International Journal of Scientific & Engineering Research Volume 8, Issue 7, July-2017
ISSN 2229-5518

EEG-Based Brain-Controlled Wheelchair

Dr.N.Sathish Kumar [1]
Professor ECE
Sri Ramakrishna Engineering College
sathishkumar.n.@srec.ac.in

Sivaram.N[2]
B.E IV year
Sri Ramakrishna Engineering College
sivaram.1302254@srec.ac.in

Sudhirdeep.S[3]
B.E IV year
Sri Ramakrishna Engineering College
sudhirdeep.1302221@srec.ac.in

Siranjeevi.M[4]
B.E IV year
Sri Ramakrishna Engineering College
Sriranjeevi.1302205@srec.ac.in

***Abstract*- This project discussed about a brain controlled wheel chair based on Brain–computer interfaces (BCI). BCIs are systems that can bypass through conventional channels of the communication (i.e., muscles and thoughts) to they provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time. With these commands a wheel chair can be controlled. The intention of the project work is to develop a wheel chair that can assist the disabled people in their daily life to do some work independent of others. Here, we analyse the brain wave signals. Human brain consists of millions of interconnected neurons. The pattern of interaction between these neurons are represented as thoughts and emotional states. According to the human thoughts, this pattern will be changing which in turn produce different electrical waves. A muscle contraction will also generate a unique electrical signal. All these electrical waves will be sensed by the brain wave sensor and it will convert the data into packets and transmit through Bluetooth medium. Level analyser unit (LAU) will receive the brain wave raw data and it will extract and process the signal using MATLAB platform. Then the control commands will be transmitted to the wheel chair to process. With this entire system, we can move a wheel chair according to the human thoughts and it can be turned by blink muscle contraction.**

***Index Terms*: EEG signal processing, P300 speller, brain computer interface, visual stimuli, P300 evoked Potential, Servomotors control, robotic arm.**

I.INTRODUCTION

The main objective of this project is to design a Brain wave controlled Wheel chair for disable people. We used a brain wave sensor for analysation of thoughts by disable people such as the muscle contraction can be detected and the signals are captured by the electrode present in the brain wave sensor. The captured signals are the low wave signals. The low wave signals are sent to the matlab application software. The coding is the process of converting the low wave signals into the high frequency signals. The low frequency signals have a noise such as the filtering process is done so the noise in the frequency can be detected and the noise is removed

The signal transferring from the brain wave sensor to the personal computer is done by the using of Bluetooth module. The Raw data is transferred from the brain wave sensor to the personal computer. Such as the signals are processed by the matlab and it send to the Arduino where the Arduino controls the wheel chair for the movement of Forward, Left turn, and the Right turn

The control movement can intimate to eye blink of the disable people. Such as the thoughts of moving forward, left turn, and the right turn can be done using the blinking eyes. The attention and the meditation readings can be able to detect the current status of the disable

II.LITERATURE SURVEY

SURVEY: 1: Ha Hoang Kha and Vo Anh Kha" Real-Time Brainwave-Controlled Interface Using P300 Component in EEG Signal Processing" Alphabets and the symbol are displayed in the LCD screen where the disable person can be able to select the letters by moving his finger on the LCD screen. But here we used to motor to move the wheel chair automatically

SURVEY: 2: L.A. Farwell and E. Donchin" Talking off the top of your head toward a mental prosthesis utilizing event-related brain potentials" P300 component is used to 26 alphabet letter, together with a several other symbol and command are displayed on a computer screen which serves as the keyboard. But here we used the thoughts of the disable person so the person can able to move his without any other people's help

