BRAINTRACK:

A Replicable and Accessible Methodology for Customized Brain-Machine Interface Applications

NECST laboratory

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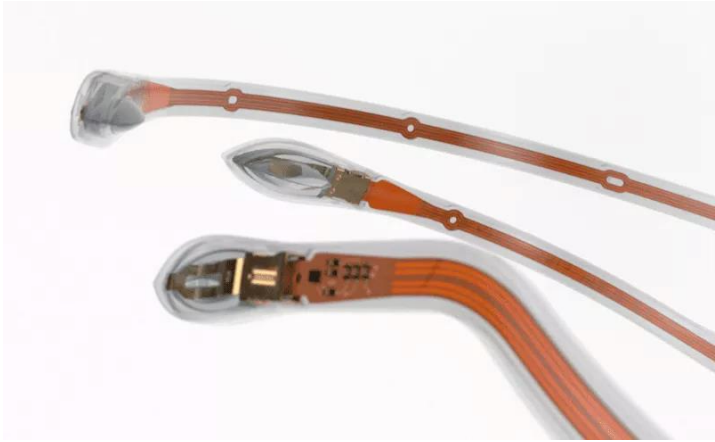
WHAT IS A BCI?

A Brain-Computer Interface (BCI) is a technology that allows direct communication between the brain and an external device by interpreting brain signals

The most used non-invasive implementation of BCIs is based on **electroencephalography** (EEG)[1]

- EEG measures the electrical activity on the scalp
- Multiple electrodes read the brain's spontaneous electrical activity over time

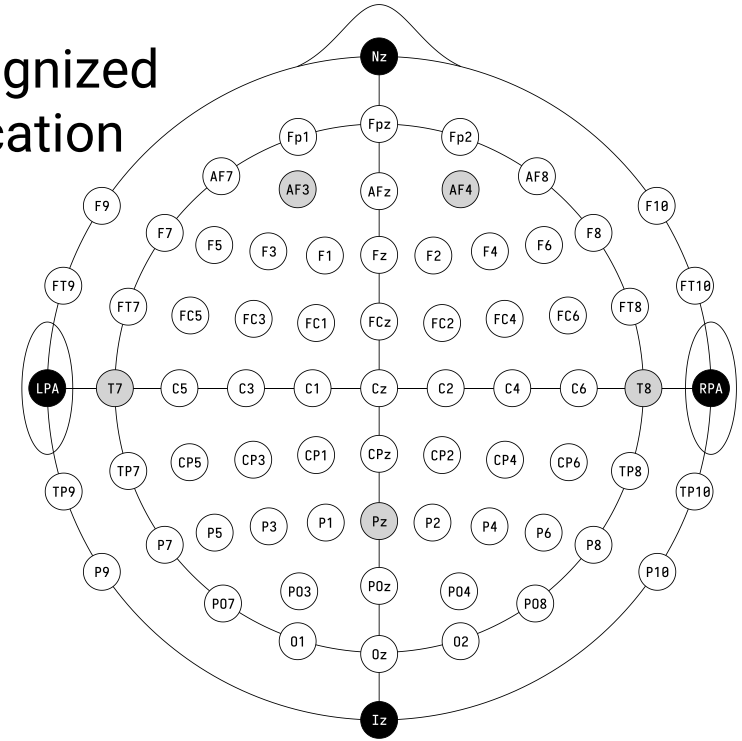


Emotiv Insight's semi-dry polymer sensors [2]

[1] F. Carpi, D. De Rossi, and C. Menon, *"Non invasive brain-machine interfaces," ESA Ariadna Study*, vol. 5, p. 6402, 2006
[2] https://www.emotiv.com/insight/

