

A Brain Computer Interface for Smart Home Control

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Abstract— The goal of this work is to help physically disabled and paralyzed people. The Brain computer Interface (BCI) is a transmission between the human brain and computer or external device. NeuroSky Brainwave sensor is used to sense attention values of the brain signal and eye concentration. ARM7 processor is used as interfacing device. According to the attention values and concentration the switching of devices will be controlled.

Keywords - *Brain Computer Interface (BCI), NeuroSky Brainwave sensor, Electroencephalogram, ARM7 Processor.*

I. INTRODUCTION

The Electroencephalographic signals (EEG) recorded the brain activity using the Mind wave headset and it is interface with the help of Bluetooth module. The user will control various devices in home by using attention values.

BCI is a system that capture the brain electrical activity in the form of EEG signal and translate those signal into computer readable commands. The BCI can be divided into invasive type and non-invasive type.

Different brain states are gives the different patterns of neural interaction. These waves characterized by different amplitude and frequencies. The signal which are generated by brain and was received by the brain sensor, it will divided into packets and packet data transmitted to Bluetooth. And this raw data convert into signal using MATLAB. Then the instructions will be sending to the home appliances module like fan, bulb. The project operated with human brain assumption and the ON-OFF condition of home appliances is based on concentration.

II. LITERATURE REVIEW

M.H. Masood, M. Ali Kathia present a paper states that the system is used to facilitate the handicapped and needy or paralyzed persons. NeurSky headset is used to sense the Electroencephalogram (EEG) signal or attention values from brain activity and concentration. Recognizing the brain activity for certain thoughts and concentration patterns, we managed with the switching of the home appliances like fan and bulb.

Robert-Bela NAGY1, Florin POPENTIU2, Radu C. TARCA3 proposed the system Brain Computer Interface (BCI) is also called Brain Machine Interface. It is direct communication between the human brain and external device. Brain Computer Interface system offer communication and control capabilities to people with severe disabilities. One example of BCI application is the EEG based brain controlled mobile robots that can serve as powerful aids for disabled people.

Brent J. Lance presented a paper focuses on using online brain signal processing to enhance human computer interaction; it highlights past and current BCI applications.

Chin-Teng Lin, the paper states that a brain computer interface-based on smart living environmental auto-adjustment control system (BSLEACS). Recently, many environmental control systems have been proposed to improve human quality of life. Now, research has focused on environmental control directly using the human physiological state. Based on the advantage of technique on brain computer interface (BCI), integrated the BCI technique with universal plug and play home networking for smart house applications like fan and bulb.

Guger C¹, Holzner C¹, Grönegress C², Edlinger G¹, Slater M² Iss, proposed paper state that the purpose was to discover to detect the dynamic variations of brain activities. A brain computer interface for smart home control system is developed for physically disabled people.

III. CURRENT STATE OF ART

In BCI system, Neurosky brainwave headset connected to a computer through wired or wireless connection. The headset is used to record and transmits the brain signals to computer.



Fig. 1 NeuroSky Brainwave sensor

IV. PROPOSED WORK

A. MEASUREMENT OF EEG SIGNALS

To acquire the EEG signal by using NeuroSky brainwave sensor headset that are placed on the user scalp. NeuroSky brainwave sensor that fits comfortably head. The NeuroSky brainwave sensor consists of two electrodes, one is connected at the forehead right above the left eye and other one is connected to the left ear that consider as ground. The headset capture the brain waves signals and transmits it to the computer via Bluetooth.

B. PRE-PROCESSING OF RAW DATA

Electroencephalogram (EEG) signals are very low power signals. Pre-processing and signal conditioning on EEG signal are performed to improve the signal quality.

C. BCI BASED SMART HOME CONTROL

A paper presents BCI based smart home appliances control system. Non-invasive type BCI system is used to develop smart home control system. A NeuroSky brainwave sensor is used to analyse EEG signals. A BCI is a direct communication link between the human brain and the external devices. According to the human thoughts i.e. brain attention values the external devices are operated.

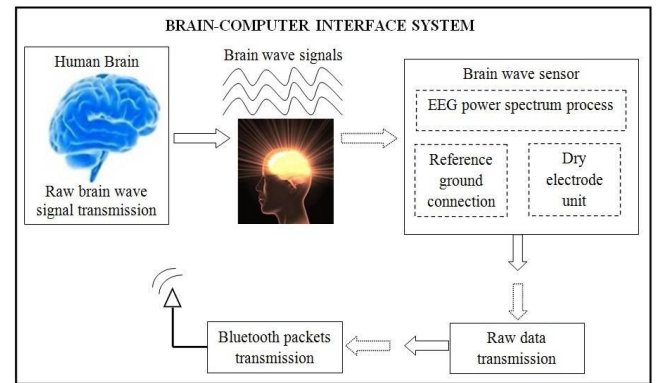


Fig. 2 Brain-Computer Interface section

Computer sense that raw signals which are generated by human brain and then converted it into appropriate frame format which will be recognized by the computer. After the frames get generated, these frames are sent to the computer via Bluetooth communication transmitter.

