Block Diagram…………………………………………………… 6. Software/Hardware Requirement………………………………… | 5  6  7  15  16  17 |

1. **Problem Statement**

The mute person is a person which has a lack of ability to speak. Reason for person being mute can vary (for example. by birth and due to some kind of accident). The mute person uses a sign language to communicate with other person. Sign language is not understandable by each and every one that’s make it hard for the mute person to communicate with everyone.

With this research project we are intended to design and implement the Machine learning application based on brain computer interface. The appropriate sound response will get generated by analyzing the EEG waves. This application will use the nuroheadset which will capture electroencephalogram (EEG) waves from persons head and the headset will transfer this wave to the computer based application where it will be analyze by the machine learning application to generate the appropriate response. Once the appropriate sound response is generated; the sound will be played through the speaker attached with the computer.

1. **Feasibility Analysis**

The purposed system is system that will be embedded in small computer based chip (for example raspberry pi) with a nuroheadset connected wirelessly. The feasibility of the system will be based how accurate the response will get generate for an particular EEG wave form and how compact and portable the system will be for the person who is using it.

The system will be developed on the windows platform which later will be embedded to the chip and the will be tested and trained on the single mute person.

1. **Literature Survey**

This section details the usefulness of EEG in assessing neurological disorders, problems in unmixing the EEG and discusses various statistical techniques based brain-maps and the ongoing research involving them in identifying various neurological disorders specially epilepsy. A survey on epilepsy, its causes, classification is presented. A study on various ICA techniques explaining their need because of source localization is explained.

**3.1 Basics of EEG**

The electroencephalogram (EEG) is a dynamic non-invasive and relatively inexpensive technique used to monitor the state of the brain. The International Federation of Clinical Neurophysiology (http://www.ifcn.info/) defines the EEG as

* + the science relating to the electrical activity of the brain
  + the technique of recording electroencephalograms

The greatest advantage of EEG is that it is an instantaneous and continuous indicator of brain`s function. An EEG signal recorded with electrodes placed on the scalp consists of many waves with different characteristics. Arrays of electrodes are distributed over the entire scalp. It is possible to record EEG signals continuously for longer than 24 hours from many channels; depending on the application, electrode counts can range from single/dual channels to the 10-20 clinical system using a montage of electrodes.

EEG has a number of clinical uses that range from monitoring normal wakefulness or arousal states to complex clinical situations involving seizure or coma. EEG records the electrical activity from the scalp, which has been used as a clinical diagnostic tool for nearly century. The scalp Electroencephalogram (EEG) / Magnetoencephalogram (MEG) occupies an important position as a diagnostic and research tool because of four main characteristics:

* it has an exceedingly high time resolution
* it is noninvasive
* it is simple to record and it is inexpensive
* it is the only technique by means of which the dynamics of brain activity can be monitored in the freely moving subject

It is a popular clinical technique that provides important information about a variety of brain disorders which includes epilepsy or seizure disorders, coma, encephalopathy, brain death and sleep disorders. It is also a first-line method for the diagnosis of tumors, stroke and other focal brain disorders. Many other advantages among other measures of brain function are that it is the most sensitive functional test to changes in brain function over short time periods, it is inexpensive, non-invasive, and has a superior temporal resolution compared with imaging techniques such as Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET).

The brain contains unique information in many regions at any given time. The EEG or brain signals which are captured using multichannel electrodes are highly complex and random in nature. Their characteristics strongly depend on the individual, age and mental state. The occurrence of abnormal electrical activity is at random in time scale. Hence, understanding the behavior and dynamics of billions of interconnected neurons involves several linear and nonlinear signal processing techniques and its correlation to the physiological events.

When brain cells (neurons) are activated, local current flows are produced. EEG measures mostly the currents that flow during synaptic excitations of the dendrites of many pyramidal neurons in the cerebral cortex. Differences of electrical potentials are caused by summed post synaptic graded potentials from pyramidal cells that create electrical dipoles between soma (body of neuron) and apical dendrites (neural branches).

Brain electrical current consists mostly of Na+, K+, Ca++, and Cl- ions that are pumped through channels in neuron membranes in the direction governed by membrane potential. The detailed microscopic picture is more sophisticated, including different types of synapses involving variety of neurotransmitters.