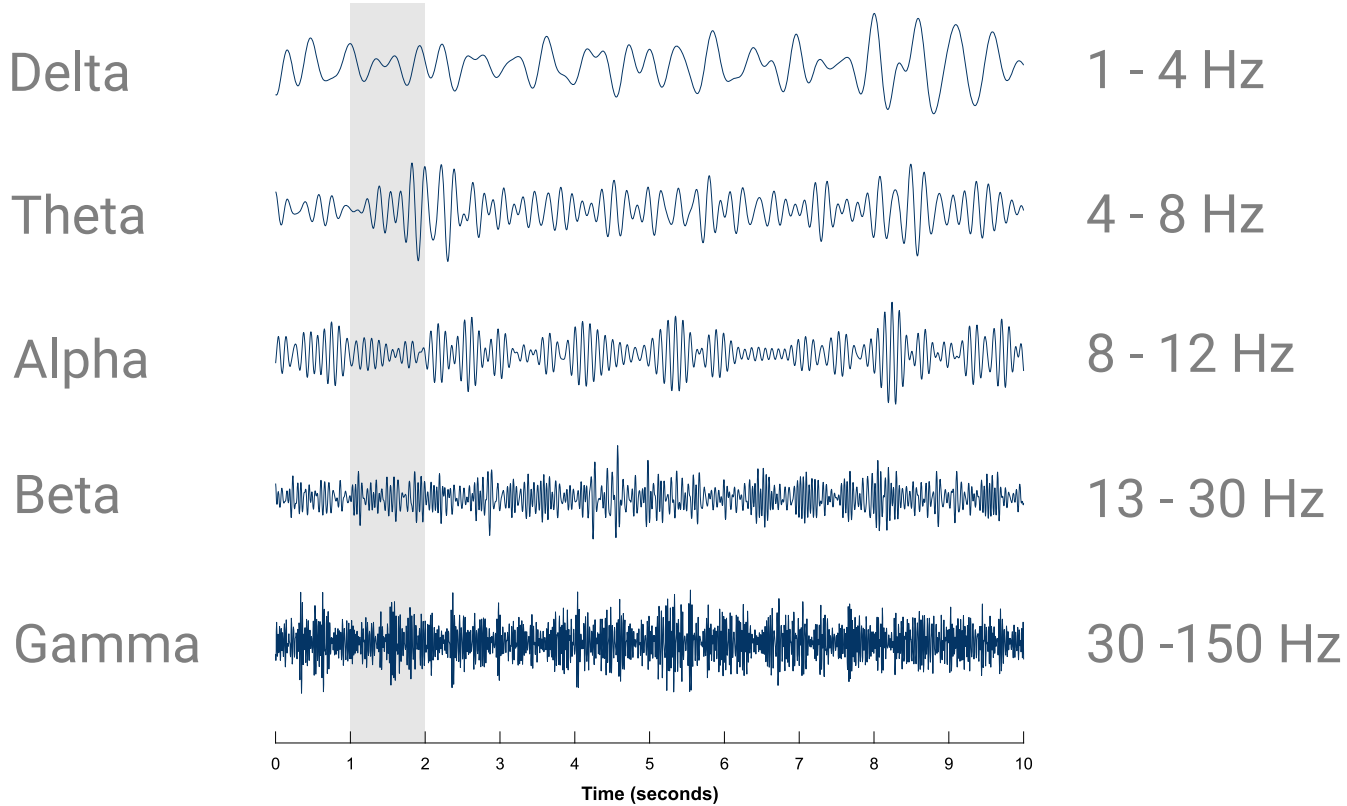
10-10 system: an internationally recognized method to describe and apply the location of scalp electrodes

- 10-10 or 10-20 refer to the distances between adjacent electrodes
- Each label describes the area of the brain underneath



L. Koessler, L. Maillard, A. Benhadid, J. P. Vignal, J. Felblinger, H. Vespignani, and M. Braun, “Automated cortical projection of eeg sensors: anatomical correlation via the international 10–10 system,” *Neuroimage*, vol. 46, no. 1, pp. 64–72, 2009.