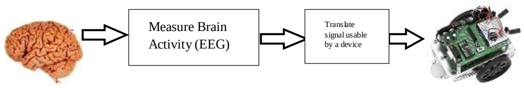

Fig-1: process diagram

III. Hardware Description

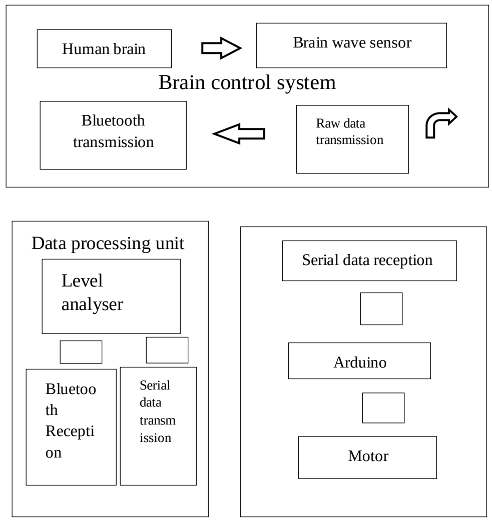

Fig-2: Block diagram

A. Brainwave sensor:

Electroencephalography (EEG) signals are commonly used in almost all brain-controlled interface (BCI) system which are designed for people with server motor disabilities. Such disable people need special system to help them to be able to communicate with their surroundings. A BCI system could be a breakthrough technology to express disable people's intentions and expressions via a brainwave sensor. On top of the p300 wave, which is an event related potential (ERP) of EEC or say in a general way, a component of our brain signal, is used in many BCI system and has characteristics among the noisy background EEG signal. The P300 (P3) wave is an event related potential (ERP) component elicited in the process of decision making. It is considered to be an endogenous potential, as its occurrence links not to the physical attributes of a stimulus, but to a person's reaction to it. More specifically, the P300 is thought to reflect processes involved in stimulus evaluation or categorization. It is usually elicited using the oddball paradigm, in which low-probability target items are mixed with high-probability non-target items. When by using the component EEG-electroencephalography (EEG) P300 component, it surfaces as a positive deflection in voltage with a latency (delay between stimulus and response) of roughly 250 to 500 ms. The signal is typically measured most strongly by the electrodes covering the parietal lobe The performance of an asynchronous BCI can be measured by the true positive rate (TPR) during the control state and the false positive rate (FPR) during the idle state. Thus, researchers strive not only to improve the TPR in the control state, but also to keep the FPR as low as possible in the idle state.

Our paper aims at proposing a novel scheme of P300-speller which is capable of processing real-time EEG signals. Unlike conventional P300-speller that elicits only one classification result for each separate session, our proposed method could produce the subjects command continuously. This novelty would be applicable to various new real-life Brain Control Interface applications

Band	Frequency	Application
Delta	1-3 Hz	Found during continuous attention task
Theta	4-7 Hz	Drowsiness in adults
Alpha 1 Alpha 2	8 -9 Hz 10-12 Hz	Relaxed closing the eye
Beta 1 Beta 2	13-17 Hz 18-30 Hz	Active thinking, Hi alert Focus
Gamma 1 Gamma 2	31-40 Hz 41-50 Hz	Shown in short term memory matching and in cross modal sensory

Table: 1 EEG rhythmic activity frequency bands

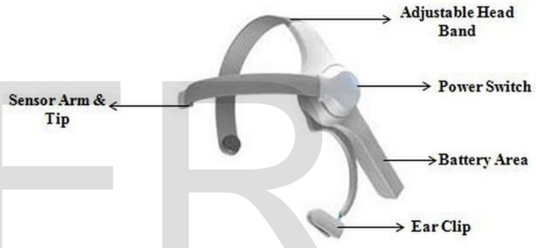

Fig-3: Brainwave Headset

B. Delta band (1-4 Hz)

Delta oscillations reflect low-frequency activity (1-4 Hz) typically associated with sleep in healthy humans and neurological pathology. In adults, delta power has been shown to increase in proximity of brain lesions and tumours during anaesthesia and during sleep. Moreover, inverse relationships between delta activity and glucose metabolism have been reported in both pathological and normal conditions. In our own study, an inverse relationship between delta current density and glucose metabolism was found within the subgenual prefrontal cortex Delta is also the predominant activity in infants during the first two years of life. Ontologically, slow delta and theta activity diminish with increasing age, whereas the faster alpha and beta bands increase almost linearly across the life span Collectively, these findings suggest that delta activity is mostly an inhibitory rhythm.