Only large populations of active neurons can generate electrical activity recordable on the head surface. Between electrode and neuronal layers current penetrates through skin, skull and several other layers. Weak electrical signals detected by the scalp electrodes are massively amplified, and then displayed on paper or stored to computer memory. Due to capability to react both the normal and abnormal electrical activity of the brain, EEG has been found to be a very powerful tool in the field of neurology and clinical neurophysiology

The human brain electric activity starts around the 17-23 week of prenatal development. It is assumed that at birth the full number of neural cells is already developed, roughly 1011 neurons. This makes an average density of 104 neurons per cubic mm. Neurons are mutually connected into neural nets through synapses. Adults have about 500 trillion (5 X 1014) synapses. The number of synapses per one neuron with age increases, however the number of neurons with age decreases, thus the total number of synapses decreases with age too.

From the anatomical point of view, the brain can be divided into three sections: cerebrum, cerebellum, and brain stem. The cerebrum consists of left and right hemisphere with highly convoluted surface layer called cerebral cortex. The cortex is a dominant part of the central nervous system. The cerebrum obtains centres for movement initiation, conscious awareness of sensation, complex analysis, and expression of emotions and behaviour. The cerebellum coordinates voluntary movements of muscles and balance maintaining. The brain stem controls respiration, heart regulation,biorhythms, neuro hormone and hormone secretion, etc. The highest influence to EEG comes from electric activity of cerebral cortex due to its surface position.

**3.2 Variables Used in the Classification of EEG Activity**

A standard terminology is used to describe EEG wave patterns. These terms summarize the electrocerebral activity and abnormal activity or transient in each region of brain. The terms are frequency, amplitude, polarity, morphology, distribution, rhythmicity, synchrony, reactivity and persistence. A few key terminologies are explained below:

* **Frequency**

Frequency refers to rhythmic repetitive activity (in Hz). The frequency of EEG activity can have different properties including:

1. Rhythmic-EEG activity consisting in waves of approximately constant frequency.

2. Arrhythmic-EEG activity in which no stable rhythms are present.

3. Dysrhythmic-Rhythms and/or patterns of EEG activity that characteristically appear in patient groups or rarely or seen in healthy subjects.

* **Voltage**

Voltage refers to the average voltage or peak voltage of EEG activity. Values are dependent, in part, on the recording technique. Descriptive terms associated with EEG voltage include:

* **Attenuation**

1. Attenuation-(synonyms: suppression, depression)-Reduction of amplitude of EEG activity resulting from decreased voltage. When activity is attenuated by stimulation, it is said to have been "blocked" or to show "blocking".

2. Hypersynchrony-Seen as an increase in voltage and regularity of rhythmic activity, or within the alpha, beta, or theta range. The term implies an increase in the number of neural elements contributing to the rhythm. (Note: term is used in interpretative sense but as a descriptor of change in the EEG).

3. Paroxysmal-Activity that emerges from background with a rapid onset, reaching (usually) quite high voltage and ending with an abrupt return to lower voltage activity. Though the term does not directly imply abnormality, much abnormal activity is paroxysmal.

* **Morphology**

Morphology refers to the shape of the waveform. The shape of a wave or an EEG pattern is determined by the frequencies that combine to make up the waveform and by their phase and voltage relationships. Wave patterns can be described as being:

1. Monomorphic Distinct EEG activity appearing to be composed of one dominant activity

2. Polymorphic distinct EEG activity composed of multiple frequencies that combine to form a complex waveform.

3. Sinusoidal Waves resembling sine waves. Monomorphic activity usually is sinusoidal.

* **Transient**

It is defined as an isolated wave or pattern that is distinctly different from background activity.

1. Spike-a transient with a pointed peak and a duration from 20 to under 70 m.sec.

2. Sharp wave-a transient with a pointed peak and duration of 70-200 m.sec.

* **Synchrony**

Synchrony refers to the simultaneous appearance of rhythmic or morphologically distinct patterns over different regions of the head, either on the same side (unilateral) or both sides (bilateral).

* **Periodicity**

Periodicity refers to the distribution of patterns or elements in time (e.g., the appearance of a particular EEG activity at more or less regular intervals). The activity may be generalized, focal or lateralized.

