RoBIK : **Ro**bust **B**rain **I**nterfaced **K**eyboard

Submitted in partial fulfilment of the requirements

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Bachelor of Engineering

by

Chirag M. Bellara

Raj S. Madheshia

Pranali S. Patil

under the guidance of

Mrs. Vinita Mishra

V.E.S.
Since 1962

Department of Information Technology

Vivekanand Education Society's Institute of Technology

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Vivekanand Education Society's
Institute of Technology
Since 1962
(Affiliated to University of Mumbai, Approved by AICTE & Recognized by Govt. of Maharashtra)

Department of Information Technology

CERTIFICATE

This is to certify that **Mr. Chirag M. Bellara, Mr. Raj S. Madheshia, Ms. Pranali S. Patil** of Third Year Information Technology studying under the University of Mumbai have satisfactorily presented the mini project entitled **RoBIK : Ro**bust **B**rain **I**nterfaced **K**eyboard as a part of the MINI-PROJECT for Semester-VI under the guidance of **Mrs. Vinita Mishra** in the year 2018-2019.

Date:

Examiner 1

Examiner 2

(Dr. Shalu Chopra)
Head of the Department

(Mrs. Vinita Mishra)
Guide

Principal

College Seal

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1. INTRODUCTION

1.1. Introduction

The principle of a Brain-Computer Interface (BCI) is to control a device through the extraction and interpretation of signal features from electroencephalograms (EEG) collected either from the surface of the scalp or through invasive measurements[3,15]. This old idea of communication technique, offers the advantage of bypassing the need for muscle activity in the chain of control, and is therefore presented as a promising alternative to restore communication and control in severely disabled people or those who have lost partial or complete control of their muscles[4].

Firstly, a literature research on BCI shows that a third of published papers deal with algorithms aiming to provide higher and more robust overall performances[14]. Unfortunately, only a few algorithms are made available on one of the two open-source platforms for BCI. Secondly, nearly a quarter of the publications focus on neurophysiology and the use of EEG features with no major breakthrough in this direction, as BCI mainly makes use of late paradigms: Event Related Potentials (ERP)[7, 8], Steady State Visual Evoked Potentials (SSVEP)[9], motor rhythms[10] and Local Field Potentials (LFP)[11].

People who have severe movement disorders like Amyotrophic Lateral Sclerosis (ALS) or Locked in Syndrome, is a condition where a patient is awake and aware of its surrounding but unable to communicate or perform any action due to paralysis of almost every voluntary muscles in the body (with the exception of eye movements and blinking)[6]. The people who are suffering from severe Cerebral Palsy disorder are not able to speak or not understandable enough so they could not communicate and interact with others.

These people also have severe movement disorder.Imagine these patients having a fully functional brain trapped within a non-functioning body. The brain of the patient would be fully conscious and aware of its surroundings, it could think and process stimuli, but unable to translate thought into action. This is caused by a gradual degeneration of the nerve cells in the central nervous system that controls voluntary muscle movement.

1.2. Problem Statement

This project aims at the development of a BCI system for communication via the usage of a virtual keyboard that could be used on a daily basis by patients without the help of a trained team of researchers or any other professional as such. This project is concentrated on developing a BCI system, a Virtual Keyboard by usage of hardware components like EEG Sensor and software technologies like Python, JavaScript and LABView.

1.3. Objectives

The main objective of this project is to develop a communications system for the physically disabled specially those who suffer from severe movement disorders like Amyotrophic Lateral Sclerosis (ALS) or Locked in Syndrome. Also, during the development phase the primary focus of the project will be to develop a system for the patients who suffer from partial or complete body paralysis[6].

1.4. Scope

This project aims at the development of a BCI system for communication via the usage of a virtual keyboard that could be used on a daily basis by patients without the help of a trained team of researchers or any other professional as such[5,14]. In this project we are going to use Neurosky mindwave which give EEG single as an output[2]. From this we are specifically targeting the EOG (Electrooculography) signals which targets only intensional Eye blinks[12]. We are going to use machine learning techniques for classification of Single eye blink and normal blink, which is then feeded into Virtual Keyboard[11]. The Virtual Keyboard will be present which can be handle by blinks. The virtual keyboard is divided into grid which will allow users to move between alphabet fast and easily[11]. The keyboard will also have auto word completion for easy of users.

