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An Advanced Wheelchair Controlling using EEG Technology

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Abstract: **This project discussed about a brain controlled robot based on Brain–computer interfaces (BCI). BCIs are systems that can bypass conventional channels of communication (i.e., muscles and thoughts) to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time. With these commands a mobile robot can be controlled. The intention of the project work is to develop a robot that can assist the disabled people in their daily life to do some work independent on others.**

Keywords*: EEG; Robot movement.*

I. INTRODUCTION

Here, we are analyzing the brain wave signals. Human brain consists of millions of interconnected neurons. The patterns of interaction between these neurons are represented as thoughts and emotional states. According to the human thoughts, this pattern will be changing which in turn produce different electrical waves. A muscle contraction will also generate a unique electrical signal. All these electrical waves will be sensed by the brain wave sensor and it will convert the data into packets and transmit through Bluetooth medium. Level analyzer unit (LAU) will receive the brain wave raw data and it will extract and process the signal using MATLAB platform. Then the control commands will be transmitted to the robotic module to process. With this entire system, we can move a robot according to the human thoughts and it can also be turned by blink muscle contraction.

ELECTRO-ENCEPHALO-GRAPHY (EEG): The main purpose of the current chapter is to review recent advances within the EEG field. to grasp these developments it'll initial be necessary to detail the physiological basis of the EEG signal. After, vital problems related to knowledge acquisition, signal process, and quantitative analyses are going to be mentioned. the most important portion of the chapter are going to be dedicated to reviewing rising supply localization techniques that are shown to localize EEG activity while not postulating a priori assumptions concerning the amount of underlying sources. As we are going to discuss, maybe the best advancements within the EEG field within the last 5-10 years are achieved within the development of those localization techniques, especially once utilized in concert with high-density EEG recording, realistic head models, and different purposeful neuro imaging techniques. The time unit temporal resolution of electroencephalogram permits scientists to analyze not solely fluctuations of electroencephalogram activity (i.e., increases/decreases) as a operate of task demand or subject samples however conjointly to differentiate between practical repressive and excitant activities. Low frequencies (e.g., delta and theta) show massive synchronal amplitudes, whereas electroencephalogram frequencies (e.g. beta and gamma) show tiny amplitude owing to high degree of asynchrony within the underlying somatic cell activity. In adults, the amplitude of normative electroencephalogram oscillations lies between ten and a hundred (more ordinarily between ten and fifty; Niedermeyer, 1993). within the following section, a quick review of varied electroencephalogram bands and their supposed practical roles are going to be given. The review of the muscular and physiological basis underlying the generation of varied electroencephalogram oscillations.

