Technical Report on Controlling a mobile Robot by Brain Signals using Emotiv BCI

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Technical Report on Controlling a mobile Robot by Brain Signals using Emotiv BCI

I. Objective

The Report is the outcome of the Neurobot Project. Which aims to utilize a wireless brain signals-controlled robot for helping disabled people perform their tasks easier.

II. Introduction

People with disabilities can find it difficult to move from one place to another without the help of others. This project aims to give an alternative easy way for navigation using mobile robot that can be controlled by the brain wirelessly in a range of 1500 meters in the eyesight. this approach can be used in wheel chairs that can be controlled to bring things to the patient without himself move physically from his place.

III. Robot Construction

The robot is constructed to make it easy to navigate through tough indoors environment.

A. Motors

I have used four DC geared motors with the following technical specifications:

DC motor (GR 42x25)	Unit of measurement	
Nominal voltage	VDC	24
Nominal speed	RPM	3600
Nominal torque	Ncm	3.8
Nominal current	A	0.9
Starting torque	Ncm	20
Starting current	A	4
Demagnetisation current	A	6.5
Mass moment of inertia	gcm2	71
No-load speed	RPM	4200
No-load current	A	0.17
Motor weight	gr	390

B. Hardware and electrical system

The robot consists of two main chips that controls the robot:

- The Motor Drivers: The motor Drivers used are Cytron MD10C which is designed to drive high current brushed DC motor up to 10A peak current continuously. Tech specifications:
  - Power Input Voltage : 5-25V
  - I MAX (Maximum Continuous Motor Current): 10A
  - Maximum PWM Frequency: 20 KHZ

Fig. 1. Cytron MD10C

- The Arduino Mega 2560 chip to control the whole system. I used Arduino Mega 2560 specifically because of its sufficient number of GPIOs that enables me to expand the circuit and use many sensors at the same time. Arduino Mega 2560 board specifications:
  - Microcontroller: ATmega2560
  - Input Voltage (recommended): 7-12V
  - Input Voltage (limit): 6-20V
  - Digital I/O Pins: 54 (of which 15 provide PWM output)
  - Flash Memory: 256 KB of which 8 KB used by bootloader
  - SRAM: 8 KB
  - EEPROM: 4 KB
  - Clock Speed: 16 MHz

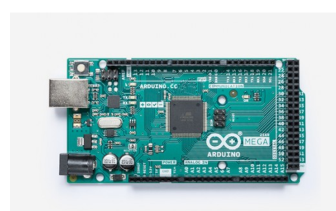

Fig. 2. Arduino Mega 2560

- Lidar lite for obstacles detection. The sensor can be integrated with the circuit using either I2C or PWN with the following technical specifications :
  - Power: 4.7 - 5.5V DC Nominal, Maximum 6V DC
  - PWM Range Output: PWM Signal proportional to range, 1msec/meter, 10sec step size
  - Range: 0-40m Laser Emitter

- Accuracy: +/- 0.025m
- cquisition Time: ¡ 0.02 sec
- Rep Rate: 1-100Hz

Fig. 3. Lidar Lite V1

IV. Design Process and Flow of control

This robot is programmed and integrated after many trials with previous robots and projects to overcome electrical and control faults it also makes it easier to communicate with the Emotiv epoch+ headset. The Emotiv communicate with the Robot using EmoKey which is included in Emotiv SDK this application makes it possible to convert mental activity into written characters. The Characters are then sent to the XCTU application on the laptop which communicates wirelessly with the robot via Xbee modules with a range of about 1500 meters of eye sight. Finally the robot takes an action based on the caracter it receives.

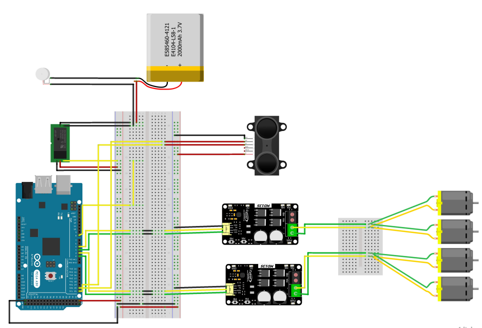

Fig. 4. Schema

V. Software and Code

This robot is controlled and programmed using Arduino. The Arduino decodes the message from the Computer and performs an action based on it. For the computer side the signals recieved from the epoch+ sensor and encoded by the emo key software that communicates with the Emotiv SDK. For more about the Code please visit the github repository : https://github.com/MoghazyCoder/BCI-controlled-Bot

VI. Performance Results scussion

It is noticed and recorded that the robot performs well during manual control using laptop. The Lag through the laptop-Arduino communication is minimum and doesn't affect the efficiency of the robot When Using Emotiv epoch+ the control was tested with few errors that decrease on long term training process that is because most users are trying to use it for the first time but when they trained to use it for less that one hour the errors decreased dramatically and the learning proceeded smoothly with fewer errors.

VII. Conclusion

From the results we gained after experimenting with four people that used it for the first time the direction we adopt seems promising as the error declines as the training period increases and that proves that the idea can be ready to be used on wheel chairs with appropriate training given to patients before using it

VIII. Future Work

This project is planned to be the early beginning of a self driving wheel chair that will help people with different disabilities to live easier .The project consists of three phases and this is the first phase of the project. The second and third phases of this project will be considered as future work according to the project plan as follows :

- Phase 2 :
  - Experimenting the system on a real wheel chair.
  - Making the robot semi Autonomous.
  - Implementing a Deep Learning classifier more efficient and more specific than the currently used SDK.
- Phase 3 :
  - Optimizing the system for commercial use.
  - Making it a Self Driving Wheel Chair.

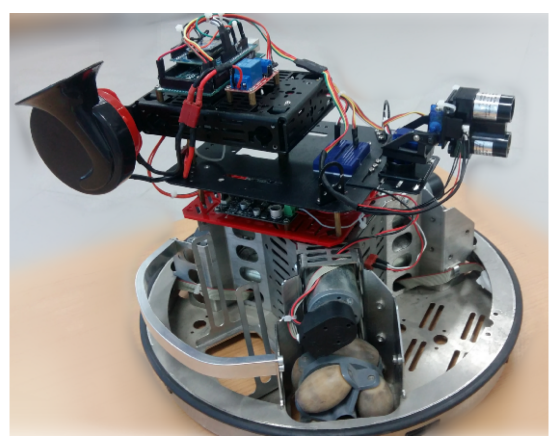

Fig. 5. Robot Image