IJCTA, 9(37) 2016, pp. 555-561

EEG Signal Control Image Transmission in Mobile Robot

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Abstract: This project discussed about surveillance robot using brain waves. BCIs are systems that provide direct communication and control among the human brain and physical devices by translating different patterns of brain activity into commands in real time. Brain Machine Interface (BMI) technology is very useful made for disabled people to communicate with the external machine using their own sense. Human brain consists of neurons. According to the human thoughts the pattern of interaction of neurons will change which produces electrical signals. A blink eye contraction also produces unique electrical waves. All these signals will be sensed by the brainwave sensor and it will convert the data into packets and transmit these packets through Bluetooth medium. Level analyzer unit (LAU) will receive the brain wave raw data and then it will extract and process the signal using MATLAB platform. Now the control command is transmitted to the robot module to process. With this entire system, we can move a robot according to the attention or meditation level and it can be turned by blink muscle contraction. Now if the user needs to see the image of the robotic visible region the user have to send some continuous high EEG signals based on blink muscle contraction. This process makes the robot to activate the CMOS camera to capture the image. Through MATLAB GUI, user can see the image in computer.

Keywords: (BMI) Brain machine interface, (LAU) Level analyzer unit, Eye blink contraction.

1. INTRODUCTION

Robot is mostly used in industry but now a day it is gradually enter in human life. Generally healthy people can use the robots by using conventional input devices such as keyboard, mouse or joystick. Using of these devices are difficult for elderly or disabled individuals. People suffering from motor disability have to face many problems in their daily life. A lot of techniques has been developed for physically disabled people to interact with physical devices. Due to the more efficiency than other biomedical signals application of EEG signals increases. EEG signal has been also been used in biometric to provide identification and authentication[1].brain computer interface (BCI) is one of the technique that provides the direct communication between human brain and physical devices [2]. A BCI based satellite television control has been developed in [3]. Previously BCI was be established by using 10-20 standard electrode system. In 10-20 electrode system 20 electrodes are fixed on the users scalp at 20 standard locations. Because of the more complexity and less accuracy 10-20 standard electrode system has been replaced by neurosky brain wave sensor [4].

Every NeuroSky product comes with a Think Gear chip which enables the interface between user's brain and robotic systems. This TGAM (Think Gear) module consists of an onboard chip to filter the electrical noise by processing the data sets. Raw brainwaves and the essence (attention and eye blink) values can be determined and also calculate the most recent eye blinks of user for controlling the physical devices. A typical BCI is composed of signal sensing and signal processing [2, 4]. Although many researchers have MADE various Brain-controlled robots, to the best of our knowledge but none of the existing brain-controlled mobile robots comes in the controlled laboratory environment. The reason for this is that EEG signal has not in stationary nature. Thus, to make these robots usable in real-world there is a need of the stable BCI. If a BCI system is not stable, some other techniques should be further developed to improve its

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overall performance. First all of Rebsamen et al., Iturrate et al developed a robotic wheelchair by combing P300 BCI and an autonomous navigation system. The advantage of the latter is that it allows the user to control the wheelchair to take turn left or right at any time by concentrating his attention on the "turn left" or "turn right" icons at the lower section of the visual display.

This paper presents brain-controlled mobile robot by using "direct control by the BCI," where EEG signals are translated into motion commands to control robots by using BCI technique directly. Initially this method developed a brain-controlled robotic wheelchair where the left or right turning movements of this wheelchair is directly controlled by corresponding motion commands translated from user brain signals when the users imagine left or right limb movements, and this system is tested in real-world situations [5]. The proposed robotic system also used a BCI based on motor imagery to build a brain-controlled surveillance robot which can perform three motion commands including turning left and right and going forward, and apart from this it captures the image. This robot can be validated t in a real world.

2. PROPOSED SYSTEM

A. Block Diagram and Working

The operation is very simple. The brain wave sensor contains two dry sensors. One of the sensor tip placed at the forehead of the brain detects the electrical signal of the brain. At the same time, the sensor tip also pick up the ambient noise generated by human muscle, computers, and other electrical devices. The second sensor, ear clip, is a ground reference and it allows think gear chip to filter out the electrical noise. Brain wave sensor measures the raw signal, power spectrum (α, β, γ, δ, θ) attention level, mediation level and eye blink strength. The raw EEG data received at a rate of 512 Hz. Other measured values are made every second. Therefore, raw EEG data is a main source of information on EEG signals using Mind Wave MW001. All these signals will be sensed by the brainwave sensor. The brainwave sensor will convert the data into packets and transmit these packets through Bluetooth medium. Raw data will be received by computer. Now the on the computer these signals will be processed using MATLAB platform. Now the control command is given to robot module to process. With this entire setup the robot is work according to Brain signal.

