

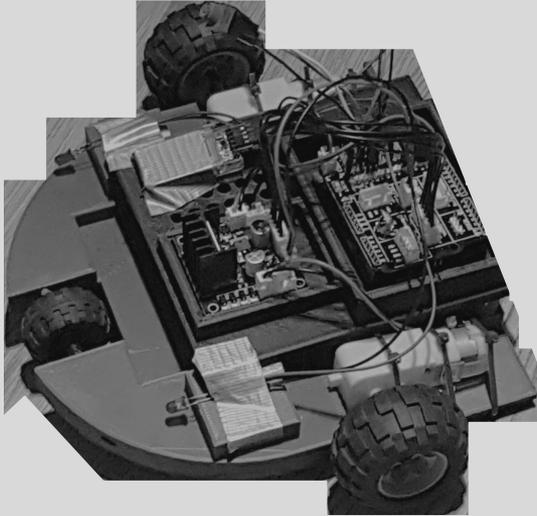
EEG-Controlled Vehicle

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Idea

As technology improves, concepts that seemed far-fetched now seem feasible. Controlling items with your mind has been a fantasy of people for generations. We decided to develop a car that a person can control with their mind, specifically with their level of attention.



Defining Objectives:

- Research the individual technologies. ie: EEG, Arduino, Servos
- Decide and procure the parts
- Design a car to fit all of these
- Design the required custom parts such as base and 3-D print
- Use EEG to monitor electrical signals
- Program the car to move forward when “Attention” level reaches threshold
- Test

Idea to product

Following parts are included in our car:

- EEG headset - Neurosky Mindwave Mobile2
- Arduino UNO R3
- Two servo motors
- Base
- Wheels
- Rechargeable battery
- Small breadboard
- Driver

Finding the headset

Electroencephalography (EEG), is a simple concept. The brain is constantly sending out signals, in the form of electrical signals. In the left temple, various signals can be read, including attention and meditation.

The headset we decided to use is the Mindwave Mobile 2, which can be connected to our car via bluetooth. This headset provides accurate data, and constantly monitors. The headset is available for a relatively low price, €100. This headset measures the electrical activity of the brain, and separates it into 4 categories: Attention, meditation, heart rate, and blinking.



Prototype 1; Phase 1:

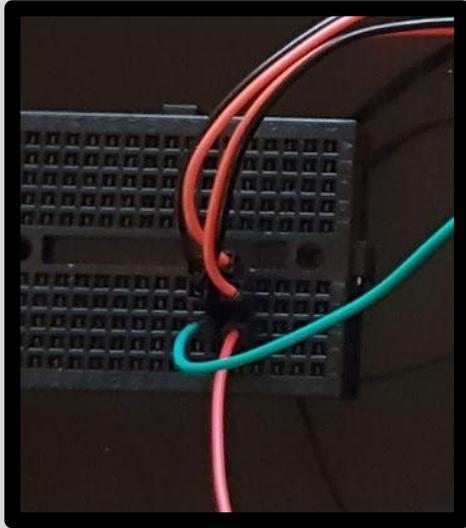
Our first phase was to design the basic dimensions for the vehicle using LEGOs. The back of the base is larger for the battery to fit. The base has two sides open for the motors. The Arduino board and the breadboard would have space on top of the battery. The first phase did not include any of the components listed above.

We also started research on how to control motors (for wheels) using Arduino, learn coding for Arduino.

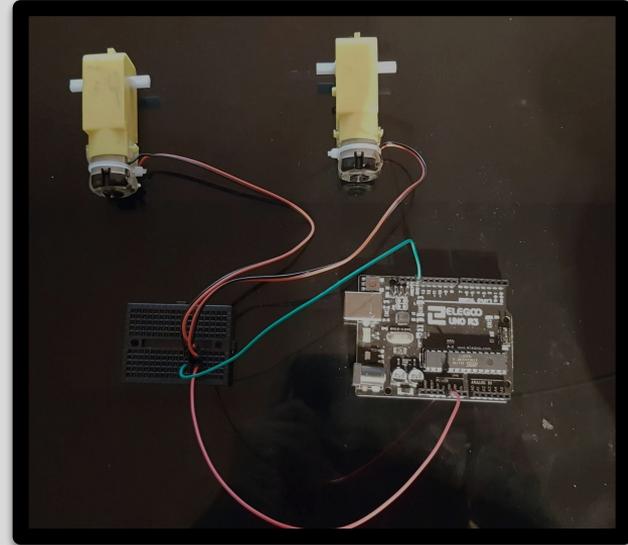
Part of the learning included learning 3D design software, designing individual elements and using Lulzbot Taz 5 printer.

