Mind Wave based Robot Control & Home Automation

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Abstract— Brain Computer Interface (BCI) systems are the tools which are proposed to help the damaged people whom are impotent of making a motor response to interface with computer using brain signals. The aim of BCI is to translate brain activity into digital form which performs as a command for computer. The BCI application can be used in different areas such as education, industrial, gaming, robotics, home automation and medical areas. In our project EEG based brain controlled robot and home automation using Zigbee has been developed using BCI with the help of NeuroSky technology. The fetched brain signals are transmitted to microcontroller via Zigbee module. Robotic module designed consists of Renesas microcontroller coupled with dc motor to perform the control. The attenuation level was used to monitor the direction of robotic and meditation level was used to monitor the home appliances. The wireless BCI system could allow the paralysed people to control the robotic and home appliances without any difficulty, provided it is portable and wearable.

Key words: EEG, NeuroSky, ZigBee, BCI

I. INTRODUCTION

Nowadays, humans have fantized to communicate and interact with machines through the thoughts and also create devices that work with human mind and thoughts. Human mind imagination is captured.

In the form of modern science fiction stories and ancient myths. However, cognitive neuroscience and brain imaging technologies have recently started to provide people with ability to interface with human brain. Using sensors some of the physical activity that occurs within the brain corresponds with the forms of thought can be monitored. For the needs of people in growing society recognition on, researchers have used this technology to build brain computer interfaces (BCIs), communication systems, i.e., a computer system that does not depend on peripheral muscles and nerves of the brain. BCI is used to build a direct control channel between users brain, i.e., users intention and computer system. Such a system can help two kinds of people, firstly the people who have damage in their physical system to recover their activities with a wheelchair, or control over a neuro prosthesis or a robot and so on.

Secondly for healthy people, it could be an additional man machine interface, which is able to increase the productivity and the efficiency in the high throughput tasks. Among different techniques for the non-invasive measurement of electro physiological signals of brain oscillations, electroencephalography is commercially used and has excellent results, which enables real time interaction through BCI.

Electroencephalography refers to an electrophysiological monitoring method which will record the electrical activity which is occurring at the surface of the brain using electrodes or sensors placing on the scalp of the brain. EEG measures electrical signals from the brain in voltage fluctuations currently occurring in the neurons of the brain. This action, in-turn, will appear on the screen of the computer which in turn connected to electrodes implanted in the brain as waveforms of varying amplitude and frequency measured in voltage or as digital values. EEG waveforms are categorized in accordance to their amplitude, shape frequency as well as the site on the scalp at which electrical signals are recorded. The most intimate grouping uses EEG waveform frequencies like alpha, beta, theta, delta, spindal, etc. The most frequently used approach to diagnose epilepsy and stroke is EEG, which causes irregularity in EEG readings. It is also used to diagnose brain death, sleep disorders, comma, muscle injury and encephalopathy. EEG used to be a primary method of diagnosis for tumors, epilepsy, stroke and other brain disorders.

In this project the 4 wheel robot is built using DC robot and L293. In this system we use Renesas microcontroller for robot analysis and human automation. In this there are 2 parts, one is transmitter and other is receiver. In which transmitter part consists of mind wave neurosky, Renesas microcontroller and Zigbee. Whereas in receiver part Zigbee, Renesas microcontroller, l293, used. DC motor, relay, toggle switch and sockets are used.

Transmitter part has mind wave neurosky using Zigbee it will be responsible for the actions of robot and home automation. Receiver part uses Zigbee for the movement of robot in forward, reverse, left and right directions. And it also uses relay for 2 purposes, one is to run the fan and other to glow the light. This has toggle switch which is used for robot movement and home automation.
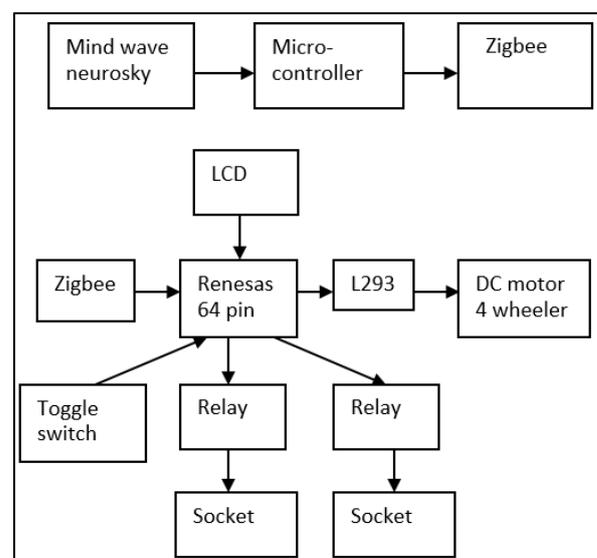
II. BLOCK DIAGRAM