3. PROPOSED METHODOLOGY

Electroencephalography is the detection and measurement of electrical activity of the human brain. In this project brainwave sensor is used to analyze the EEG signals. This design discuss about processing and recording the raw EEG signal from the Brain Wave sensor in the MATLAB environment and through ZigBee transmission, control commands will be transmitted to the Robot section. Brain wave sensors are not only for clinical use, but it is also used in the Brain Control Interface (BCI) technology. The BCI is a technique to provide the direct communication between the brain and an external device.

1. Design Theory

A. Matlab Platform

The platform allows including thinkgear.dll. This environment has large support in toolbox, which makes it ideal for a scientific research. This paper presents recording and processing of raw EEG signal in MATLAB environment using Mind Wave sensor. The Communication Protocol shows a set of digital rules for exchange the information between MATLAB environment and Mind Wave MW001 device. This topic also shows the main parameters of think gear library.

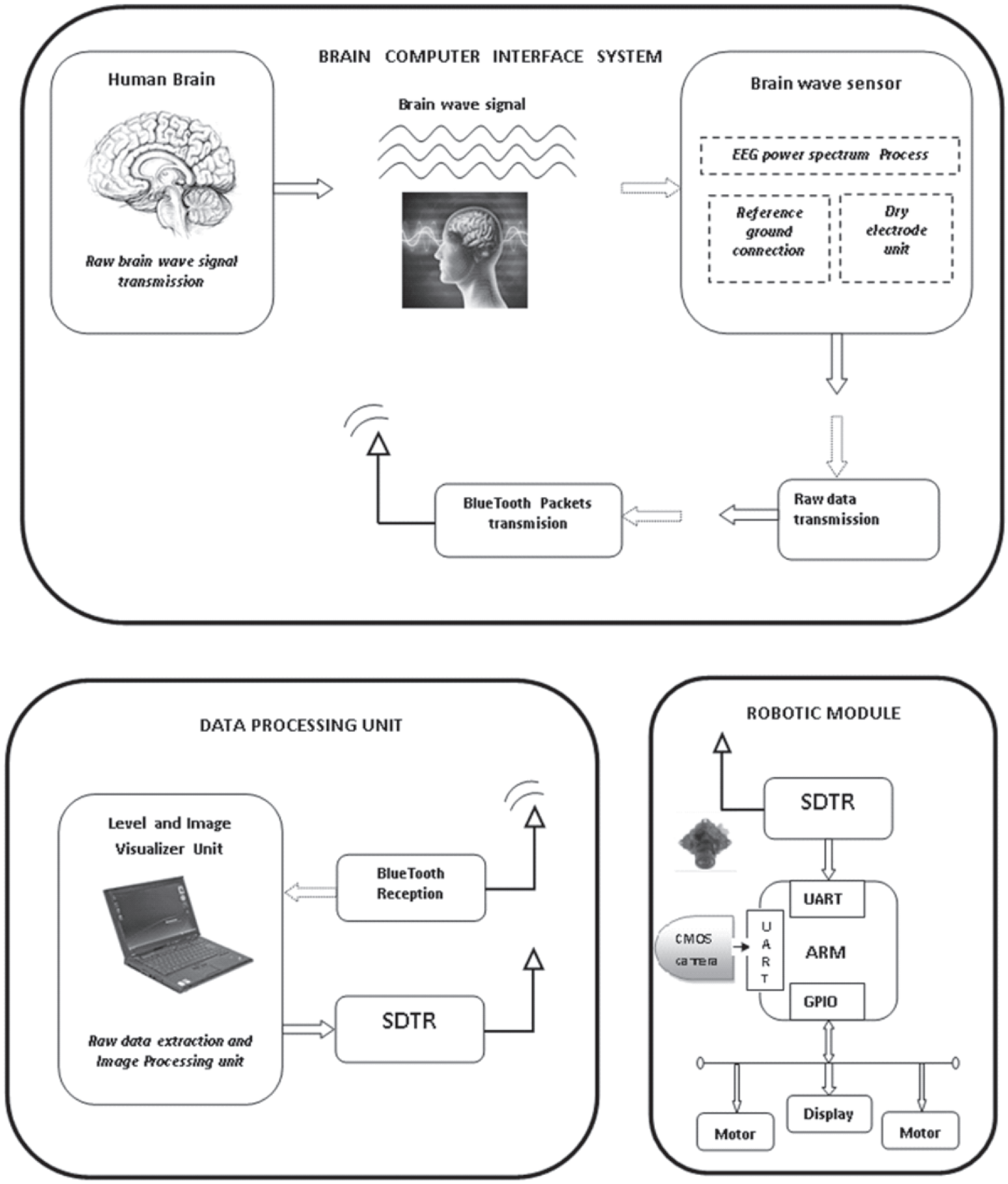

Figure 1: Proposed system block diagram

B. The Communication Protocol

The proposed communications protocol is a set of simple rules to exchange the message between pc and the EEG device. It consists of 7 basic steps, which are presented in following steps.

- Load the Think Gear library into MATLAB
- Find a new connection ID handle to Think Gear
- Attempt to connect the connection ID handle to com port "COMx"
- Waiting to establish the connection
- Read packets from the connection
- Close the connection
- Unload Think Gear library

C. Hardware Section

The value of raw EEG signal can be read with the maximum frequency of 512 Hz. So we set the Sampling frequency on 512 Hz, and control time delays in sampling. The value of the signal and time are written to the array data. The data which are stored in array will be compared with the threshold points given by the user. In this project, the Mat lab section waits for three consecutive blink in order to send the hardware activation signal. Then based on the blink level signal, the control signals will be passed to the robotic processor in form of ASCII UART transmission. These functions are driven based on interrupts generated by respective events of MATLAB by analyzing the brain signals, furthermore CMOS camera drivers are also been implemented with serial UART configuration.

The module uses an Omni Vision CMOS VGA color sensor with a JPEG compression chip that makes a low cost and low powered camera system. The module has a serial interface (TTL or RS232) to provide direct communication between any host micro-controller UART and a PC system COM port.

User's EEG commands are transmitted to controller to capture image by using a simple serial protocol. After getting the users command the controller can instruct the CMOS camera to send low resolution (160×120 or 80×60) single frame raw images for a quick viewing or high resolution (640×480 or 320×240) JPEG images for storage or viewing.