II. BLOCK DIAGRAM

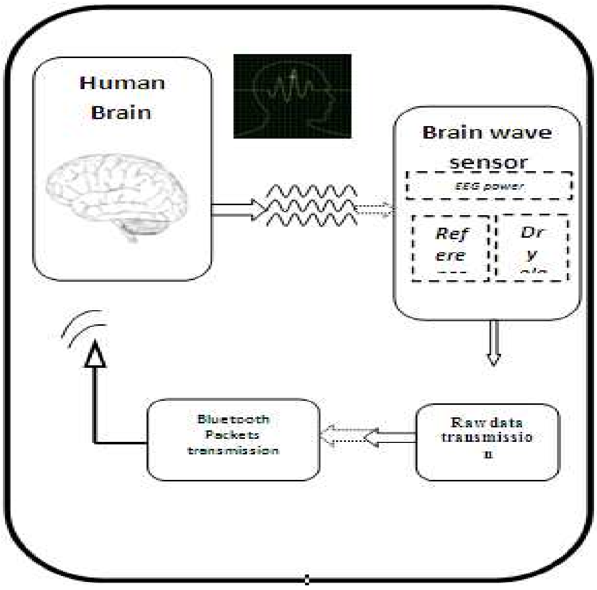


Fig a1: Brain Wave Capturing Section

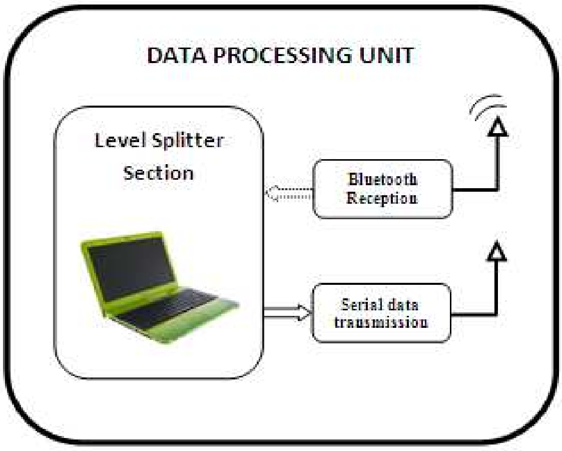


Fig a2: Data processing unit

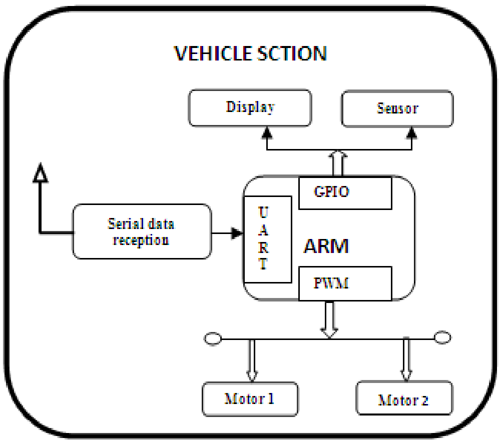


Fig a3: Vehicle section

This project work consists of a Processor using ARM9 core, brain wave sensor and an effective brain signal system using Mat lab platform. In this project initially the person's attention level or else the driver's drowsy level should be found out by the brain wave sensor. Whenever a person is starting the car, the brain wave sensor unit will calculate the blinking level and it will compare with the minimum attention levels of human when ever not sleeping. If the blinking level are to equal the set point then automatically vehicle will move without any problem. Most case, we can compare the owner's blinking levels with stored blinking levels.

III. DESIGN AND IMPLEMENTATION

This project uses two important platforms. 1. Coding Platform and 2. Execution Platform. These platforms are discussed below

1. Coding Platform:

In this project a brain computer interface system is used which will do the key role in the entire operation. Basically a BCI system consist of a brain wave sensor which captures the brain signals and a computer section (with MATLAB tool) which process the raw EEG data so that it will be understandable by the robotic module.

Here for capturing the brain waves and calculating the blinking levels we are using a neurosky product which is called mind wave headset MW001. The principle of operation is quite simple. Two dry sensors are used to detect and filter the EEG signals. The sensor tip detects electrical signals from the forehead of the brain. At the same time, the sensor pick 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 think gear 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 MindWave MW001.

On the producer page, we can find more than 130 applications classified into 4 platforms, 5 genres and 16 developers. These apps do not provide the source code. Therefore, change of functionality is not possible. However, dynamic-link library (thinkgear.dll) is available to handle the connection to the device.

The MATLAB allows to include thinkgear.dll. This environment has broad support in toolbox, which makes it ideal for a scientific research.

The device sends the measured data to MATLAB for further processing using the following communication protocol which consist of seven simple steps as follows

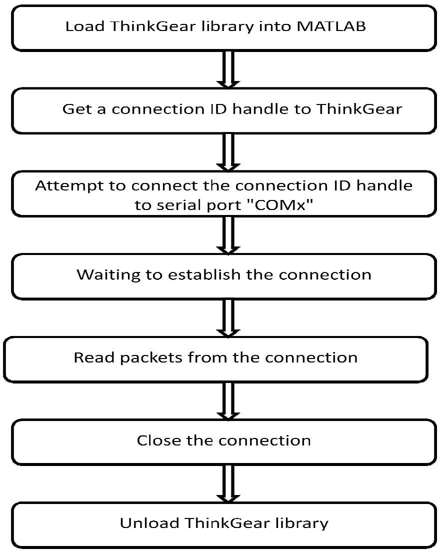

Load ThinkGear library into MATLAB
Get a connection ID handle to ThinkGear
Attempt to connect the connection ID handle to serial port "COMx"
Waiting to establish the connection
Read packets from the connection
Close the connection
Unload ThinkGear library

Fig b: The communication protocol

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_GetDriver***

Version') – returns the version of loaded library.