C. Theta band (4-8 Hz)

Theta activity refers to EEG activity within the 4-8 Hz range, prominently seen during sleep. During wakefulness, two different types of theta activity have been described in adults. The first shows a widespread scalp distribution and has been linked to decreased alertness and impaired information processing. The second, the so-called frontal midline theta activity, is characterized by a frontal midline distribution and has been associated with focused attention, mental effort, and effective stimulus processing. Recent studies have implicated the anterior cingulate cortex (ACC) as a potential generator of frontal midline theta activity. Consistent with these findings, in a recent study integrating electrical (EEG) and metabolic measurements of brain activity, we found that the ACC was the largest region with significant positive correlations between theta current density and glucose metabolism Physiologically, the septo-hippocampal system has been strongly implicated in the generation of theta oscillations, although theta has also been recorded in numerous other limbic regions, including the ACC, entorhinal cortex, and the medial septum, among others In rodents, generation of hippocampal theta activity is crucially dependent on afferents from the medial septum/vertical limb of the diagonal band of Broca complex, which is considered the pacemaker of hippocampal theta Additional evidence suggests that theta can be generated in the cingulate cortex independently of the hippocampal system. In light of the observation that these oscillation facilitates transmission between different limbic structures, it has been speculated that theta activity may subserve a gating function on the information processing flow in limbic regions

D. Alpha band (8-13 Hz)

The alpha rhythm refers to EEG activity within the 8-13 Hz range. In healthy adults, alpha activity typically has amplitude between 10 and 45 V, and can be easily recorded during states of relaxed wakefulness, although large individual differences in amplitudes are not uncommon Topographically, alpha rhythms show their greatest amplitude over posterior regions, particularly posterior occipito-temporal and parietal regions, and can best seen during resting periods in which the subjects have his/her eyes closed. In fact, alpha rhythm can be greatly diminished or abolished by eye opening, sudden alerting, and mental concentration, a phenomenon known as “alpha blockage” or “alpha desynchronization”. The alpha rhythm can also be attenuated when alertness decreases to the level of downiness; this attenuation is, however, often accompanied by a decrease in frequency.

The physiological role of alpha rhythm remains largely unknown. Traditionally, the posterior distribution of these oscillations and the observation of alpha blockade with eye opening have been interpreted as suggesting that alpha may be associated with visual system functions emerging in the absence of visual input. Indeed, some authors have expanded upon this notion by suggesting that alpha synchronization may represent an electrophysiological correlate of cortical “idling” or cognitive inactivity. In recent years, this conjecture has been heavily debated in the literature, particularly in studies investigating evoked EEG activity, in which alpha synchronization has been described during information processing. Further complicating the physiological interpretation of alpha, emerging evidence indicates that different alpha sub-bands may be functionally dissociated, in particular with increasing task demands. Specifically, in cognitive tasks, lower alpha desynchronization has been associated with stimulus-unspecific and task-unspecific increases in attentional demands. Upper alpha desynchronization, on the other hand, appears to be task-specific, and it has been linked to processing of sensory-semantic information, increased semantic memory performance, and stimulus-specific expectancy. Based on these and other findings, proposed that “upper alpha desynchronization reflects search and retrieval processes in semantic long-term memory

E. Arduino

We will be using the Arduino Uno board. This combines a micro-controller along with all of the extras to make it easy for you to build and debug your projects. The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogy inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.

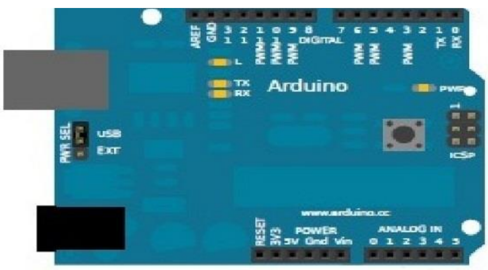

Fig- 4: Arduino board

IV. SOFTWARE DESCRIPTION

In our project we are using the Arduino, MATLAB and Brainwave visualizer software. The program is written in c language for Arduino by using the Arduino IDE and the MATLAB Program is also written by using the c language

G: Arduino Programming

The Uno can be programmed with the Arduino Software (IDE). Select "Arduino/Genuino Uno" from the Tools > Board menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Uno comes preprogramed with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

H: MATLAB Programming

The program we written in the C and FORTRAN programs language that interact with MATLAB. It includes facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

Various toolboxes are there in MATLAB for computing recognition techniques, but we are using image processing toolbox.

