Brainwave Sensor Based Vehicle Attention Tracking Using Arduino

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Abstract **-** This project discussed EEG-Based Drowsiness tracking system during Distracted Driving based on Brain computer interfaces (BCI). BCI is system that can bypass conventional channels of communication (i.e., muscles and thoughts) to produce direct communication and control between the human brain and physical device by translating different patterns of brain activity into command in real time. With these signal from brain in matlab signals spectrum analyzed and estimates driver concentration and meditation conditions. The patterns of interaction between these neurons are described as thoughts and emotional states. According to the human thought, this pattern will be change in turn produce different electrical waves. Muscle contractions will also generate unique electrical signals. All these electrical waves will be captured by the brain wave sensor and it will convert the data into packet wise and transmit via Bluetooth medium. Level analyzer unit (LAU) will receive the brain wave raw data and it will be extract and process the signal using Mat lab platform.

Keywords- ARDUINO, BCI, ultrasonic sensor.

I. INTRODUCTION

Driving is a typical task, requiring full concentration and calm attitudes. Stressed and strong emotions, whether they result from the driving task itself or unrelated matters, can affect a driver's abilities. For example, research has shown that emotional drivers are more likely to take risks such as speeding, rapidly switching lanes, tailgating and jumping red lights. EEG signal can be best feature of BCI for detecting driver's state of mind. The main objective is to study the different mental state recognition methods based on EEG signals. Later work is done on analyzing different mental states of a driver in different traffic situations and based on the study, predicting whether driver is mentally fit or not. Recent past, it has been observe the drivers with mental fatigue lead to accident. In, authors have proposed a robust real-time embedded platform to monitor the loss of attention of the driver during day and night driving conditions. The alertness level can be assessed using different measures, such as electroencephalogram (EEG) signals, ocular features, blood samples, speech and others. The EEG signals were reported to be highly authentic for estimating the state of drowsiness. In a novel method for multi fractal analysis of EEG signals named generalized Higuchi fractal dimension spectrum (GHFDS) was proposed and applied in mental arithmetic task recognition from EEG signals.

Block Diagram:

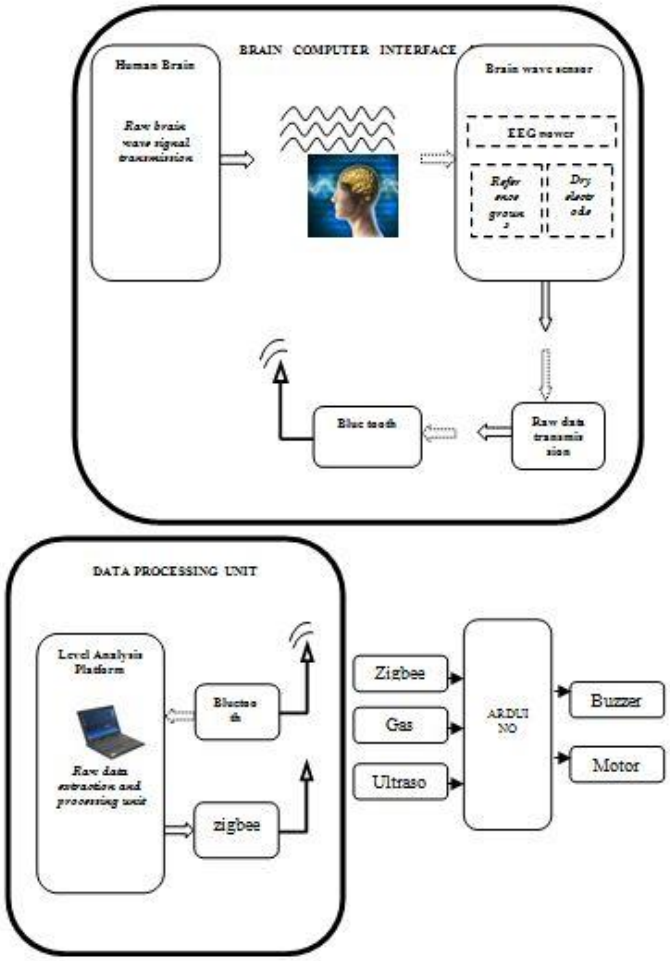

Fig.1 BCI- attention tracking

II. DESIGN AND IMPLEMENTATION

Electroencephalography (EEG) is the measurement of electrical activity in the living brain. In this project we used a brinwave sensor MW001 to analyse the EEG signals. This design discuss about processing and recording the raw EEG

signal from the MindWave sensor in the MATLAB environment and through Serial transmission control commands will be passed to the voice chip. Mindwave sensors are not used in clinical use, but are used in the Brain Control Interface (BCI) and neurofeedback (one of biofeedback types). The BCI is a direct communication pathway between the brain and an external device.