In the next step, the function ***calllib('Thinkgear', 'TG_GetNewConnection Id')*** 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). Additionally, we can use three formats of data streams: packets, 5V RAW and file packets. In this project author uses the 115200 bps rate and stream 5V RAW mode. The connection is established by using the following command: ***calllib('Thinkgear', 'TG_Connect', Id, ComPortName,TG_BAUD_115200,TG_STREAM_5VRAW)***

In the next step, it must attempt to read a Packet of data from the connection. it uses the ***TG_ReadPackets()*** function to read the data such as blink level and attension level. 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. Hence by using above it waits for blinks to cross the set point. Afterwards, it checks attention level and accordingly send a predefined control command to the robotic module as shown below.

```
if (data_ATTENSION (k) > 90)
   %            if(Drive mode == 1)
                 fopen (serial  One);
                 fwrite (serialOne,'Q');
                 fclose(serial  One);
   %            end
           end
```

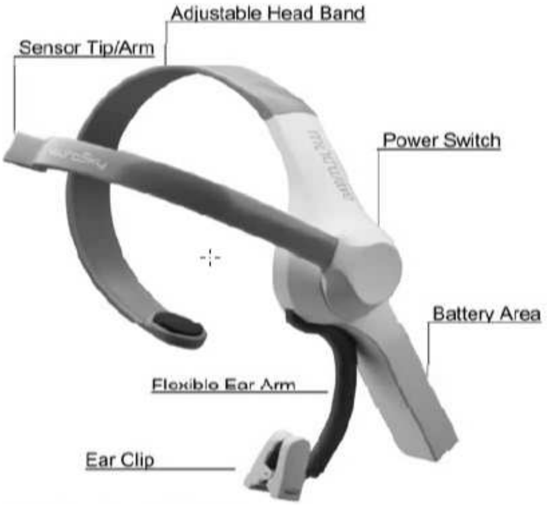
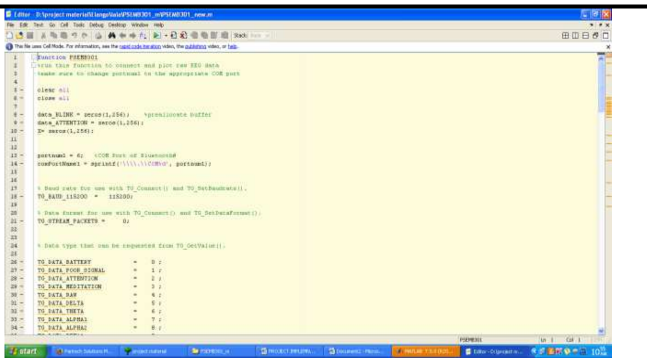


Fig b1: Nuerosky MindWave Set MW001


Editor - D:\project material\Ilango\Vala\PSEMB301_m\PSEMB301_new.m
File Edit Text Go Cell Tools Debug Desktop Window Help
This file uses Cell Mode. For information, see the rapid code iteration video, the publishing video, or help.

```
function PSEMB301
%run this function to connect and plot raw EEG data
%make sure to change portnum1 to the appropriate COM port

clear all
close all

data_BLINK = zeros(1,256);     %preallocate buffer
data_ATTENTION = zeros(1,256);
X= zeros(1,256);


portnum1 = 6;   %COM Port of Bluetooth#
comPortName1 = sprintf('\\\\.\\COM%d', portnum1);


% Baud rate for use with TG_Connect() and TG_SetBaudrate().
TG_BAUD_115200  =   115200;

% Data format for use with TG_Connect() and TG_SetDataFormat().
TG_STREAM_PACKETS =     0;


% Data type that can be requested from TG_GetValue().

TG_DATA_BATTERY            =    0 ;
TG_DATA_POOR_SIGNAL        =    1 ;
TG_DATA_ATTENTION          =    2 ;
TG_DATA_MEDITATION         =    3 ;
TG_DATA_RAW                =    4 ;
TG_DATA_DELTA              =    5 ;
TG_DATA_THETA              =    6 ;
TG_DATA_ALPHA1             =    7 ;
TG_DATA_ALPHA2             =    8 ;
```

Fig b2 : MATLAB Running Image

2. Execution Platform:

This half consists of ARM core processor as a main unit and a LCD unit for displaying purpose.