Steps to be followed for signal Classification Using MATLAB programming:

1. Assign port num1 to the appropriate COM port.

2. Initialize the EEG headset.

3. Get the Neuro signals from Wireless EEG headset Via RF module.

4. Checks, If (Blinking Strength > 40 && blink level == 3), Interrupt has been sent to start the wheelchair.

5. Then, Check If (Focusing level > 50), for moving forward.

6. Check, If (blink strength > 90), send an interrupt for moving right side.

7. Else.

8. Check, If (blink strength < 60), send an interrupt for moving the left side.

9. Go back to Step 6.

I: Result Discussion

In this paper we utilise the Brain wave sensor, Which is the 14 channels wireless low – cost EEG device, Thus the EEG device is used to record the raw EEG signal. There is a study that proves that the EEG channel selection for better performance. On the other hand, a thorough research on P300 waveform of Emotiv EPOC's channels was presented

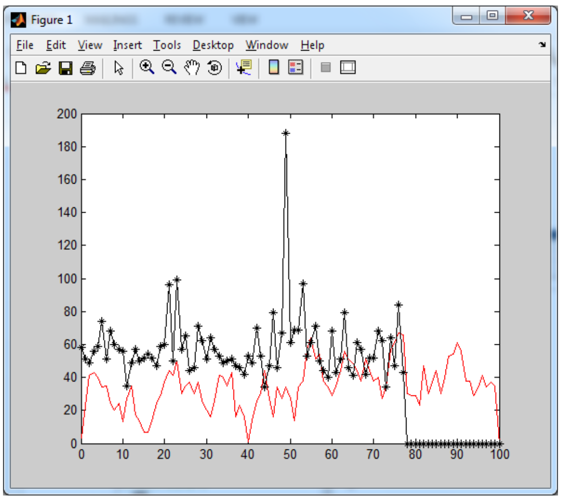

Fig-5: The figure show the eye blink readings and the attention value readings

In the above figure red colour waveform denotes the attention level of the user and the black colour waveform denotes the blink Strength The attention value is greater or equal to 40 and the eye blink count is two the wheel chair will move forward, If the Eye blink count is one the wheel chair turn left side and the count is again one then the wheel chair will move to right side. If the attention values reaches less than 40 and the mediation value reaches less than 20 means the wheel chair will automatically stops

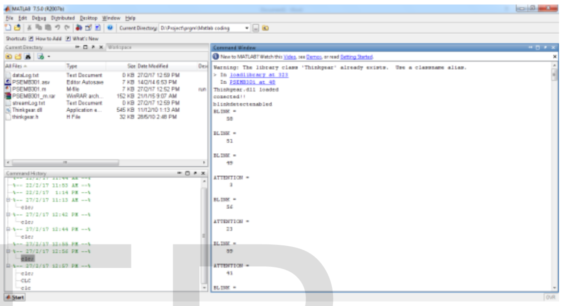

Fig-6: shows the blink readings and the attention readings

Thus the above figure shows the Attention value and the blink value in readings. Such as the attention values greater than 40means the wheel chair begins to move if the value less the 40means the wheel chair still remains in the same place

V. DESIGN FLOW

The work flow gives the step by step process about the brain-controlled wheel chair. Initially, the NeuroSky headset 16 is turned on, which is the capable of gathering the neuro signal. The EEG, dry, Bio sensor captures the signal and send to thinkGear technology for pre-processing the raw EEG signal., After analysing, digital signals are send to the MATLAB computing environment for extracting the alpha and beta wave signals for further classification. The Level analyser technique is used to process the signal. The eye blink and focusing level will be taken for analysing the process. According to the level of the eye blink and focusing level, The corresponding interrupt will be send to the processor via RF module. The two DC motors coupled with the processor controls the movements of the wheelchair. Each interrupt has a corresponding control operation like (Forward, Turn right, Turn left, Stop)

