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Mind Controlled wheelchair

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***Abstract*— The aim of this project is to control the wheelchair by the Electro Encephalo Gram (EEG) signals observed by the EEG headband to control the basic wheelchair movement which are left, right, forward and reverse. The specific objectives are: i) To acquire and process the EEG signal from the EEG headband device, ii) To analyze the EEG signal in term of attention and meditation level by using their peak and average value, iii) To classify the EEG signal into four basic movements based on various visible and nonvisible user- input representations.The brain wave raw data is sent to the computer and it will extract and process the signal using MATLAB platform. Then the control commands will be transmitted to the ARM7 processor to process and with this entire system, we can move the chassis wheelchair prototype based on the human thoughts and blink muscle contraction.**

INTRODUCTION

THIS paper is an attempt to propose a mind controlled wheelchair which uses the brain activity signals to control the wheelchair. Electroencephalography is a technique in which a headset that is placed on the user head for the catching of the EEG signals which are transferred to the MATLAB software and translated into movement commands by the ARM7 micro controller which in turn move the wheelchair.

The electrical activity of the brain can be SRM INSTITUTE OF SCIENCE AND checked in actual– time using electrodes, which are attached on the forehead in this process known as electroencephalography. In order to bypass the peripheral nervous system, we need to find some reliable correlates in the brain signals that can be mapped to perform specific actions. We are going to implement mind controlled wheel chair using EEG and Microelectromechanical systems (MEMS). The EEG will monitor the brain signals and wheel chair will move according to the movement of the head with help of MEMS. The model is realized through data comparison in serial communication with the special purpose microcontroller IC. This is detected like an object cross in a transmitter and receiver, and it will intimate.

I. BRAIN COMPUTER INTERFACE (BCI)

The electrical activity of the brain can be monitored in real– time using an array of electrodes, which are placed on the scalp in a process known as electroencephalography (EEG). In order to bypass the peripheral nervous system, we need to find some reliable correlates in the brain signals that can be mapped to the intention to perform specific actions. In the next two subsections, we first discuss the different brain wave signals which will be used for the understanding of the philosophy of different BCI paradigms, before explaining our chosen implementation and method for controlling the wheelchair.

A. Brain Wave Signals

This is a method used in measuring the electrical activity of the brain. Brain electrical activity is generated by billions of neurons (nerve cells). Each of these neurons is connected to thousands of other neurons. All the signals from other neurons sum up in the receiving neuron and when this sum exceeds a certain potential level, the neuron fires nerve impulse. EEG can measure the combined electrical activity of millions of neurons. An EEG is characterized by its amplitude and frequency. The amplitudes of the EEG signals typically vary between 10 and 100 V (10 and 50 V in adults). The electrical activity goes on continuously in every living human's brain without rest. The brain remains active even when one is unconscious. The following lists four prerequisites, which must be met for the activity of any network of neurons to be visible in EEG signal: 1) The neurons must generate most of their electrical signals along a specific axis oriented perpendicular to the scalp; 2) The neuronal dendrites must be aligned in parallel so that their field potentials summate to create a signal which is detectable at a distance; 3) The neurons should fire in near synchrony; 4) The electrical activity produced by each neuron needs to have the same electrical sign. Various properties in EEG can be used as a basis for a BCI:

1. Rhythmic brain activity
2. Event-related potentials (ERPs)
3. Event-related desynchronization (ERD) and event-related synchronization (ERS).