4. SYSTEM HARDWARE

A. LPC2148 Processor

It is based on The ARM7TDMI-S CPU core. These microcontrollers are general purpose 32-bit microprocessor, which offers high performance and also allows very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, so its instruction set and related decodes mechanism are much simpler than those of micro programmed Complex Instruction Set Computers (CISC) which results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core.

Pipeline techniques are used so that all parts of the processing and memory systems can operate continuously. The ARM7TDMI-S processor also used a unique architectural strategy called as Thumb that makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue.

The idea behind Thumb is that here instructions set will be reduced more.

B. Brain Wave Sensor

It detects the electrical activity of the human brain. The brain wave sensor contains two dry sensors. One of the sensor tip placed at the forehead of the brain detects the electrical signal of the brain. At the same time, the sensor tip also pick up the ambient noise generated by human muscle, computers, and other electrical devices. The second sensor, ear clip, is a ground reference and it allows think gear chip to filter out the electrical noise. Brain wave sensor measures the raw signal, power spectrum (α, β, γ, δ, θ), attention level, mediation level and blink detection. The raw EEG data received at a rate of 512 Hz. Other measured values are made every second.

C. CMOS Camera

This micro camera is a highly integrated serial camera module can be attached with any host system that requires a video camera or a JPEG compressed camera in embedded application for robot vision. Although CMOS sensor has same sensitivity as CCD sensor CMOS sensors are very fast. It is 10 ~ 100 times faster than CCD. So CMOS camera is very good for special applications. Because the use of less peripheral circuits the total power consumption by the CMOS camera is less than the CCD camera.

D. ZigBee Module

Sigsbee technology is an industry standard wireless communication technology used by the Xbee module. This Wireless communication technology is widely used for the ZigBee home automation systems, industrial automation, remote control systems, medical care equipment's, agriculture automation.

It is an IEEE 802.15.4 standard. It allows up to 100 meters wireless communication when it is placed with other Bee module. But in mesh topology it offers a long distance communication. ZigBee technology is mostly used for low data rate application with long battery life. ZigBee technology is low cost, low power, easy to install, low maintenance, and comes with multiple topology. In the proposed system ZigBee technology is used to provide the wireless communication between pc and robotic module.