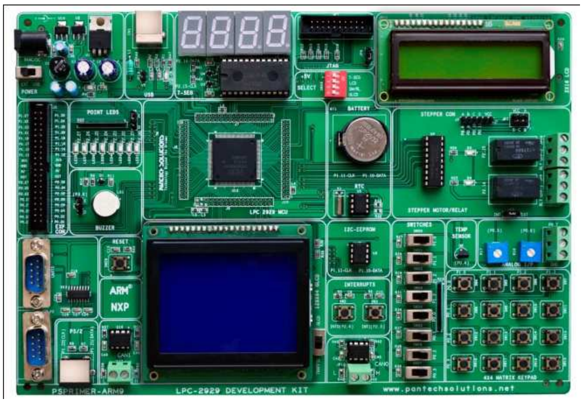


Fig c: LPC2929 with ARM9 Processor

ARM processor is employed for dominant the system. Here we have a tendency to square measure victimization the LPC2929 series, which has 2 UART. In UART0 we'll interface the GPS receiver to induce the orbital info and in UART1 we will interface the computer for image process. Then the ignition driver circuit is connected to the GPIO pin of ARM. Interrupt routine code is employed to visualize whether or not we have a tendency to have gotten any serial interrupt (i.e,) from owner any command is returning or not. For this project we have a tendency to square measure having some interrupt checking commands ‘Q’ and ‘X’.The interrupts routine code for command checking is given within the column below.

Once ARM processor receives a command ‘Q’ through UART1, then the processor can move the motive force circuit. attributable to this the engine are going to be move instantly. Next, if the processor receives a command ‘X’, then UART0 receiver interrupt are going to be enabled. So, this worth within the information base can compare mechanically the motive force management unit can stop. This interrupt routine code are going to be checked by the processor endlessly that will increase the potency of the project. These interrupt checking technique must tack the vector address. that the vector address configurations for each UART square measure given below. The Vectored Interrupt Controller (VIC) takes thirty two interrupt request inputs and directly programmable assigns them vectored IRQ. VIC Int Select may be a register that have the management of all interrupt registers. As we have a tendency to square measure victimization the UART0 interrupt and UART1 interrupt we've to simply modify the sixth and seventh little bit of the VIC Int Select register. When facultative for every interrupts separate slot ought to be enabled for process. thus whenever associate interrupt is returning from the device, then ARM processor will directly jumb to the interrupt routine to process the command.. due to this facility ARM will handle the various interrupts from the device and might do the individual functions with none fault.

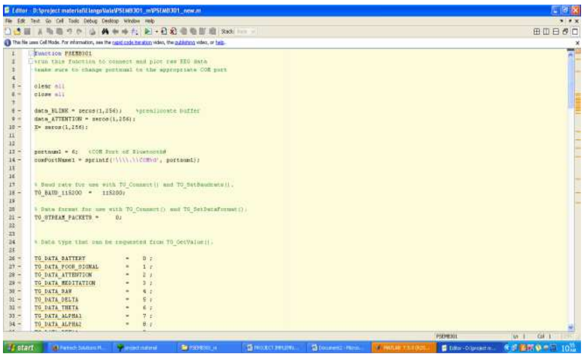
during this project the engine unit are going to be controlled by a driver circuit. the motive force circuit consists of a driver unit, electrical device and a semiconductor unit. If the automobile is started, the engine are going to be turned ON which implies ARM processor can offer the bias voltage to the semiconductor unit to modify on the relay that successively activate the automobile engine. meantime the processor can check the interrupt routine. Once if it receives the interrupt 'X' through UART then the processor can cut the bias voltage to the semiconductor unit. So that, the engine is going to be turned off.

IV. WORKING

- ➢ Firstly turn on the power switches of MW001 headset and the robot section.
- ➢ Secondly after getting on the mindwave device safely measures the EEG signal at a sampling frequency of 512Hz with the help of EEG electrode on the sensor arm, resting on the forehead above the eye(FP1 position) .
- ➢ Nextly the thinkgear chipset removes the unwanted noise from the raw brainwaves using filtering process outputs the EEG power spectrums(alpha waves, beta waves etc), attention and meditation levels & eye blinks.
- ➢ Nextly mindwave device transfer the whole information with the help of in-built Bluetooth chip to the computer section.
- ➢ Nextly MATLAB software tool at the computer section capture the information transferred by the mindwave device using the communication protocol.
- ➢ Nextly as soon as the blink value in the received information becomes 3 the computer section starts the sending the control command to the robot section in the following way

  - ✓ If one blink is detected it sends a control command 'A' to the robot, which means " turn left " at the robot side.
  - ✓ If two blink is detected it sends a control command 'D' to the robot, which means " turn right " at the robot side.
  - ✓ If the attention level is greater than 50 it sends a control command 'W' to the robot, which means " move forward " at the robot side.
  - ✓ If the attention level is less than 50 it sends a control command 'S' to the robot, which means " move backward " at the robot side.
- ➢ Finally in this way the above process is going on until and unless power switches is on.