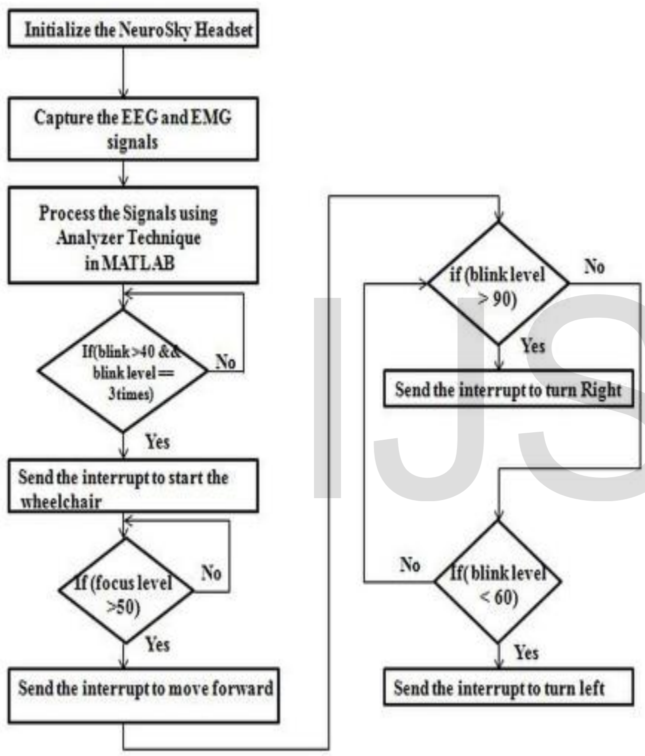

Fig-7: Design control flow of Wheelchair

VI. CONCLUSION

The signal generated by brain was received by the brain sensor and it will divide into packets and the packet data transmitted to wireless medium (blue tooth). the wave measuring unit will receive the brain wave raw data and it will convert into signal using MATLAB gui platform. Then the instructions will be sending to operate the modules. The project operated with human brain assumption and the Wheel chair is moved is based on changing the muscle movement with blinking.

VII. REFERENCES

[1] Ha Hoang Kha and Vo Anh Kha, “Real-Time Brainwave-Controlled Interface Using P300 Component in EEG Signal Processing,” in International Conference on Computing & Communication Technologies, Research, Innovation, and Vision for the Future, November 2016.

[2] L. A. Farwell and E. Donchin, "Talking off the top of your head: toward a mental prosthesis utilizing event-related brain potentials;' in Electroence. Clin. Neurophysiology, vol. 70, no. 6, 1988, pp. 510--523.

[3] H. Bouma, "Interaction effects in parafoveal letter recognition," in Nature, vol. 226, 1970, pp. 177-178.

[4] Feng, C. Jiang and S. He, "Horizontal and vertical asymetry in visual spatial crowding effects," in Journal of Vision, vol. 7, no. 2, 2007, pp. 1-10.

[5] A. Toet and D. M. Levi, "The two-dimentional shape of spatial interaction zones in the parafovea," in Vision Res., vol. 32, no. 7, 1992, pp.1349-1357.

[6] M. Treder and B. Blankertz, "Covert attention and visual speller design in an ERP-based brain-computer interface;' in Behavioral and Brain Functions, vol. 6, 2010, p. 28.

[7] R. Fazel-Rezai, "Human Error in P300 Speller Paradigm for BrainComputer Interface," in Engineering in Medicine and Biology Society,

2007. EMBS 2007. 29th Annual International Conference of the IEEE,
Aug 2007, pp. 2516-2519.
[8] N. Kanwisher, "Repetition blindness: type recognition without token individuation," in Cognition, vol. 27, 1987, pp. 117-143.