E. DC Motor

A dc motor is a device that converts the electrical energy into mechanical energy. It has two major parts.

1. Stator: it is the static part of motor that housing the field windings and receive the supply.
2. Rotor: it is the rotating part of the motor that brings about the mechanical rotation.

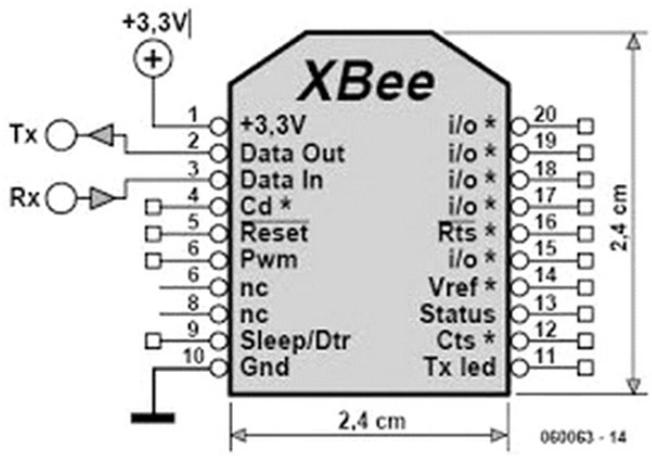

Figure 2: Pin diagram of XBee module

The operating principle of dc motor is very simple. If a current carrying conductor is placed in the uniform magnetic field it experiences some force due to which the rotor rotates in that direction. The direction of the force is given by the "Fleming's left hand rule".

5. SIMULATION RESULTS AND OBSERVATION

After connecting the brain wave sensor with computer and running the matlab program user can obtain the attention level, meditation level and eye blink strength corresponding to their brainwave signals. Figure 3.1 and 3.2 shows the attention level and eye blink strength values at different instant of time also attention level and eye blink strength level plot has been shown. From the Matlab command window it is clear that when the attention level reaches above its threshold value the help dialog window shows 'forward'. This command will be transmitted to the robot to move it in the forward direction. Similarly the user can give the command to take left or right turn according to the eye blink signal. Similarly the robot can capture the image according to the brain signal command given to it. The forward movement and left turning movement is shown in Figure 3.1 and 3.2 respectively. The result can be implemented on the hardware also.