V. RESULTS



```
function PSEM8301
%run this function to connect and plot raw EEG data
%make sure to change portnum1 to the appropriate COM port

clear all
close all

data_BLINK = zeros(1,256);    %preallocate buffer
data_ATTENTION = zeros(1,256);
X= zeros(1,256);


portnum1 = 6;   %COM Port of Bluetooth#
comPortName1 = sprintf('\\\\.\\COM%d', portnum1);


% Baud rate for use with TG_Connect() and TG_SetBaudrate().
TG_BAUD_115200 =   115200;

% Data format for use with TG_Connect() and TG_SetDataFormat().
TG_STREAM_PACKETS =     0;


% Data type that can be requested from TG_GetValue().

TG_DATA_BATTERY             =    0 ;
TG_DATA_POOR_SIGNAL         =    1 ;
TG_DATA_ATTENTION           =    2 ;
TG_DATA_MEDITATION          =    3 ;
TG_DATA_RAW                 =    4 ;
TG_DATA_DELTA               =    5 ;
TG_DATA_THETA               =    6 ;
TG_DATA_ALPHA1              =    7 ;
TG_DATA_ALPHA2              =    8 ;
```

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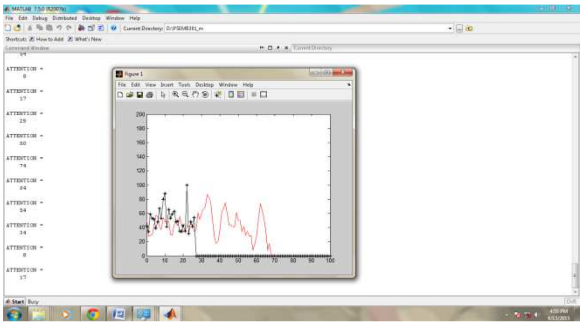
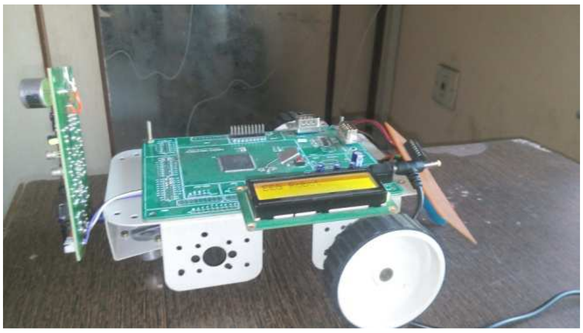
File Edit Text Go Cell Tools Debug Desktop Window Help
This file uses Cell Mode. For information, see the rapid code iteration video, the publishing video, or help.
start



```
ATTENTION =
     8

ATTENTION =
    17

ATTENTION =
    29

ATTENTION =
    50

ATTENTION =
    74

ATTENTION =
    64

ATTENTION =
    54

ATTENTION =
    34

ATTENTION =
     8

ATTENTION =
    17
```

MATLAB 7.5.0 (R2007b)
File Edit Debug Distributed Desktop Window Help
Current Directory: D:\PSEM8381_m
Shortcuts How to Add What's New
Command Window
Current Directory
Figure 1
File Edit View Insert Tools Desktop Window Help
200
180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
Start Busy



VI. CONCLUSION

The project wireless control of robot using brain-controlled interface has been successfully designed and tested. The research and development of wireless control of robot using brain-controlled interface will received a great deal of attention because it can help bring mobility back to people with devastating neuromuscular disorders and thus improve their quality of life.

VII. FUTURE SCOPE

The major difference between brain-controlled mobile robots and other brain-controlled devices is that these mobile robots require higher safety because they are used to transport disabled people. Hence the overall driving performance of the robot must be highly perfect.

Basically there are two types of brain-controlled robots, one is **"**direct control by the BCI**"**, which means that the BCI translates EEG signals into motion commands to control robots directly and another one is **"**shared control**"**, where a user (using a BCI) and an intelligent controller share the control over the robots. Hence, we can design shared brain controlled robots to ensure the safety of disabled people.

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