2. Literature Survey

2.1. Literature/Techniques studied

The literature survey for this project was majorly based on the findings from the papers that were referred during the course of the project. Also apart from research papers, some field survey was conducted to come to the conclusion of usage of eye blinks as a deciding factor.

The major part of the literature survey was theoretical and involved going through the approaches that have been previously tried by the people around the world. Other techniques of literature survey also included some data gathering in the form of 'Survey Forms'.

Thus, the data gathered during the course of time can be divided as theoretical and practical with theory dominating by a good margin.

2.2. Papers/Findings

2.2.1. A Novel Method for Analysis of EEG Signals Using Brain Wave Data Analyzer[1]

The research paper describes how the brain activity (to detect the alertness of a person) is measured using Mindwave EEG signal data transmission device. The brain electric signal are measured by EEG (Electroencephalograph) which shows a demand for better accuracy and stability and facilitates the graphical illustration of spatial features of electric brain activity. The changes between conscious and drowsiness state are mapped and used as threshold value. This paper is that the application can be used for EEG data acquisition, processing and visualization. It provides a very promising technology for physically disabled people who are unable to access their hands and in this paper, brief discussion of how the data acquisition can be done by using biosensor.

Finding :- Better accuracy and stability and facilitates the graphical illustration of spatial features of electric brain activity.

2.2.2. Online Voluntary Eye Blink Detection using Electrooculogram[12]

The proposed method in the paper differentiates between normal blink, double blink and wink, with the help of electrical activity of vertical and horizontal EOG. Detection of characters on EOG and template signal of double blink in feature extraction. Virtual keyboard was implemented and characters are separated using blocks. The Machine learning model SVM is used on voluntary eye blink detection.This paper proof wink is suitable for trigger switch of BCI system, and online method for voluntary eye blink detection.

From the research paper, we can find the possibility that wink is suitable for the trigger switch of BCI system.The simulation result of the paper showed that voluntary eye blinks can be detected as an online system.

Finding :- By using training model like SVM for classification of data gives accuracy of about 97.69%.

2.2.3. Virtual Keyboard BCI using Eye blinks in EEG[5]

The Blink signal is taken into consideration for BCI keyboard. The electrodes are connected to frontal lobe and ear lobe to get potential difference between them and then eye blink can be detected using the positive and negative peaks of amplitude.
A single selection of the block is obtained in 20s, the column in the block is selected in the next 20s and the character is selected in the next 20s. Every selection by the user is accompanied by giving a visual feedback to the user by glowing the corresponding block/column/character in the Virtual Keyboard.

Speed :- Approx 1 characters can be typed in one minute.

2.2.4. Touchless Virtual Keyboard Controlled by Eye Blinking and EEG Signals[11]

Each key can be selected by three double eye blinks registered by EMG sensor. EEG signals are used as a support that allows the user to change the input mode of single characters to the mode of predicted words selection.
The results of experiments show that the best mode is the mode using meditation threshold of 80. It achieves efficiency of 1.27 Words Per Minute, but we should note that the words prediction was used. Selecting the meditation as a parameter for the mode of predicted words, the number of errors is lower in comparison to the experiment using attention. It is also found that the keyboard efficiency can be improved by using a list of predicted words, even the number of those words is low and they are short.

3. Proposed System

3.1. Methodology

Hardware : EEG Brainwave Sensor.
Software : Python & LABView.
The entire process is divided into two parts i.e Signal Processing and Data Acquisition and Processing.
Signal Processing :
In signal processing, electrodes are used for sensing EEG signals generated in human brain.The EEG signal is acquired using Biopac MP36 system. The Biopac disposable vinyl electrodes (EL 503) are placed on the FP1 and F3 region in the 10-20 International electrode system. The reference electrode is placed on the earlobe. The lead set SS2L connects the electrode to the Channel 1 (CH-1) of the MP36 system which is further connected to the computer via USB port.

