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Driver Drowsiness Detection for Accident Prevention Using EEG Signal

[1]Awanish Tiwari and [2]P.K. Senthil Kumar

[1]Department of Electronics and Control, SRM University, Chennai, India
[2]Department of Instrumentation and Control, SRM University, Chennai, India

Abstract: Now a day Drowsiness is a major issue in case of traffic accident. Sometimes people will mentally sleep with eyes open for a few seconds that causes very big accidents in driving. So in this proposed paper I am analyzing the mental activities of brain using EEG signals based on Brain- Computer Interface (BCI) technology. This paper describes about an accident prevention method for vehicle based on brain computer interface (BCI). The pattern of interaction of neurons is changed according to human thoughts which produce electrical waves. A mentally sleeping person with open eyes has a changed attention level from the normal condition. This proposed method uses a brain wave sensor which detects the brain signals and converts it into packets and transmitted it through Bluetooth to the level analyzer unit (LAU) to check the attention level. Now the LAU analyses the attention level and gives the drowsy driving alert and keep the vehicle to be in self-controlled function until awaken state. This can save a lot of lives in road transportation.

Key words: Brain computer interface (BCI) · Level Analyzer unit (LAU) · Drowsiness · Interaction of neurons

INTRODUCTION

For safe driving driver requires directing their full attention to control their cars [1]. Thus lack of attention is a major cause of vehicle crashes. Now a day's technology and informational capabilities changes the driving environment [2]. Adaptive control systems automatically adjust the speed to maintain a safe following distance from the vehicles in front of driver [3]. During driving conversing on phone is also cause of distracting even if hand free system [4, 5]. Because the conversation contents have more effect on driving than the method of phone conversation does [5]. In such case driver divert a portion of their attention from the driving task to the conversation which cause a decrease in driving performance. Fig 1 shows the overview of the entire process. first of all the brain activity is measured and converted into commands to control the vehicle. In this proposed system we are using a single electrode brain wave sensor that reduces the complexity and increases the accuracy as compared to 10-20 electrodes brainwave sensor. Here in this proposed method brain computer interface (BCI) technique has been used. This technique is used to provide the direct communication between users and physical device. In this case the physical device is nothing but vehicle.

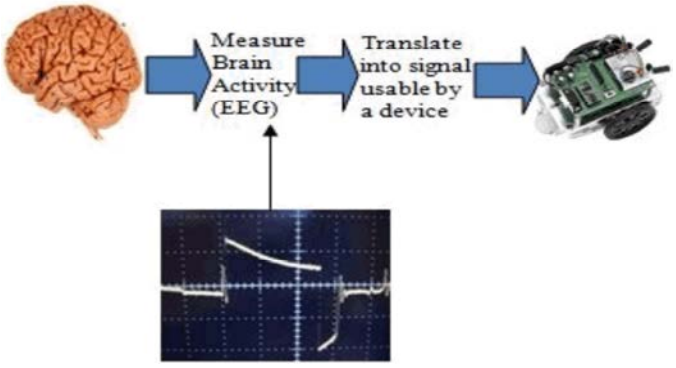

Fig. 1: Overview of the process

Corresponding Author: Hesam Saiedy, Department of Industrial Management, Kar University, Qazvin, Iran.

BCI based a lot of devices have been developed by the reaserchers previously. But non of the device comes in the control factroy invironment.the reason behind this is the brain signal is nonstationary in nature. Thus to make the system in real world environment main challenging task is to make the brain signal stationary. Wireless brain control robot is developed in [6]. BCI based biomatric authentication is developed in [7]. This paper presents an accident prevention system by tracking the driver's attention level. During driving drowsiness or sleeping of driver causes a major accident. Normally, Sleeping can be identified from several factors like eye blink level, yawning, gripping force on wheel and so on. But all these measuring techniques will check only the physical activities of the human. There are a lot of cases when a person is mentally sleeping even his eyes are open for a few second. Here the users' attention level is measured by LAU first and if that level is below the threshold value the LAU gives the drowsy driving alert signal and keep the vehicle to be in self-control function which saves a lot of lives in road transportation.

This paper is divided into VI section. Section II describes the block diagram and working. Section III describes the methodology used for proposed system. Hard ware description is given in section IV. Simulation result is given in section V and conclusion and future work is given in section VI.

Proposed System

Block Diagram and Working: Figure 2 shows the block diagram of proposed system. Out of two dry sensors one is placed at the forehead just above the left eye position of the user. This sensor detects the electrical activity of the user. Some amount of noise generated by computers or other electrical device is also sensed by this sensor tip which is filtered by the second sensor tip placed at the ear clip as aground reference.. Brain wave sensor measures the raw signal, power spectrum (α, β, γ, δ, θ) attention level; mediation level and eye blink strength. All these signals value has been stored in the think gear modules which convert these data into packet form and transmitted to the pc through the Bluetooth medium. On the pc signal processing is done using matlab. Now according to the control command given to the home module the home module will be operated. So the user can switch on or switch off the home module (light or fan) according to his eye blink signal and attention level signal. This is the entire process for the home control system.