Fig. 1: Block Diagram

III. METHODOLOGY

The proposed single trail EEG classification [2] in BCI Consists of two modules:

A. Signal Acquisition

For the accession system, the most frequently used recording method is EEG. The EEG method uses electrodes or sensors which are an appeal on the scalp, there is the main advantage of using this approach that is the portability of the recording system. Further methods required bulky instrumentation which is costly or is very expensive and those are invasive. The different phases of this module are:

1) Brainwaves

In this system, the mind wave mobile headset by Neurosky is utilized to read the EEG signals, shown in figure 1. The e-Sense algorithm by neurosky exercises the EEG signals and wirelessly transmits the calculated attention and meditation values through Bluetooth to a master device i.e., HC 05 Bluetooth at the rate of 1hertz.

The frequencies of the electrical signals can be measured by placing a sensor on the scalp. Table 1 [3] gives a general view of some of the commonly recognized frequencies that tend to be generated by different types of activities of brain.
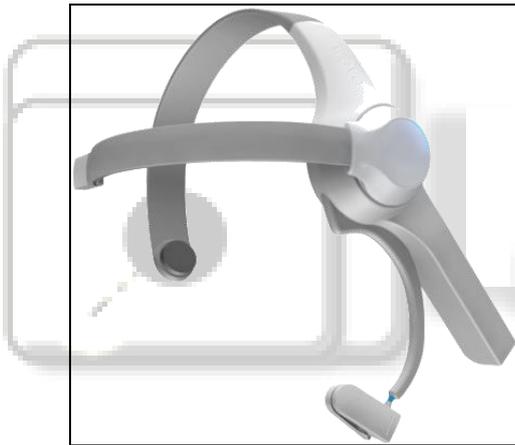

Fig. 1: Neurosky Wireless EEG-Headset

Brain Waves	Frequency Ranges	Mental States and conditions
Delta	0.1 – 3Hz	Deep sleep, dreamless sleep, unconsciousness.
Theta	4 – 7Hz	Creative, recall, fantasy, imaginary, dream.
Alpha	8 – 12Hz	Relaxed (not drowsy), conscious.
Low range beta	12 – 15Hz	Relaxed yet focused.
Medium range beta	16 – 20Hz	Thinking, aware of self and surroundings.
High range beta	21 – 30Hz	Alertness, agitation.

Table 1: Frequency Range of Different Brain Waves

2) Think Gear

Think gear is the equipment which is contemporary interior of every neurosky product that allows the device to integrate with the users brain waves. It consists of sensors which touch the forehead of the user, the reference and junction points presented in the ear clip, and the on-board chip that operates all of the data. Both the dominant brain waves and the e-Sense meters (attention and meditation) are calculated on the think gear chip.

3) e-Sense

e-Sense is the neurosky with fix algorithm for distinguishing mental states. To compute eSense, the neurosky think gear technology fleshes out the raw brain wave signal and removes the atmosphere noise and muscle moment. The eSense algorithm is then appealed to the remaining signal, resulting in elucidated eSense meter values.

4) e-Sense meter

For each different types of e-Sense,i.e., the attention and meditation meter value are described on e-sense respective scale of 1 to 100. The value across 40-60 at any given moment in time is considered "neutral" and is similar in notion to base lines. The across 60-80 is considered "slightly elevated", may be interpreted as levels of e-sense values may be higher than normal for a given person. Values across 80-100 are considered "elevated", denoting they are strongly expressive of heightened levels of the e-sense. Similarly, on the other end the values from 20-40 indicates "reduced" levels of the e-sense, while the value across 1-20 indicates "strongly lowered" levels of the e-sense.

5) Attention eSense

The eSense attention meter specifies the strength of the user's level of mental "attention" or "focus", which occurs during extreme concentration and directed (but stable) mental activity. The meter value ranges from 0-100. Lack of concentration, wandering thoughts, distraction, or anxiety may decrease the attention meter level.

6) Meditation eSense

The eSense meditation meter specifies the user's level of mental "relaxation" or "calmness". The value ranges from 0-100. The account that meditation is a meter of the person's mental states, not physical states so just relaxing of all body muscles may not quickly result in an enhanced meditation level. Nevertheless, for most people in most everyday situation, relaxing the body frequently helps the mind to relax as well. Meditation is associated to decrease the activity by the active mental process in the brain. It has been an observed that closing the eyes is often an effective method for increasing the meditation meter level. Distractions, anxiety, sensory stimuli and wandering thoughts may lower the meditation meter level.