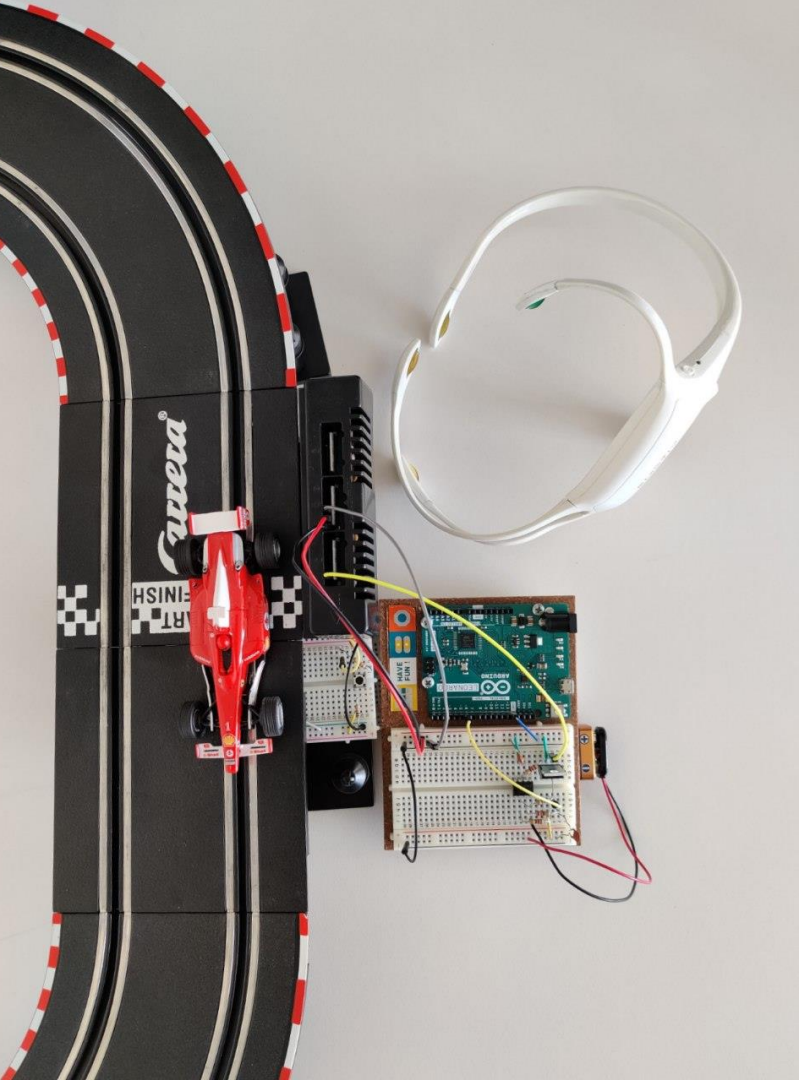
EEG signals reveal oscillatory activity in specific frequency bands:



OUR AIM

Show how a low-cost Brain-Computer Interface (BCI) device can effectively and accurately collect brain signals to control a simple machine or toy, using a versatile **methodology** that can adapt to different use cases.

What better way to demonstrate this than by adapting a toy car track to be mind-driven?