Fig. 3.1 MP36 System for Windows

The introduction of MP36 along with certain changes in the amplification ratio, low pass and high pass filter values ensures the noise free picking up of EEG signals from the scalp electrodes. Also, an adequate sampling frequency needs to be chosen to ensure appropriate delivery of data with any significant losses.

A complete flow of Signal Processing is given below,

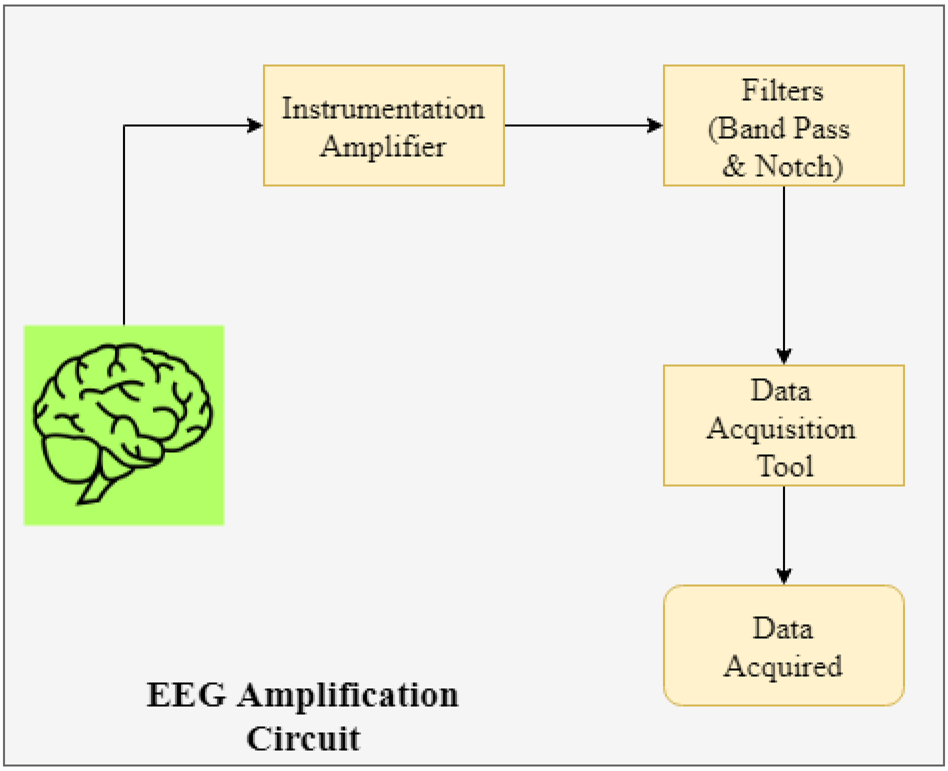


Fig 3.2 EEG Amplification Circuit

Data Acquisition and Processing :

Eye blinks are used as inputs or control signals in this BCI. The user of the BCI has to produce an eye blink in the specified time interval, say 5s interval. The BCI detects in this 5s interval whether an eye blink is present or not so a single selection can be done in atmost 20s.

In every 5s interval the user should make an eyeblink. So in effect at the end of 20s interval the BCI will detect one of the following events.

- First eye blink occurred.
- Second eye blinks occurred.
- Third eye blinks occurred.

The entire alphabets (A - Z) and the special characters like "Del", "DelW" and "DelA" where DelW means 'Delete Word' and DelA means 'DelA' are the characters available in the Virtual Keyboard. The total 27 characters are divided into rows and columns which are placed in alphabetical order.