D. LEVEL ANALYSIS PLATFORM

In this stage, the Bluetooth receiver module of computer will accept the signal transmitted by the Bluetooth transmitter which is in-built in the human brain wave sensor.

Now these frames are processed in the MATLAB software which will detect the signal send by the brain. The computer will convert the level of the signal detected by the MATLAB in to the serial data which is require to transmit at ARM7 controller using serial communication.

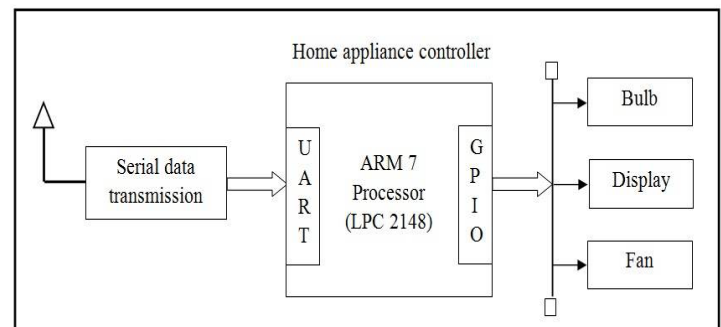


Fig. 3 Controller section

E. HOME APPLIANCES CONTROLLER

Using UART serial communication protocol, MATLAB software will transmit the serial data from computer to the ARM controller board. ARM controller will detect the signal it will process it and according to that it will turn ON/OFF the appliances such as fan and bulb.

F. ATTENTION VALUES

The human brain is made up of billions of interconnected neurons. Different brain states that different patterns of neural interaction. The attention consider that reading values

and combine them with user-generated data to determine the attention. Using NeuroSky brain wave sensor read attention values and combine them to the user-generated data.

The attention value ranges from 0 to 100. When user focuses on single thoughts or any external objects the attention level increases, and decreases when distracted. These wave characterized by different frequency and amplitude.

BAND	FREQUENCY [Hz]
Alpha	8-13
Beta	13-22
Delta	0.5-4
Theta	4-8

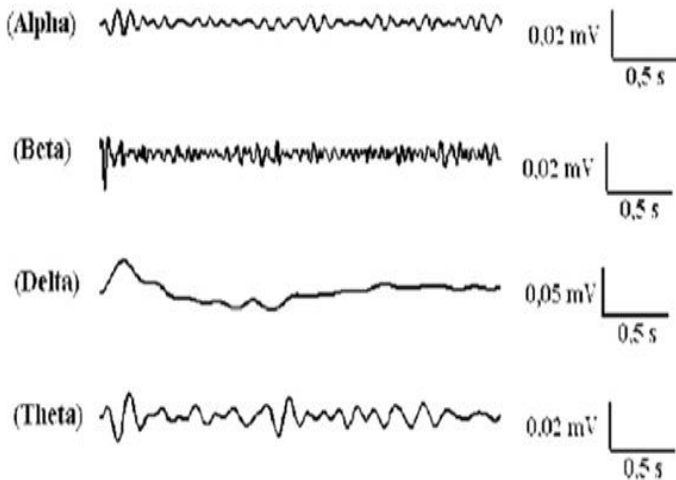


Fig. 4 EEG signal after decomposition of frequency band

V. APPLICATION

Brain computer interface is useful in various fields of research. They are involved in medical, neuroergonomics and smart environment, educational and self-regulation. BCI system hold greater potential for people who are paralyzed or otherwise unable to use their hands.

- Useful for blind people.
- Useful in industries.
- Useful in hospitality.
- Useful for physically handicapped people.

VI. RESULTS

The proposed system is implemented and desired results are obtained in controlling the physical devices using brain signals. The EEG signals that are sensed by the brainwave sensor are checked using the brainwave visualizer application. After giving the run command in MATLAB, the form of the visual basic is displayed when the concentration value is detected. Depending on the attention value the switched ON and switched OFF.

TEST RESULT

Sr. No.	CASE	ATTENTION VALUES	APPLIANCES	
			FAN	BULB
1.	A	80 to 90	ON	-
2.	B	30 to 40	-	ON
3.	C	Above 90	OFF	-
4.	D	Below 30	-	OFF

VII. CONCLUSION

The non-invasive BCI is technique which is still under research. This paper presents the design and implementation of non-invasive type of Brain computer Interface technique to control the home appliances using EEG based brain signals. It includes NeuroSky Brainwave sensor with a dry electrode. This paper works on the brain signals for controlling the physical devices, so the paralyzed and physically disabled people can independently do their work like switching ON and OFF the fan and bulb by their own. Whereas, in existing techniques remotes are used for controlling purpose. In the future, this technique can be used to replace the whole manual control system in industries with the human mind control.

VIII. FUTURE SCOPE

- Brain Computer System can also be interfaced with smart phones, desktops, game consoles, TV which can be controlled by our brain.
- Brain sensor as NeuroSky sensor can be used in future to control electronic toys or also to avoid obstacles for blind people.
- Brain Computer Interface system is also known as mind machine interface system, so it can also be used to run a car with brain.

- iv. Brain Computer System can also be interfaced for long distanced operations.

IX. REFERENCES

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