01

METHODOLOGY

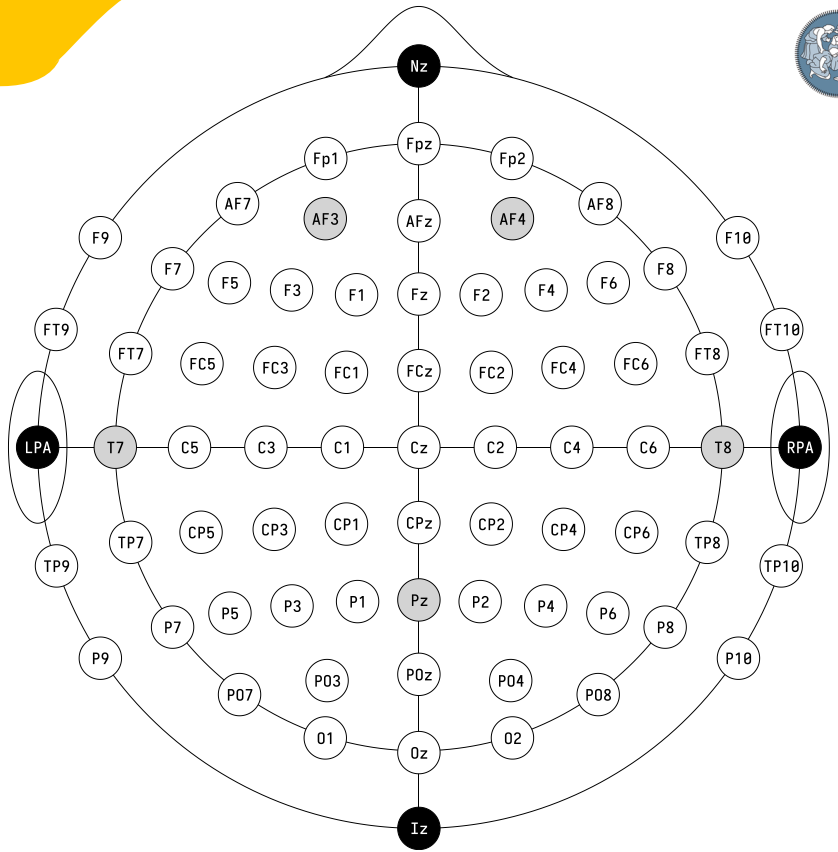
BRAIN-COMPUTER INTERFACE SYSTEM

The input system used for this project is the **EMOTIV Insight**[1]:

- **5 channel EEG**
- Minimal setup time
- Semi-dry polymer sensors
- Wireless connection

[1] https://www.emotiv.com/insight

Equipped with **five semi-dry polymer sensors** placed at channels:
AF3, AF4, T7, T8, and Pz
Uses two additional reference channels (CMS/SRL on left mastoid)



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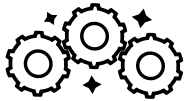
USABLE METRICS

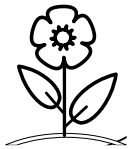
EMOTIV provides six basic measures of mental performance, derived directly from mental activity[1]