A complete working for the various steps is described below,

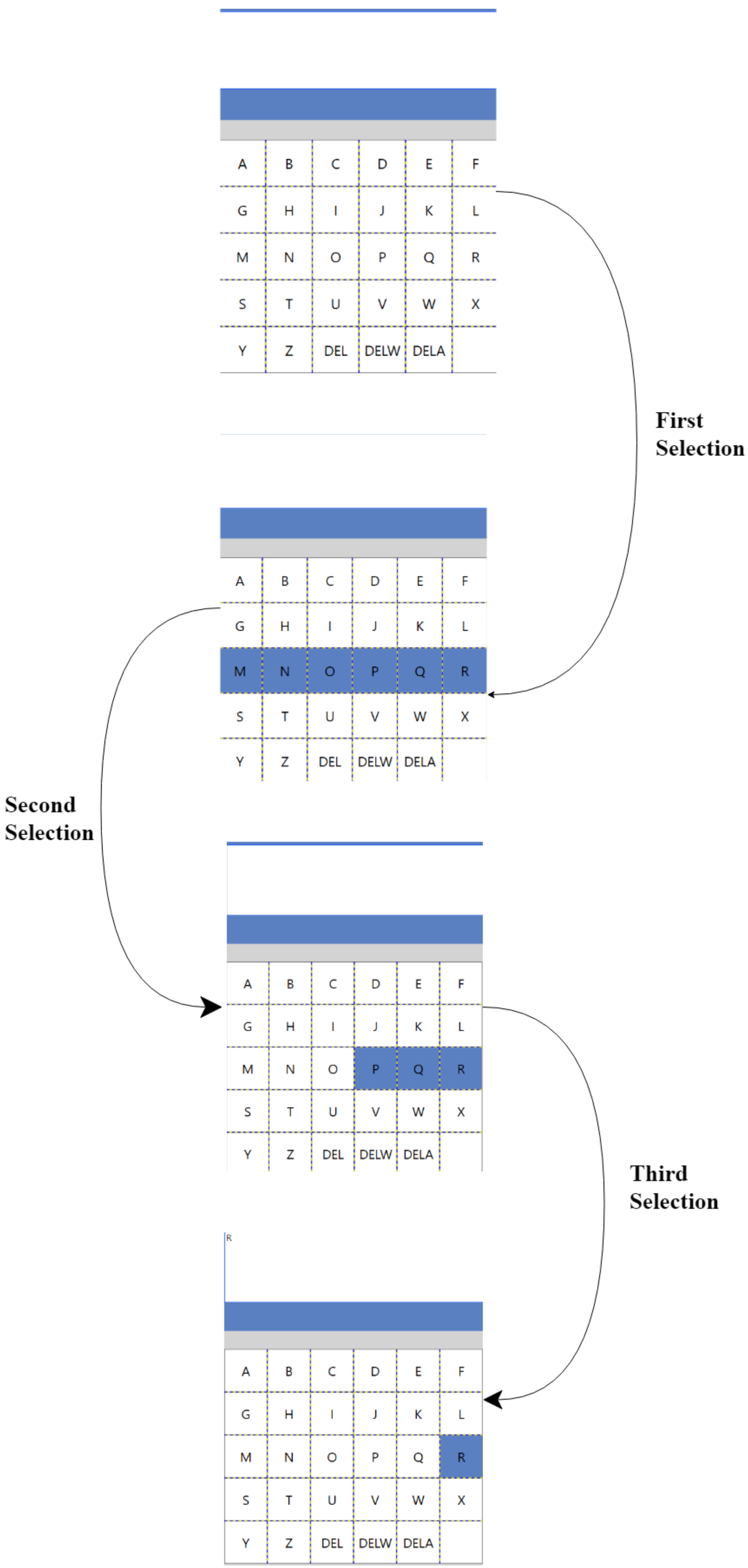