Prototype 1 Phase 2

Our second phase was to simply attach the Arduino board and motors, and get the car to drive forward. We connected the motors to a breadboard, on two separate rows so that it won't short circuit. The 5V and ground pins to the breadboard, so the motors will receive power.



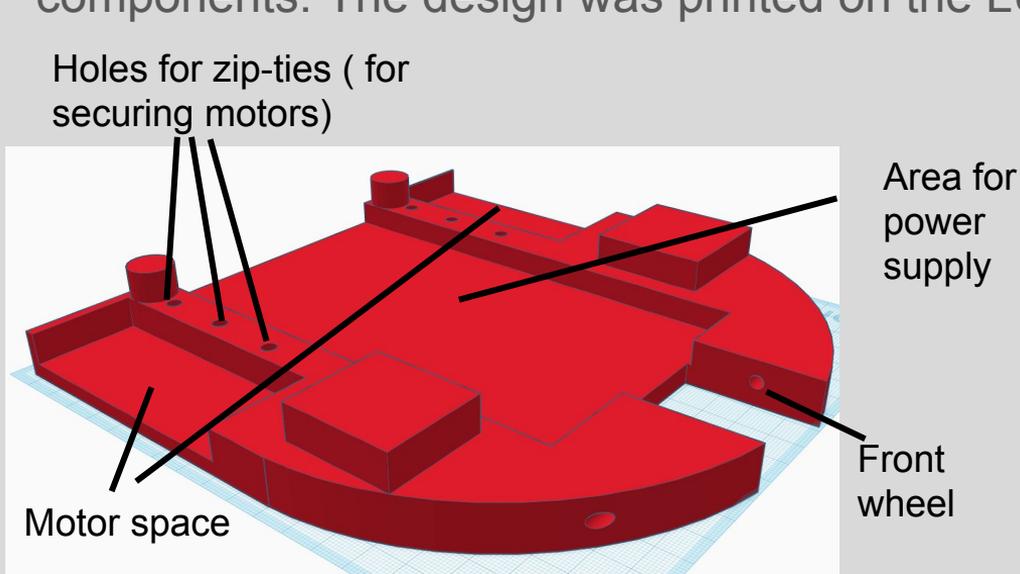
Close up of the breadboard



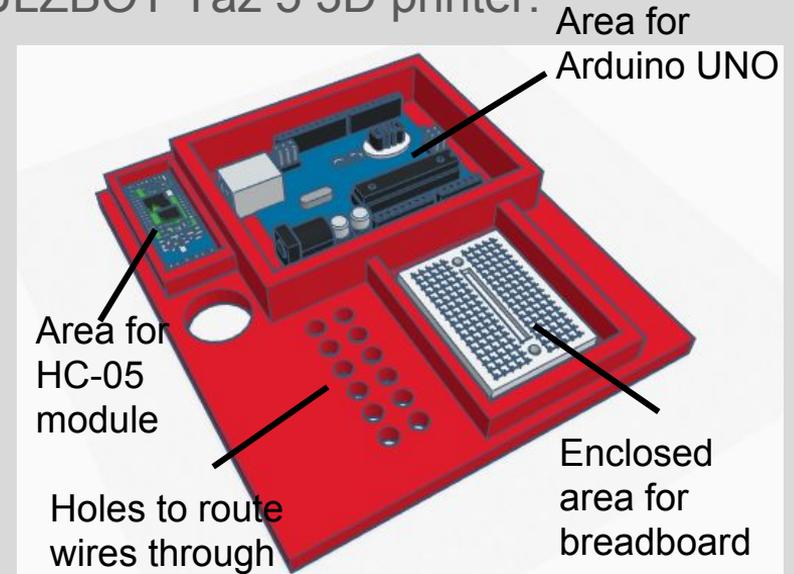
Motor setup, outside (Not including battery)

Prototype 2 - 3D design

We created a 3D design using an online software called Tinkercad. This would allow us to design and print a base for our final design, which has space for all the components. The design was printed on the LULZBOT Taz 5 3D printer.