**3.3 Electrode Position and Montages**

The EEG signals are recorded from electrodes placed on the scalp. An EEG is most often recorded from many electrodes arranged in a particular pattern or montage. The recording of the EEG depends on the location of the electrodes. Usually these electrodes are placed in locations in the frontal, central, temporal, parietal and occipital regions of the brain. A common standard for describing these positions is the International 10􀀀20 System. The International Federation of Societies for Electroencephalography and Clinical Neurophysiology has recommended the conventional electrode setting also called 10􀀀20 electrodes (excluding the earlobe electrodes) on the skull based on skull landmarks (inion, nasion and right and left periauricular points)

whose distances are subdivided in a specific manner. A pair of electrodes makes up a channel.

EEG recordings, in this work, typically have about 16 channels recorded in parallel. This is called multichannel EEG recording and the montage position are as shown in Figure. 4.1. There are two types of EEG recordings: (i) mono polar (ii) bipolar. Mono polar recording picks up the voltage difference between an active electrode on the scalp and a reference electrode on the ear lobe. Bipolar electrodes give the voltage difference between two scalp electrodes. The electrical activity of the brain has amplitude in the micro volts range typically ranging from 10 to 150\_v. Typical inter electrode distance is 6 cm. The letters specify the region in the brain as follows:

* Fp: Frontopolar
* F: Frontal
* C; Central
* T: Temporal
* P: Parietal
* O: Occipital

Often the earlobe electrodes called A1 and A2, connected respectively to the left and right earlobes, are used as the reference electrodes. Electrodes with odd number (Fp1, F3, C3, P3, O1, F7, T3, T5 and A1) represent the left side of the head and even number (Fp2, F4, C4, P4, O2, F8, T4, T6 and A2) represent right side of the head. Midline electrodes are designated by the letter \z". The EEG obtained from these electrodes can be recorded onto a paper chart or more commonly these days, digitized into a computer for frequency analysis.

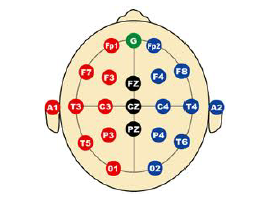


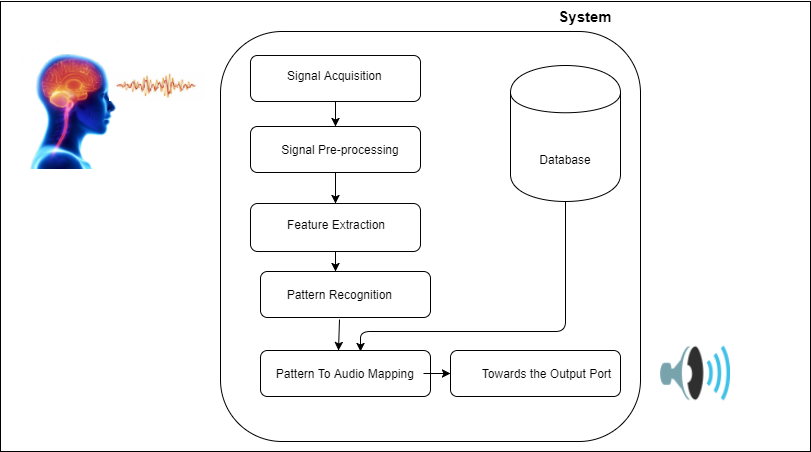
Figure 4.1: EEG scalp electrodes of 10-20 system.

1. **System inputs**

**4.1. EEG Data Acquisition**

For this work, we will collect the EEG samples from mute person using the EEG nuroheadset and will be processed using the system for patterns in the EEG wave form. Currently we haven’t selected any EEG machine which will be the part of the system. So the complete data acquisition process can’t be explained at this moment.

1. **Block Diagram**

****

**Figure 5.1 System Block Diagram**

1. **Software/Hardware Requirement**

Hardware Requirement:-

1. EEG machine
2. Nvidia Jetson TX2 Module
3. Development machine

Software Requirement: -

1. Data Acquisition tool for EEG (Mostly comes with the EEG machine)
2. NVIDIA JetPack SDK
3. Development Language tools

There will be an addition requirement for space to setup the complete development environment where the EEG machine will be kept along with other machine like development machine, cables, electrode etc.