Fig 3.3 Character Selection Process

3.2. Flow Diagram

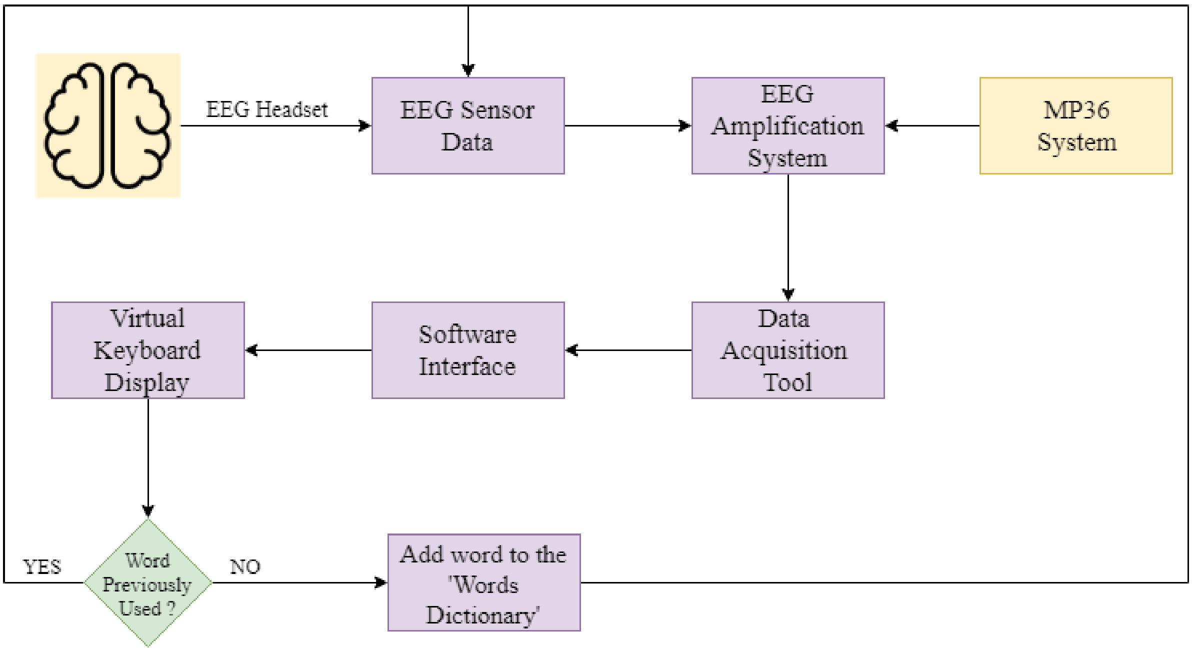
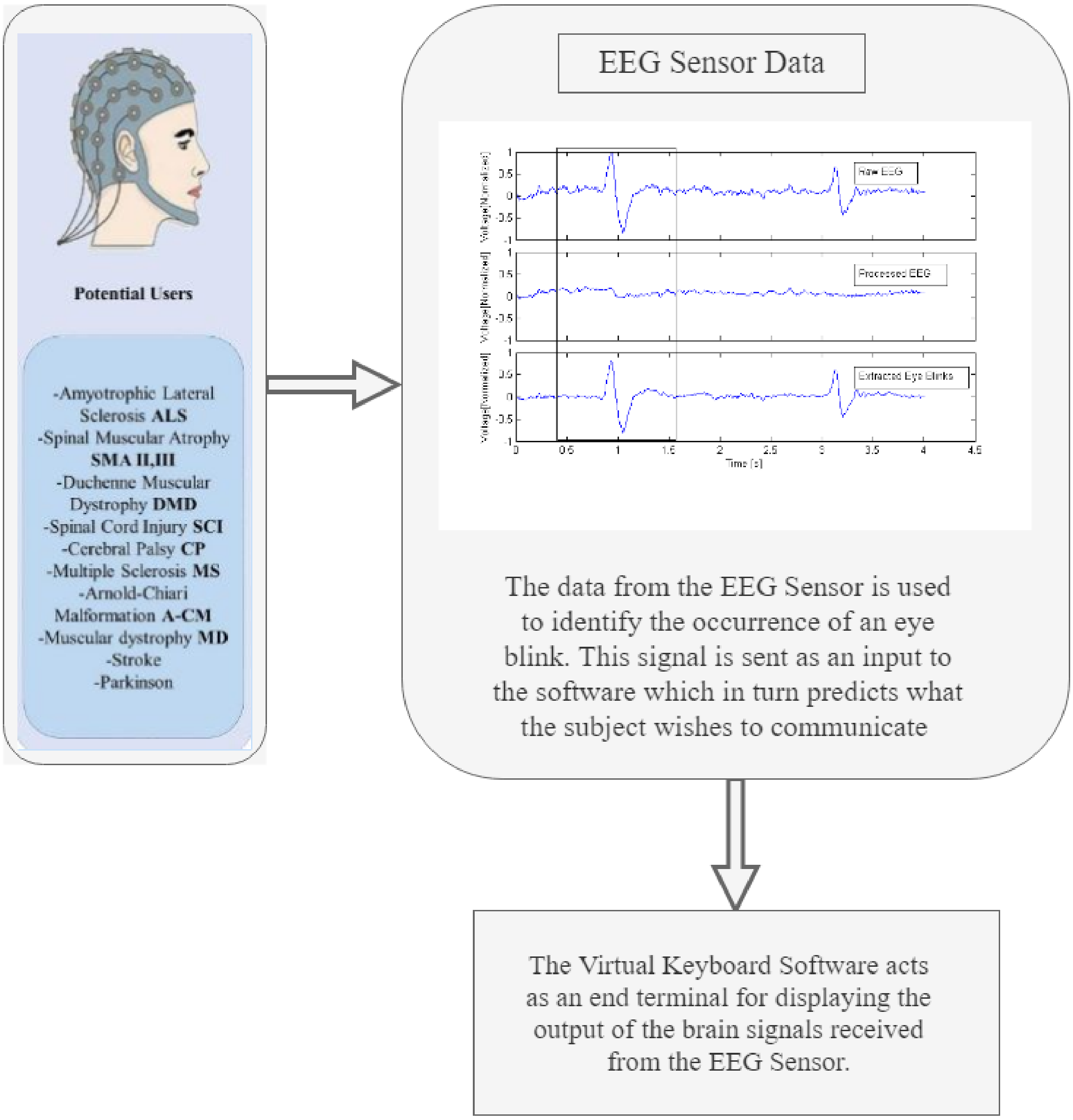