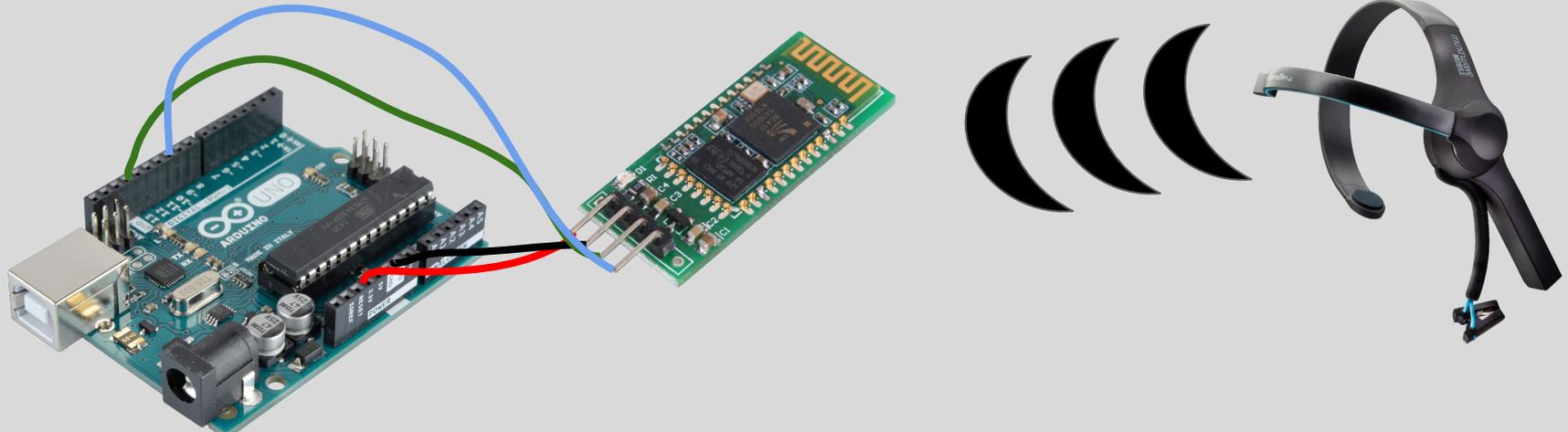
3D Car Model: Bottom half



3D Car Model: Top Half

Final product - Connecting EEG to Arduino

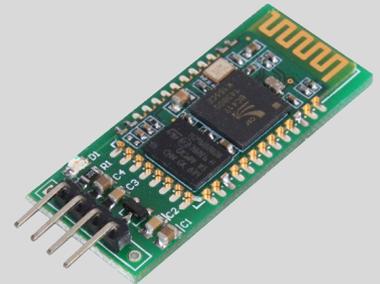
When attempting to connect the EEG headset with the Arduino board, we encountered a problem. Arduino UNO did not come with bluetooth capabilities. We had previously assumed that Arduino UNO had bluetooth capabilities in the base edition, but this was fixed with a bluetooth module. An HC-05 module can be connected to the Arduino UNO, which we bought.



Final product - Pairing HC-05 module to EEG

To program the HC-05 module, we had to connect the module through a serial port using AT commands. The AT command used are listed below:

1. AT+NAME="EEGCAR" This command defines the name of the module
2. AT+UART="57600,0,0" This command defines the baud rate for talking with the headset
3. AT+ROLE="1" This command sets the role of the module to being Master
4. AT+PSWD="1234" This command sets the password to "1234"
5. AT+CMODE="0" This command would set the slave
6. AT+BIND="0081F9128CF9" This command binds the module with the headset using it's unique pin
7. AT+IAC="9E8B33" This command inquires the access code
8. AT+CLASS="0" This sets the bluetooth type to be special, making it quicker for the device to connect
9. AT+INQM="1,9,48" This sets parameters for pairing, E.G. maximum length of pairing, stops pairing once more than 9 devices are found, etc.



Motor Control

During the first prototype phase, we connected the motors directly to power source and made sure the car works.

Then we connected the motors to Arduino for control and realized, Arduino Uno couldn't power the motors as is. We could make them spin at maximum speed, but not control it.

Connecting the motors to the Arduino through a Driver solved the problem of not connecting control pins, and eliminated any risk of short circuiting due to the motors.

Final Product: Code

We started by using the code that's already available online (since we all are novice at programming). But there was no code available to use for Mindwave Mobile 2 to Arduino Uno using HC-05. So, we took the older code available and made heavy modifications.

We also added code for better control parameters of EEG headset. Lot of bugs from the original code were fixed for more reliable code base. We are planning on making this code available online for anyone else interested in building this car.

Final Product: Code Loop

*This is only a part of code:

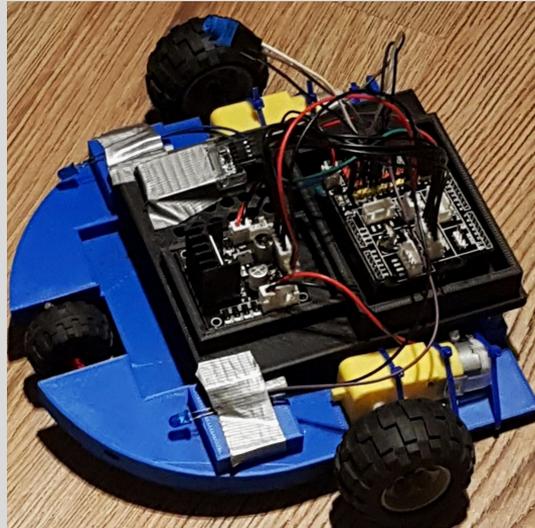
```
attention = 0;

updateAttention();
tr = getThreshold();
if (attention) {
    char txt[256];
    sprintf(txt, "attn: %d tr: %d sp=%d\n", (int)(attention * 1000), (int)(tr * 1000), (int)(speed * 1000));
    Serial.write(txt);

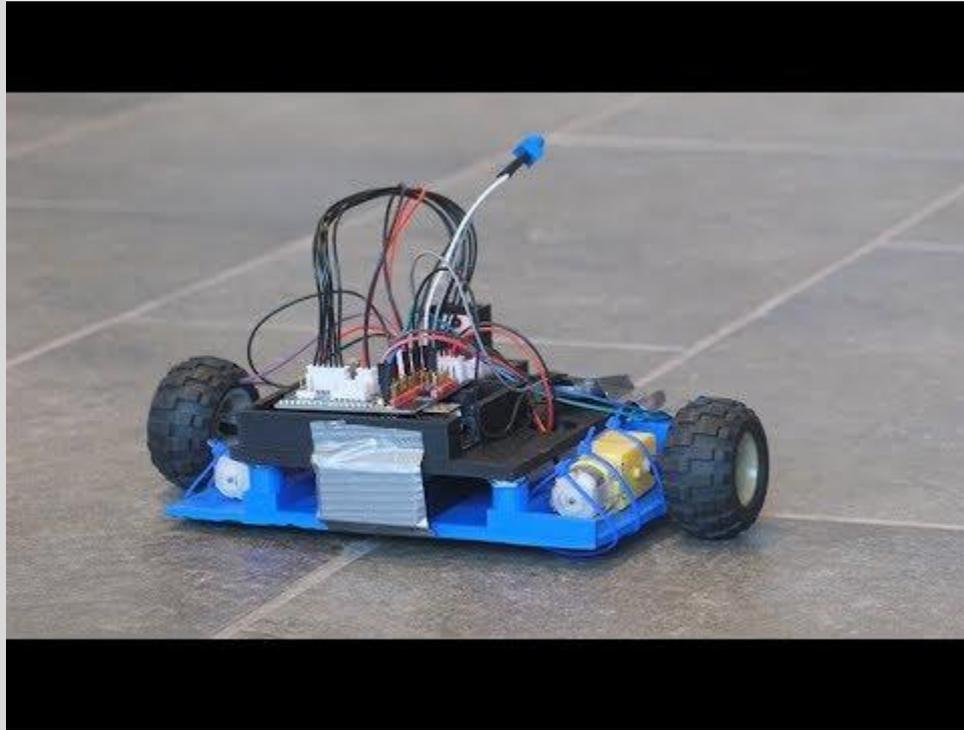
    if (attention > tr) {
        speed = attention; //
    }
}
if (attention < tr) {
    speed = speed * 0.98;
}
if (speed < 0.1) {
    speed = 0;
}
forward(speed);
}
```

Final Product: Combining Components

While assembling the final product, more changes were incurred than our original plan. We attached LEDs, for visual effects. A potentiometer is attached, to easily adjust the threshold of the attention level based on the user's average attention level. Wheels were attached, and the end product is shown below:



Video:



<https://youtu.be/yDjGgxClICY>

Full List of Materials:

- Mindwave Mobile 2 EEG headset
- Arduino UNO R3
- Relay
- 2 LEDs
- 2 Servo Motors
- HC-05 Module
- 3 Wheels
- Six zip ties
- Duct tape
- 3D Printed Base
- 7V battery pack
- 20 Wires

Sources:

<https://cdn.instructables.com/ORIG/FKY/Z0UT/HX7OYY7I/FKYZ0UTHX7OYY7I.pdf>

<https://store.arduino.cc/arduino-uno-rev3>

<https://howtomechatronics.com/tutorials/arduino/arduino-and-hc-05-bluetooth-module-tutorial/>

<https://www.pantechsolutions.net/brain-computer-interface/interfacing-mindwave-mobile-with-arduino>

<https://cdn.instructables.com/ORIG/F8O/SMME/IU5NM2JJ/F8OSMMEIU5NM2JJ.pdf>

<http://mindcontrol.botbook.com/>

<https://www.healthline.com/health/eeg>

<https://store.neurosky.com/>

Project Diary

Apart from this presentation, we also have a journal we maintained every time we met. Some are handwritten and some are typed on the computer. This presentation is put as timeline of work done.