Stress

Interest



Engagement

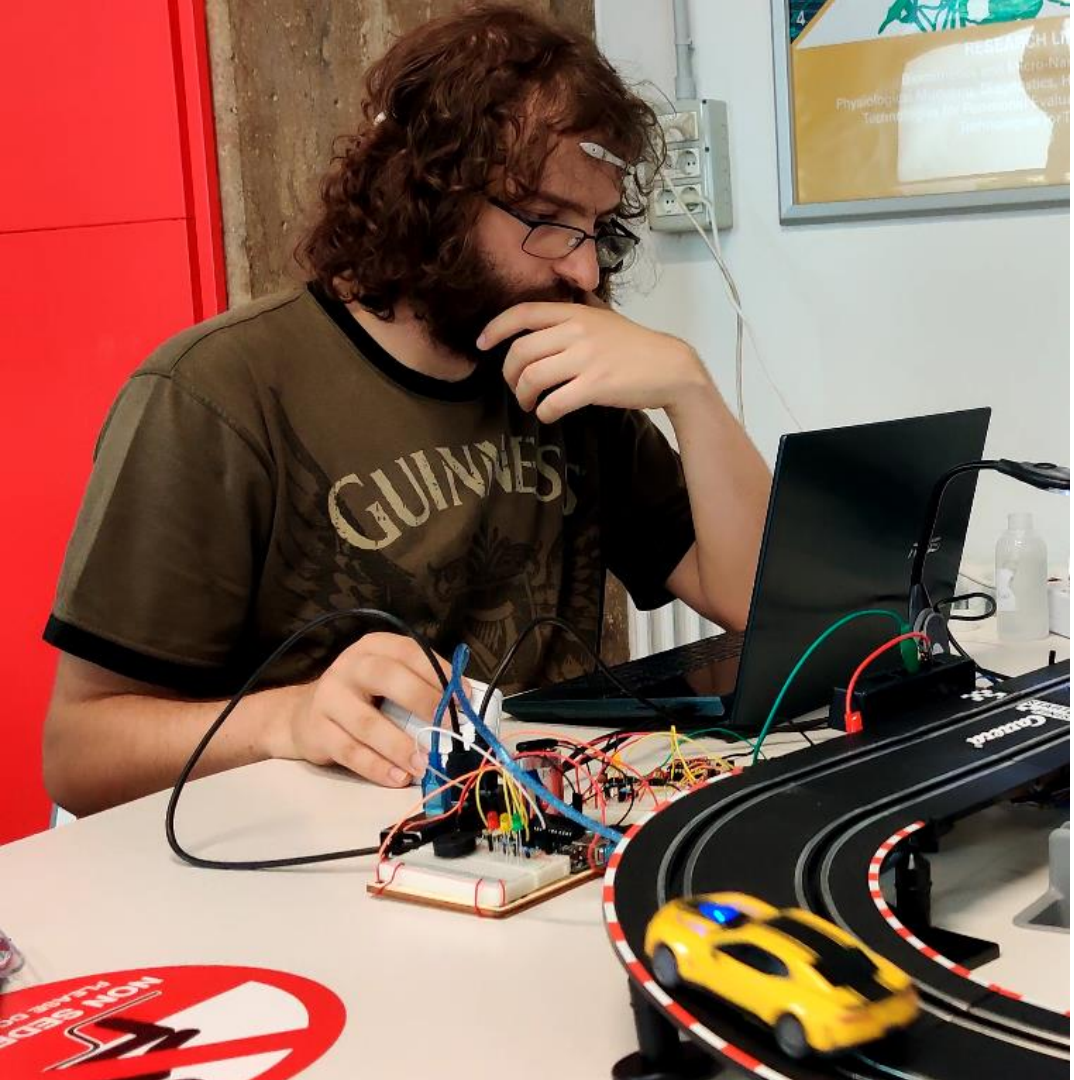


Relaxation

Excitement

Focus

[1] EMOTIV: Web documentation, *https://www.emotiv.com/knowledge-base/performance-metrics/*



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02

INTERFACING

SENDING DATA

- Send data Python->Arduino
- Operate APIs
- Adjust data

```
arduino = serial.Serial(port='COM7', baudrate=115200, timeout=.1)
```

```
arduino.write(bytes(str(newData), 'utf-8'))
```

SENDING DATA

- Send data Python->Arduino
- Operate APIs
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```
s = Subcribe()

s.do_prepare_steps()

streams = ['met', 'pow']

s.sub(streams)
```

https://github.com/Emotiv/cortex-v2-example

SENDING DATA

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```
class Subcribe():
    # A class to subscribe data stream.
    def __init__(self):···

    def do_prepare_steps(self):···

    def sub(self, streams):···

    def on_new_data_labels(self, *args, **kwargs):···

    def on_new_met_data(self, *args, **kwargs):···

            #arduino.write(bytes(str(NewEng), 'utf-8'))

    def on_new_pow_data(self, *args, **kwargs):···
```

SENDING DATA

- Send data Python->Arduino
- Operate APIs
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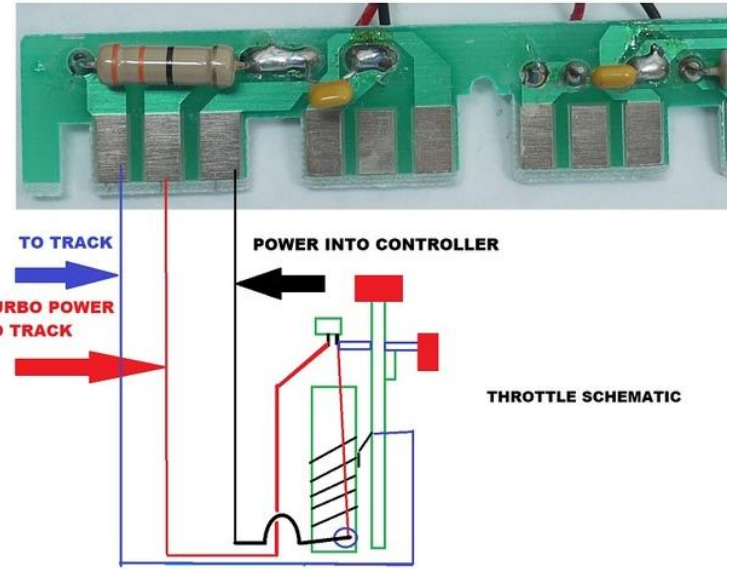
```
def dataSend(x):
    newData = round((x+0.37)*255);
    if newData > 255:
        newData = 255;
    print(newData)
    arduino.write(bytes(str(newData), 'utf-8'))
```