Fig 3.4 Process Flow Diagram

3.3. High Level Design



In simple words, the total workflow is as follows

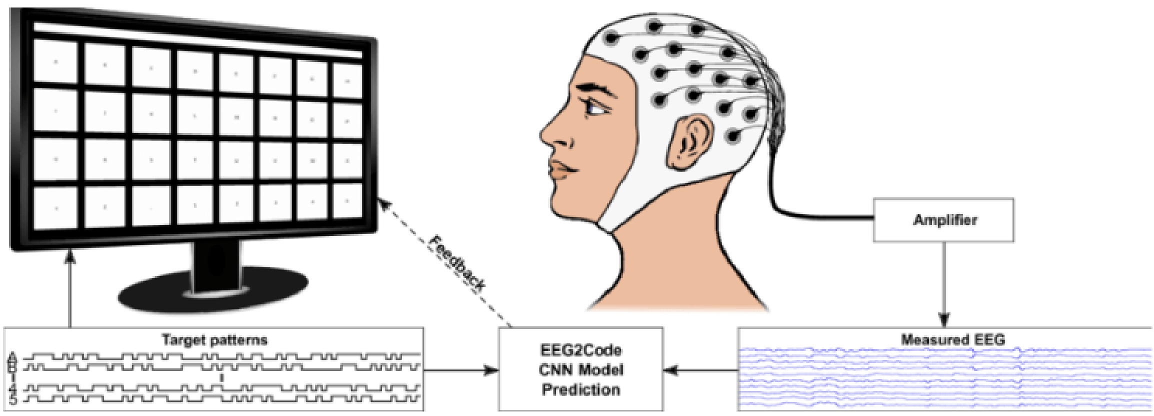


Fig. 3.5 High Level Design of RoBIK

4. Conclusions

4.1. Expected Results

We are using EEG single from Neurosky which will give output of Double blink, single blink and normal blink[12]. For predicting the double blink single blink we are going to use machine learning techniques. For our virtual keyboard we are using Double Blink allow you to select grid and Change Mode changes the mode of working from Keyboard to prediction word or vice versa[11].

4.2. Conclusion

People who have severe movement disorders like Amyotrophic Lateral Sclerosis (ALS) or Locked in Syndrome, is a condition where a patient is awake and aware of its surrounding but unable to communicate or perform any action due to paralysis. In such case Eye movement for paralysed person still works because it is not connected with spinal cord. The eye muscles are connected with brain. So till brain functions the eye muscles works and person can blink eye. For that we are collecting data from Neurosky mindwave gadget[2]. It give the EEG signal output in analog form. The data is used to check the person blinking behaviour. Blink can be Double blink, single blink and Normal blink[12]. For Classification of blinks type we are using machine learning techniques which will tell whether it is Single or Normal blink. Based on its output of ML, we are giving input to the Virtual Keyboard and text will be printed on to the screen. Since its very hard to move on each character one at a time, for that we have divided the keyboard screen into grid system. This grid system will allow the user to fast access of each character with less blinking of eye.