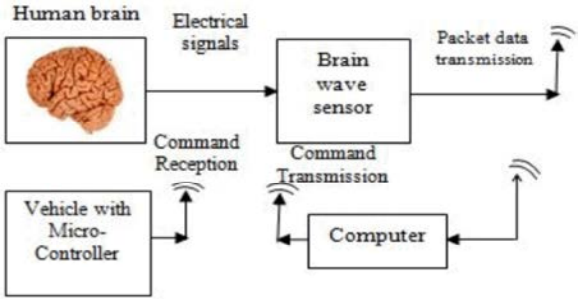

Fig. 2: Proposed System Block Diagram

Proposed Methodology: Electroencephalography has more efficiency than other biomedical signal so this is the reason why it is prefer for the home control system. It is the detection and measurement of electrical activity of the brain by placing the electrode on the scalp. In this proposed system brainwave sensor is used to analyze the EEG signals. This design discuss about wireless communication between the user and home vehicle also it discuss about processing and recording of EEG signal from the Brain Wave sensor in the MATLAB environment and through wireless transmission control commands will be transmitted to the vehicle. Brain wave sensors are not only for clinical use, but it is also used in the Brain Computer Interface (BCI) technology. The BCI is a technique to provide the direct communication between the brain and an external device.

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.

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

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 attention level signal the control signals will be passed to the vehicle. Now according to the attention level the vehicle is control. These functions are driven based on interrupts generated by respective events of MATLAB by analyzing the brain signals drivers are also been implemented with serial UART configuration. 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.

System Hardware

LPC 2148 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.

Number of affiliations, the final affiliation will be centered on the page; all previous will be in two columns.

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.

Zigbee Module: Zigbee 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.

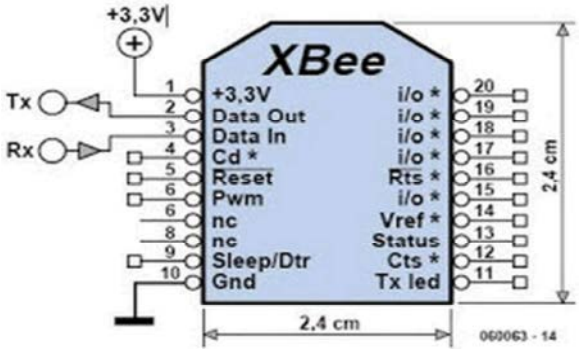

Fig. 3: Pin diagram of XBee module

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

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

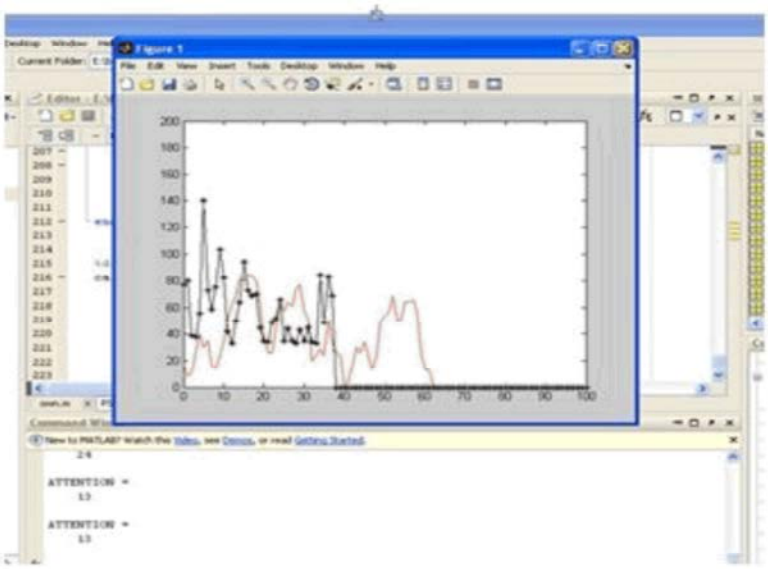

Fig. 4: Brain signal representation in MATLAB

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"*.

Simulation Results and Observation: Figure 4 shows the simulation output. The brain wave sensor senses the attention level and eye blink strength and transmitted these values to the computer. On computer the user can see his attention level. When attention level goes low below the threshold value the command signal is passed to the vehicle. This signal makes the vehicle in the self-control mode. This will protect a lot of road accidents.

CONCLUSION AND FUTURE WORK

In the coming age society BCI is used in the automobile application to prevent the accident. Lack of attention is also a major source of accident. It happens in some situations when a person is mentally sleeping even his eyes are open. For such cases BCI based attention tracking technique is useful to prevent the accident. This technique will bring the vehicle in the self-control mode. The Future work is to implement this technique in the real time to develop accident prevention system.

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