7) Zigbee

Zigbee is the most popular industry wireless mesh networking standard for connecting sensors, instrumentation and control systems. Zigbee, a specification for communication in a wireless personal area network (WPAN), has been called "Internet of Things" [4]. Theoretically, your Zigbee-enabled coffee maker can communicate with your Zigbee-enabled toaster. Zigbee is an open, global, packet based protocol designed to provide an easy-to-use architecture for secure, reliable, low power wireless networks as in figure 2. Zigbee and IEEE 802.15.4 are low data rate wireless networking standards that can eliminate the costly and damaged prone wiring industrial control applications. Flow or process controls equipments can be placed anywhere and still communicate with rest other systems. It can also be moved, since the network doesn't care about the physical location of the sensor, pump or valve.

Fig. 3: Zigbee Module

8) Renesas

The expanding family of renesas RL78 microcontroller (Figure 3) consists of both general purpose and application specific devices. This increasingly popular MCU's make possible ultralow power applications by giving system designers advanced power saving features and high performance operations. Because the devices offer important capabilities such as an innovative snooze mood that demonstrably superior solutions for a vast span of battery powered applications [6].

In this project, the renesas microcontroller is worned to gather and examine the electrical brain signals from the sensors to be used in actual-time or stored for future analysis.
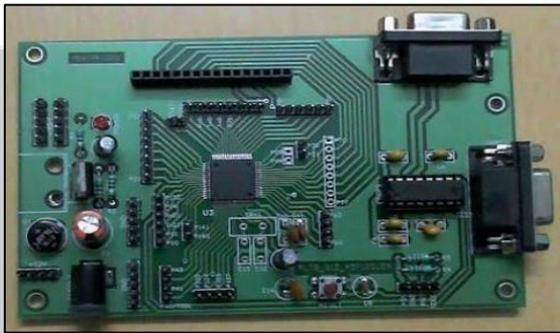

Fig. 4: Renesas Microcontroller-Rl78

IV. CONCLUSION

An EEG based brain controlled robotic and home appliance was proposed for disabled people and senior's people to lead their daily life without any arduousness. Two applications were developed. The electrical signals of attention used for making a robot to move in forwarding direction for 10 feet's and coming back to the starting position, and meditation signals where used for controlling home appliances. Based on various metrics the performance was analyzed. The prototype model of EEG-based controlling robotic and home appliances has been developed with the help of neurosky technology.

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REFERENCES

[1] Hong Zeng, Member, IEEE, and Aiguo Song, Senior Member, IEEE, "Optimizing Single-Trial, EEG Classification by Stationary Matrix Logistic Regression in Brain Computer Interface", Neural Networks and Learning Systems, IEEE Transactions, Vol. 27, Nov 2016.

[2] B. Bijitha, Nandakumar Paramparambath "Brain Computer Interface Binary Classification Using Regularized CSP and Stacked Concept", International Journal of Engineering Trends and Technology (IJETT), V38 (5), 271-275 August 2016

[3] Renji V. Mathew, Jasmine Basheer "An EEG Based Vehicle Driving Safety System Using Automotive CAN Protocol", International Journal of Engineering trends and Technology(IJETT), V26(4), 212-216 August 2015.

[4] W. Samek, Member, IEEE, Motoaki, Kawanabe, and Klaus Robert Muller, Member, IEEE, "Divergence Based Framework for Common Spatial Patterns Algorithms", Biomedical Engineering, IEEE, VOL. 7, April 2014.

[5] Dwipjoy Sarkar, Atanu Chowdhury. "A Real Time Embedded System Application For Driver drowsiness and Alcoholic Intoxication Detection", International Journal Of Engineering Trends and Technology (IJETT), VOl.10 (9), 461-465 April 2014.

[6] M. Arvaneh, Student Member, IEEE, C.Guan, Senior Member, IEEE, Kai Ken Ang, Member, IEEE, and ChaiQuek, Senior Member, IEEE, "Optimizing Spatial Filters by minimizing Within Class dissimilarities in Electroencephalogram based Brain Computer Interface", Neural Networks and learning Systems, IEEE Transactions, VOL.24, April 2013.

[7] NeuroSky Mindwave Headset, Available: http://neurosky.com/products-markets/eegbiosensors/

[8] SiliveruRamesh, K.Harikrishna, J.Krishna Chaitanya, "Brainwave Controlled Robot Using Bluetooth", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 3, pp. 11572-11578, August 2013.

[9] Sridhar Raja .D, "Application of BCI in Mind Controlled Robotic Movements in Intelligent Rehabilitation", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 2, pp. 1231-1238 ,April 2013.

[10] Luzheng Bi, Xin-An Fan, Yili Liu, "EEG-Based Brain-Controlled Mobile Robots: A Survey ", IEEE transaction on human machine systems", vol. 43, pp. 161-176, March 2013.