The First double blink will select row which is highlighted and then keyboard will then divided into two parts to select next set of character. The working of selection of character is show in the *Fig 3.3 Character Selection Process.* This is how user can select the character which ever required.

5. References

[1] Apeksha Rani H. M, Prathibha Kiran, "A Novel Method for Analysis of EEG Signals Using Brain Wave Data Analyzer", International Journal of Soft Computing and Engineering (IJSCE), Volume-5 Issue-2, May 2015.

[2] NeuroSky www.NeuroSky.com

[3] Chin-Teng Lin, Li-Wei Ko, Meng-Hsiu Chang, Jeng-Ren Duann, Jing-Ying Chen, Tung-Ping Su, Tzyy-Ping Jung, "Review of Wireless and Wearable Electroencephalogram Systems and Brain-Computer Interfaces – A Mini-Review" , Gerontology 2010;56:112–119, July 25, 2009.

[4] Kazi Sadman Kabir, Chowdhury M Abid Rahman,Araf Farayez, Mahbuba Ferdous, "An Experimental Model of An Indigenous BCI Based System to Help Disabled People to Communicate", AIP Conference Proceedings 1919, 020003 (2017); https://doi.org/10.1063/1.5018521, Published Online: 28 December 2017.

[5] Brijil Chambayil, Rajesh Singla, R. Jha, "Virtual Keyboard BCI using Eye blinks in EEG", 2010 IEEE 6th International Conference on Wireless and Mobile Computing, Networking and Communications.

[6] Rakesh Ranjan, Sasidharan P T, "Utilization of EEG Signal as Virtual Keyboard for Physically Disabled" , International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), Volume 5, Issue 5, May 2016.

[7] S. Halder, M. Rea, R. Andreoni, F. Nijboer, E. Hammer, S. Kleih, N. Birbaumer, and A. Kubler, “An auditory oddball brain-computer interface for binary choices,” Clinical Neurophysiology, vol. 121, no. 4, pp. 516–523, 2010.

[8] L. Citi, R. Poli, C. Cinel, and F. Sepulveda, “P300 based bci mouse with genetically-optimized analogue control,” Neural Systems and Rehabilitation Engineering, IEEE Transactions on, vol. 16, no. 1, pp. 51–61, 2008.

[9] G. Muller-Putz and G. Pfurtscheller, “Control of an electrical prosthesis with an ssvep-based bci,” Biomedical Engineering, IEEE Transactions on, vol. 55, no. 1, pp. 361–364, 2008.

[10] O. Bai, P. Lin, S. Vorbach, M. Floeter, N. Hattori, and M. Hallett, “A high performance sensorimotor beta rhythm-based brain–computer interface associated with human natural motor behavior,” Journal of neural engineering, vol. 5, p. 24, 2008.

[11]Krzysztof Dobosz and Klaudiusz Stawski , "Touchless virtual keyboard controlled by eye blinking and EEG signals", Conference Paper · January 2018.

[12] Masaki Nakanishi, Yasue Mitsukura, Yijun Wang , Yu-Te Wang and Tzyy-Ping Jung , "Online Voluntary Eye Blink Detection using Electrooculogram", 2012 International Symposium on Nonlinear Theory and its Applications, NOLTA 2012, Palma, Majorca, Spain, October 22-26, 2012.

[13] Martin Spuler, "A Brain-Computer Interface (BCI) system to use arbitrary Windows applications by directly controlling mouse and keyboard", 2015 IEEE International Conference.

[14] Srihari Maruthachalam, Sidharth Aggarwal , Mari Ganesh Kumar ,Mriganka Sur , Hema A. Murthy, "Brain-Computer Interface using Electroencephalogram signatures of Eye Blinks", Interspeech 2018,2-6 September 2018, Hyderabad.

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Thanking you,
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