Working Principle:

The principle of operation is quite simple. Two dry sensors are used to detect and filter the EEG signals. The sensor electrode detects electrical signals from the forehead of the brain. At the same time, the sensor picks up ambient noise generated by human muscle, computers, light bulbs, electrical sockets and other electrical devices. The second sensor, ear clip, is a grounds and reference, which allows thinkgear chip to filter out the electrical noise. The device measures the raw signal, power spectrum (alpha, beta, delta, gamma, theta), 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. Therefore, raw EEG data is a main source of information on EEG signals using Mind Wave MW001.

Design Theory:

A. Matlab Platform

The MATLAB allows to include thinkgear.dll. This environment has broad support in toolbox, which makes it ideal for a scientific research. This paper presents how recording and processing the raw EEG signal in MATLAB environment using MindWave sensor. The Communication Protocol, shows a system of digital rules for message exchange between MATLAB environment and MindWave MW001 device. This section also presents the main parameters of thinkgear library.

B. The Communications Protocol

The proposed communications protocol is a system of simple rules for message exchanges between MATLAB and the EEG device. It consists of 7 basic steps, which are presented in following steps.

- Load ThinkGear library into MATLAB
- Get a connection ID handle to ThinkGear
- Attempt to connect the connection ID handle to serial port "COMx"
- Waiting to establish the connection
- Read packets from the connection
- Close the connection
- Unload ThinkGear library

In the first step are functions with parameters in the following order::

1. libisloaded(‘Thinkgear’) – returns true if the ThinkGear library is loaded, and false otherwise.

2. loadlibrary('Thinkgear.dll','thinkgear.h') – loads the functions defined in the header file and
found in the library. Now, the function calllib() can call a function in the ThinkGear library.

3. calllib('Thinkgear', 'TG_GetDriverVersion') – returns the version of loaded library.

In the next step, the function calllib('Thinkgear', 'TG_GetNewConnectionId') gets a new connection ID handle to ThinkGear. The value -1 is returned if too many connections have been created.

In the ThinkGear library, the most important function is TG_Connect. This function needs 4 parameters: the connection ID, number of the serial port, Baud rate and type of data. The number of the serial port is given during the pairing of the device. The device can connect on modes 1200, 2400, 4800, 9600, 57600 and 115200 bits per second (bps). Here, we use the 9600 bps rate and stream 5V RAW mode, because these parameters have the minimum of transmission errors.

C. Hardware section

We can read the value of EEG signal with the maximum frequency range of 512 Hz. Sampling frequency is set on 512 Hz, and we 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 Matlab section waits for three consecutive blink in order to send the hardware activation signal. Then based on the blink level signal, the cursor will be places upon any section to get the device control. Further the person have to raise the attention to switch the device.

III. SYSTEM HARDWARE

Arduino

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world.

Brain wave sensor

Electroencephalography (EEG) is the measurement of electrical activity in the living brain. In this project we used a brinwave sensor MW001 to analyse the EEG signals . This design discuss about processing and recording the raw EEG signal from the MindWave sensor in the MATLAB

environment and through Serial transmission control commands will be passed to the Homesection. Mindwave sensors are not used in clinical use, but are used in the Brain Control Interface (BCI) and neurofeedback (one of biofeedback types). The BCI is a direct communication pathway between the brain and an external device.

ThinkGear ASIC Module

- Directly connects to dry electrode (as opposed to conventional medical wet sensors)
- One EEG channel connected with three contacts: EEG; REF and GND.
- Improper fit detected through "Poor Signal Quality" warning from ASIC to reset if off the head for four consecutive seconds, or if it is receiving a poor signal for seven consecutive seconds.
- Latest filtering technology with high noise immunity.
- Low energy consumption suitable for portable battery driven application.
- Max power consumption 15mA @ 3.3 V
- Raw EEG data output at 512 bits per second

Think Gear or TGAM Features + Technical Specifications

Measures

- Raw brainwave signal
- Processing and output of EEG electrical power spectrums (Alpha, Beta, etc.)
- Processing output of NeuroSky proprietary electrical Sense meter for Attention, Meditation, and other future meters
- EEG/ECG signal quality analysis (used to detect poor contact and whether the device is off the head)
- Eye blink detection