Band	Frequency [Hz]
Delta (_)	< 3.5
Theta (_)	4-7.5
Alpha (_)	8-13
Beta (_)	>13

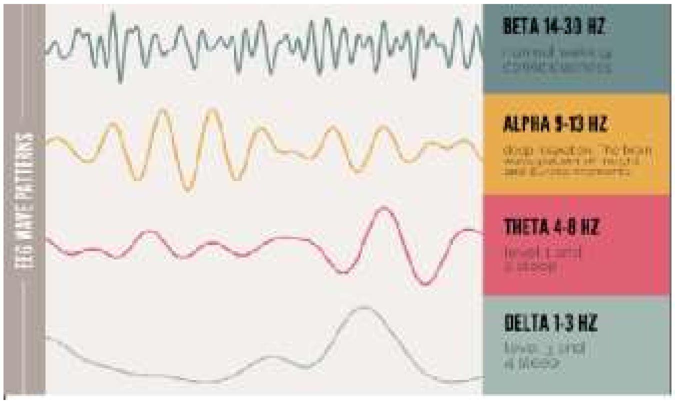


Fig-1 Brain wave frequencies

B. Implementation

For this project , the aim is to build a wireless data transmission method by Bluetooth , Radio Frequency and serial communication to interface the micro controller with the Electro Encephalo Gram (EEG) headset and the wireless joystick integrated with other electronic devices such as an ultrasonic sensor for the purpose of obstacle detection and others in order for the mobile movement of the wheelchair. This proposal has an advantage over the preexisting methods which used a wired communication setup. By the hassle of no wires, this setup will be much easier to access than the other wheelchair models.

Here, the brain wave signals are analyzed. Human brain contains of many interconnected neurons. The design of interaction between the neurons are represented as thoughts and emotional states. According to the human thoughts, this design will be changing which in turn produces different electrical waves in brain receipted by by EEG headsets. A muscle contraction can lead to generation of a idiosyncratic signal. The EEG headband will be interfaced with a Bluetooth module and the user wears that on his head. The next setup will contain another Bluetooth module connected to the micro controller setup which will be coded in embedded C language for the purpose of functioning. This second setup is interfaced with the wheelchair setup which will consist of the prototype wheelchair, the relay circuit to drive the motors and the DC Motors which will have specified rotations per minute as per the wheelchair speed requirements.

The electrical signals are then received by EEG headsets are converted into smaller bits and then transmitted through Bluetooth module. Level analyzer unit (LAU) receives the data from brain and process using MATLAB.

Then the control commands will be transmitted to the robot module to process. With this entire system, it is possible to move a robot according to the human thoughts and it can be turned by blink muscle contraction.

All this is powered by a 12V power source regulated by a voltage regulator. The mind wave headset is used in the mind controlled wheelchair to pick up EEG signals from the brain. The manual wheelchairs are generally drove by the user by using the rear wheels with supplementary rims called the Push Ring for moving forward or backward. In the proposed wheelchair modification of the manual wheelchair is done by mechanically coupling motors to rear wheels thereby making it an electric wheelchair. The active rear wheels are rotated by motors to the orientation that matches the current driving direction; the system employs differential drive. A differential drive uses two motors on either side of the wheelchair and a castor wheel on the front.

When both the Left and Right Motors are forward biased, the wheelchair moves forward. For turning the wheelchair right, the Right Motor is given forward bias and the Left Motor is given reverse bias. Forward bias on the Left Motor and reverse bias on the Right Motor turns the wheelchair left. The duration and hence the degree of turn is controlled by the mind wave signals from the user. For turning purpose, full excitation is given to the drives. The level of rousing given to the motor for movement is controlled by users mind. This way the forward speed of the wheelchair is propagated.

C. Hardware Components

Assembling the parts together is the biggest issue so integrating them together makes it a little bit tough but with all the right configurations of hardware it can be done.

1) Brain wave sensor: Electroencephalography (EEG) is an brain activity monitoring method by electrodes attached to brain which can be used for the process such as electrocorticography. EEG measures voltage fluctuations which are resulted from ionic current within the neurons of the brain waves.

2) ARM processor: The Advanced RISC Machine (ARM) processor is 32-bit embedded reduced instruction set computer microprocessor. The ARM7 requires terribly low power, has high performance and little size. ARM7 or an ARM processor can receive the signals from the Bluetooth receiver and it'll process the signals. Then it'll provide the current to the driving force Circuit queued signals received from the processor, in line with the signals received driver circuit the motors can rotate forward, clockwise and anti-clockwise direction. Here ARM processor can wait till the signals received from the Mind wave headset and when receiving the signals it'll moves the robots. The driving force circuit can only be connected to port one of the processor.

3) Relay: A relay is an electrically operated switch which are used as an electromagnet to mechanically operate a switch. Relays are used to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

4) Ultrasonic sensor: Ultrasonic transducers have three different parts: transmitters, receivers and transceivers. Transmitter helps converting electrical signals into ultrasound, receiver helps converting ultrasound into electrical signals, and transceiver can do both transmit and receive ultrasound. It is used for measuring the time between sending a signal and receiving an echo the distance of an object can be calculated.