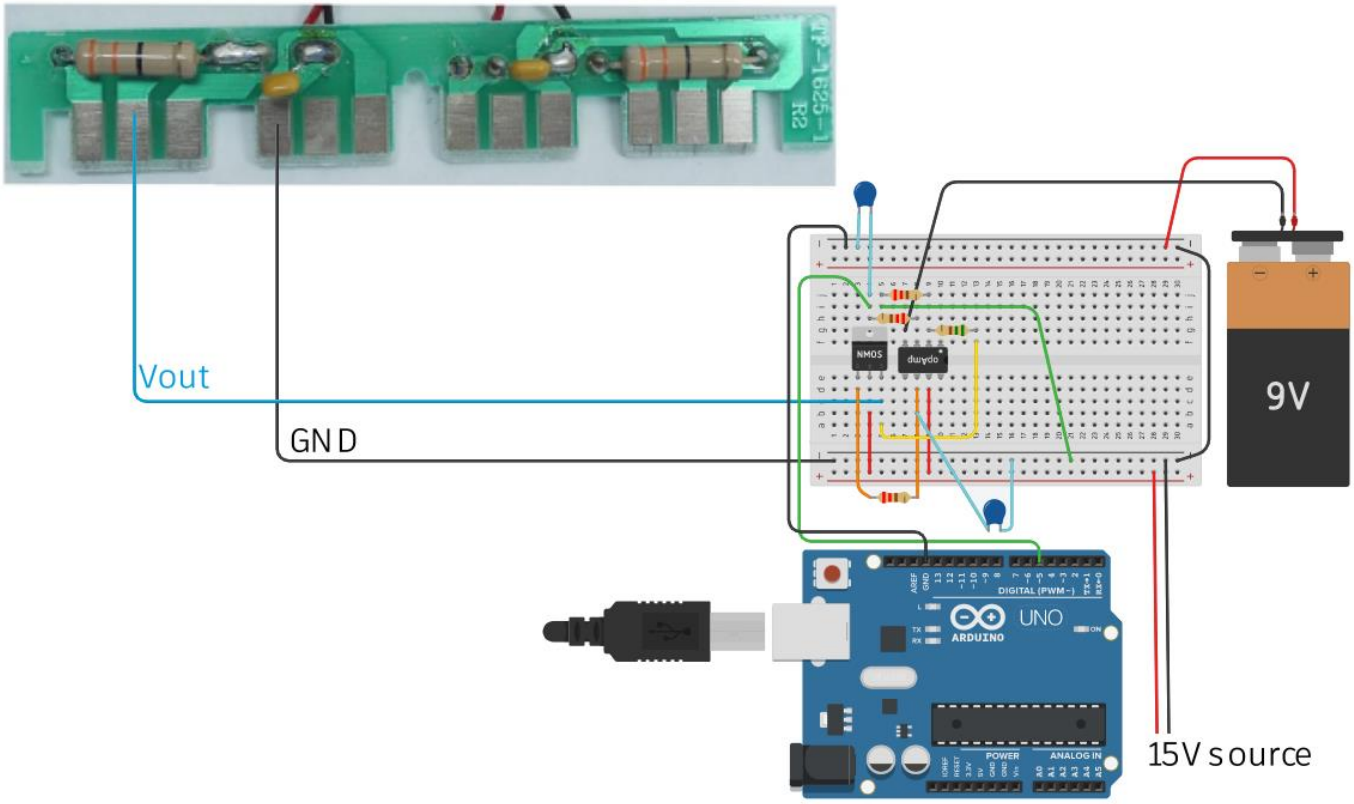
TOY ADAPTATION

Understanding the operating voltage and current

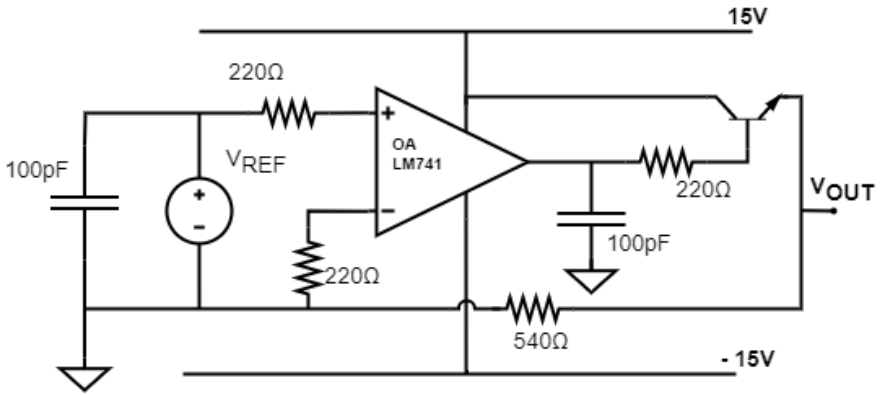
Determining the best method to replace the original controls

CONTROL REPLACEMENT



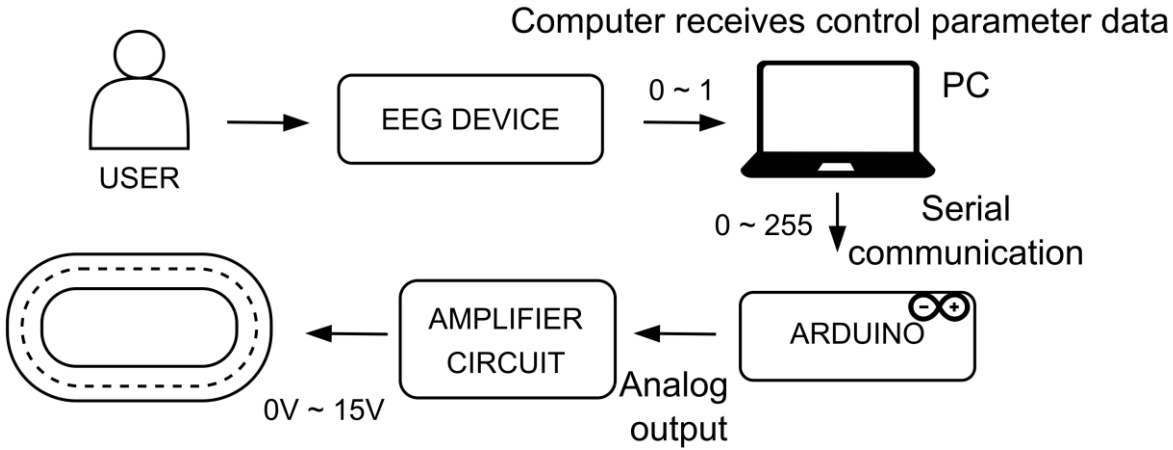

Vout
GND
NMOS
opAmp
9V
DIGITAL (PWM~)
UNO
ARDUINO
POWER
ANALOG IN
15V source

AMPLIFIER CIRCUIT



https://ieeexplore.ieee.org/document/9905223

INTERFACING



The communication between the headset and Arduino is handled using EMOTIV's software and APIs.

THANK YOU FOR YOUR ATTENTION

Do you have any questions?

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