Electrodes

- Maximum surface area is ~150mm2 (but less surface area is optimal).
- Stainless Steels, Ag/AgCl, Gold or Silver (both solid and plated material works).
- EEG electrode is located above the left or right eye of the forehead.
- Ground and reference electrode is located behind the ear or at the earlobe.
- Have enough pressure to prevent movements, with a minimum of 0.8 PSI

DC motor

DC motor is configured in many types and sizes, including brush less, servo, and gear motor type. A motor contain a rotor and a permanent magnetic field stator. The magnetic fields are maintained using either permanent magnet or electromagnetic winding. Motor is the devices that produce the actual speed and torque in a drive system. This family includes AC motor types (single and multiphase motor, universal, servo motor, induction, synchronous, and gear motor), DC motors (brush less, servo motor, and gear motor) linear, stepper motors, air motors, and motor contactors as well as starters.

Ultra Sonic Sensor

Ultra Sonic Sensor Our ultrasonic rangefinder is capable of allowing the user to determine his or her distance from an object or wall. When deciding on what type of project to design and construct, we decided that we wanted to create something that would have some practical use in life. Mostly all the groups in the past created video games, but we wanted to be different. Here, we considered issues such as safety, user interface, and ease of use, and came up with the idea of making an ultrasonic rangefinder. A rangefinder can be used in various applications such as measuring devices or an obstacle detection device.

IV.SYSTEM SOFTWARE

MATLAB's Graphical User Interface Development Environment (GUIDE) provides a rich set of tools for incorporating graphical user interfaces (GUIs) in M-function. Using GUIDE, the processing of lay out a GUI (i.e., its buttons, pop-up menus, etc.)and programming the operation of the GUI are divided conveniently into two easily managed and relatively independent tasks.

Role of Matlab in BCI

The MATLAB allows to include thinkgear.dll. This environment has broad support in toolbox, which makes it ideal for a scientific research. This paper presents how recording and processing the raw EEG signal in MATLAB environment using Mind Wave sensor. The Communication Protocol, shows a system of digital rules for message exchange between MATLAB environment and Mind Wave MW001 device. This section also presents the main parameters of thinkgear library.

The connection is established through command:calllib('Thinkgear','TG_Connect',Id,ComPortName, TG_BAUD_115200,TG_ STREAM _5VRAW). In the next step, we must attempt to read a Packet of data from the connection. We use the TG_ReadPackets() function with ID parameter and number of packet to read. The command calllib('Thinkgear','TG_ReadPackets', Id,1) returns false for error, and otherwise true. The function TG_GetValueStatus() checks if a value has been updated by TG_ReadPackets(). If this function returns true, we can use TG_GetValue() function to get the updated value of the raw EEG signal.

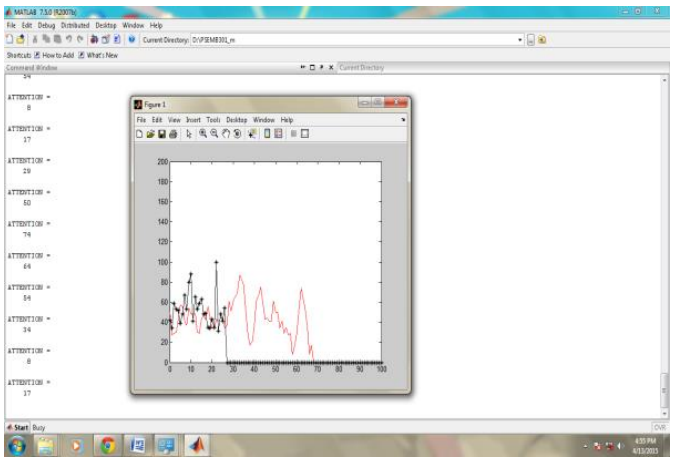

Fig.2 Brian signal representation in MATLAB
Fig.2 Cursor control in VB

The above graph shows the attention value and blink strength. Based on this signals device control file will be opened and the device will get controlled based on the brain signals.

V. CONCLUSION

The main goal of this paper is to design and implement a human thought controlled electrical switching system using BCI technology for the physically challenged people. Non invasive BCI method is used for capturing the brain signals with the help of brain wave sensor. Different cognitive state of the user like attention level, meditation level, eye-blink can be used to measure the human thought. The signals are classified according their respective frequencies ranging from 0.5 Hz to 30 Hz. By setting the threshold value for an event, the interrupt is generated. This Interrupt is sent to the microcontroller unit for operating the appliances.

VI. REFERENCES

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