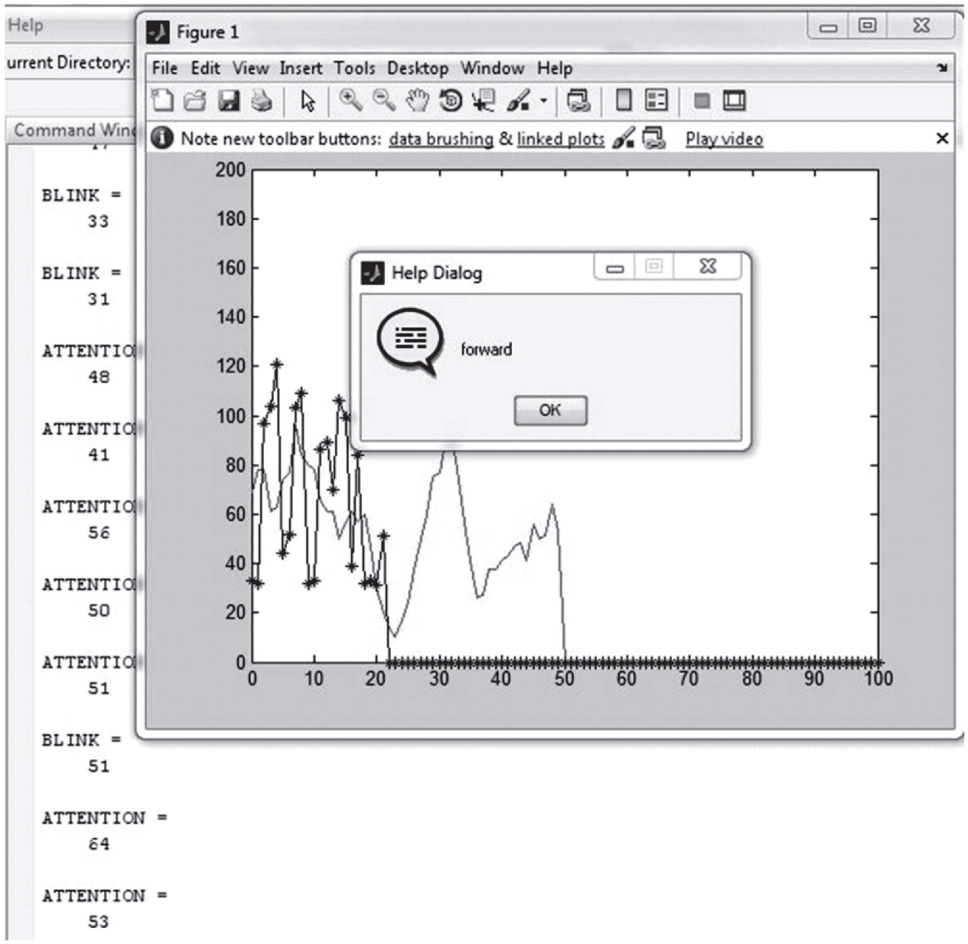

Figure 3.1: Values of Attention level and eye blink strength for forward movement of robot

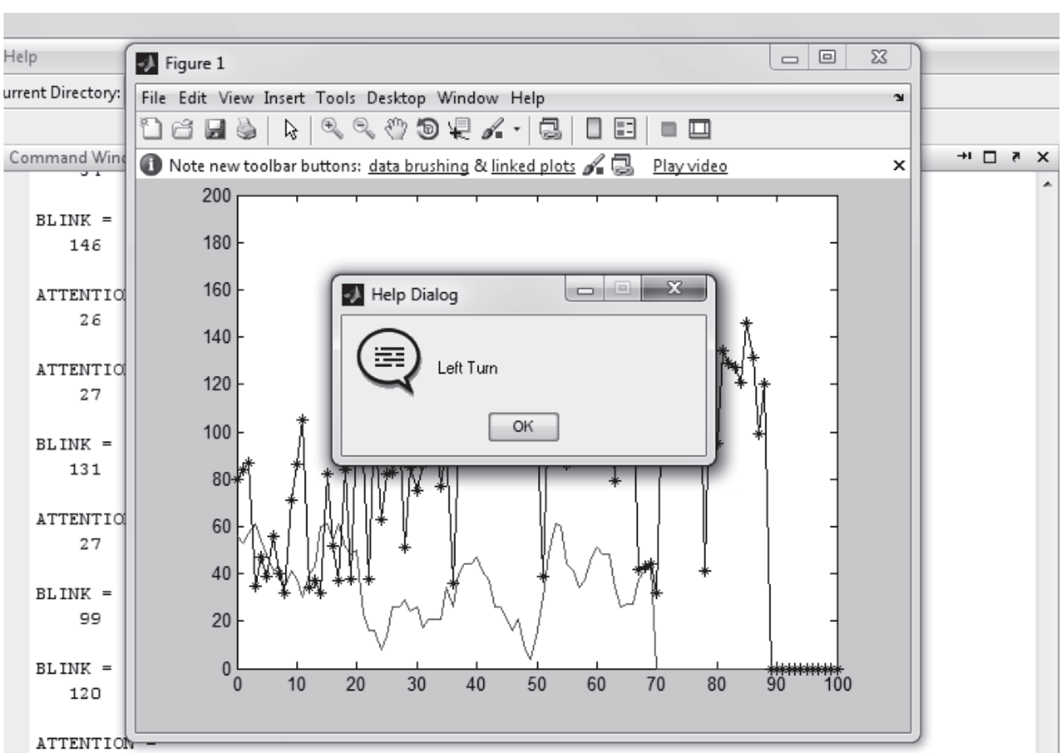

Figure 3.2: Values of Attention level and eye blink strength for left movement of robot

6. CONCLUSION AND FUTURE WORK

In the coming aging society, not only disabled people but also elderly people need an effective BCI system to control a service robot to provide appropriate service for them. With advancing technological development, different BCI systems have been designed and used to control various devices, such as wheelchairs and robot manipulators. Although current BCI systems can recognize and transfer the user's intentions into control commands, most of them are focused on investigating algorithms to improve the correct recognition rate of a certain kind of EEG signal. This study reports the differences in behavior and EEG spectra while participants performed two different cognitive tasks: a lane-keeping driving task and a mathematical problem-solving task. Measurement of these signals is done through EEG by placing electrodes along the scalp and recording the brainwave response when the subject, initially in a relaxed state, is exposed to the stimuli. The Future is to implement the BCI robot .

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