5) Bluetooth module: This module helps you to wirelessly connect the EEG headsets to ARM processor. Thus it helps to convert this project to wireless design. There are 4 pins which are basically for +5V, Ground(GND), Transmitted(TXD), Received(RXD). Supply voltage should be 3.3 - 6 V. Absolute maximum is 7 V.

6) L293D is a dual H-bridge motor driver integrated circuit (IC) which acts as current amplifiers since they take a low-current control signal and provide a higher-current signal which is ultimately used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and

reverse direction. The motor movement of two motors are controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the motor and Logic 01 and 10 will rotate it in clockwise and anticlockwise directions respectively.

7) DC motor: A Direct Current(DC) motor is translator which converts rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by artificial magnetic fields.

8) Chassis: In this project, the chassis consists of a frame or supporting structure on which the circuit boards are mounted.

9) Softwares: In this project we use **embedded c** for programming the ARM processor. We use **MATLAB** software for processing the brain wave raw data which is used to measure the no of blinks done by the user. **OrCAD PCB Designer** software is used to make PCB boards for the project such the interconnections are made wirelessly.

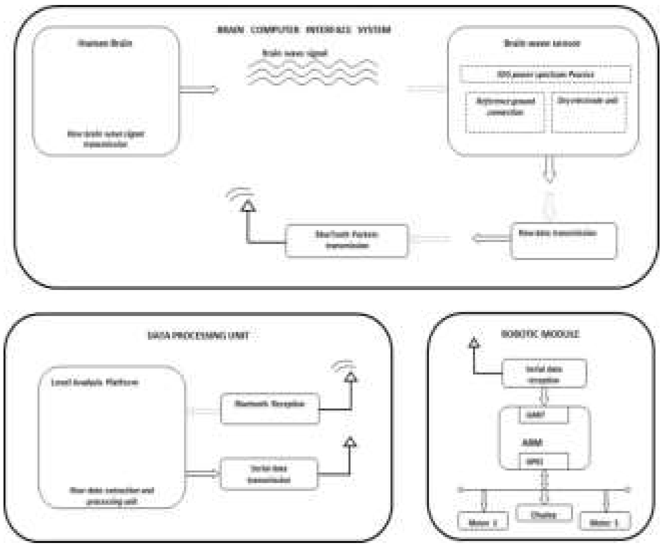
II. BRAIN COMPUTER INTERFACE COMPONENTS

1) Measurement of EEG : This is done by using the EEG headset which has one electrode placement and a ear clip electrode placement. Typically, less than 10 electrodes are used in online BCIs with sampling rates of 100-400 Hz.

2) Preprocessing : This includes amplification, initial filtering of EEG signal and possible artifact removal. Also A/D conversion is made, i.e. the analog EEG signal is digitized.

3) Feature extraction : In this stage, certain features are extracted from the preprocessed and digitized EEG signal. In the simplest form a certain frequency range is selected and the amplitude relative to some reference level measured. Typically the features are certain frequency bands of a power spectrum. The power spectrum (which describes the frequency content of the EEG signal) can be calculated using, for example, Fast Fourier Transform (FFT), the transfer function of an autoregressive (AR) model or wavelet transform . This is done in MATLAB.

4)Device control : Actual system can be mainly divided into 3 stages. In the first stage, a brain sensor with the help of EEG, acquires the raw data (signals) from the brain and transmits it in the form of packets via Bluetooth to the next stage the processing unit. The processing unit is the MATLAB software and the signals are processed here and then sent to the robotic module through serial data transmission using a ARM7 processor. Based on the data and the commands received through the ARM7 processor, the relay circuit performs actions accordingly and the wheels rotate accordingly. Keil Compiler software was used to program the ARM7 microcontroller used to communicate with the chassis .



III. CONCLUSION

Thus our proposed system provides an affordable solution to improve the efficiency of the brain controlled wheelchair with the parameter of low cost being considered as well. The further additions to the wheelchair system such as a wireless module for controlling the wheelchair as a secondary method in case the EEG fails and an obstacle detection sensor that will halt the wheelchair in case of emergencies make it even more better for this project to transform itself into a product

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