Final Year Project 2024-2025

EEG OPERATED WHEEL CHAIR

Project By:

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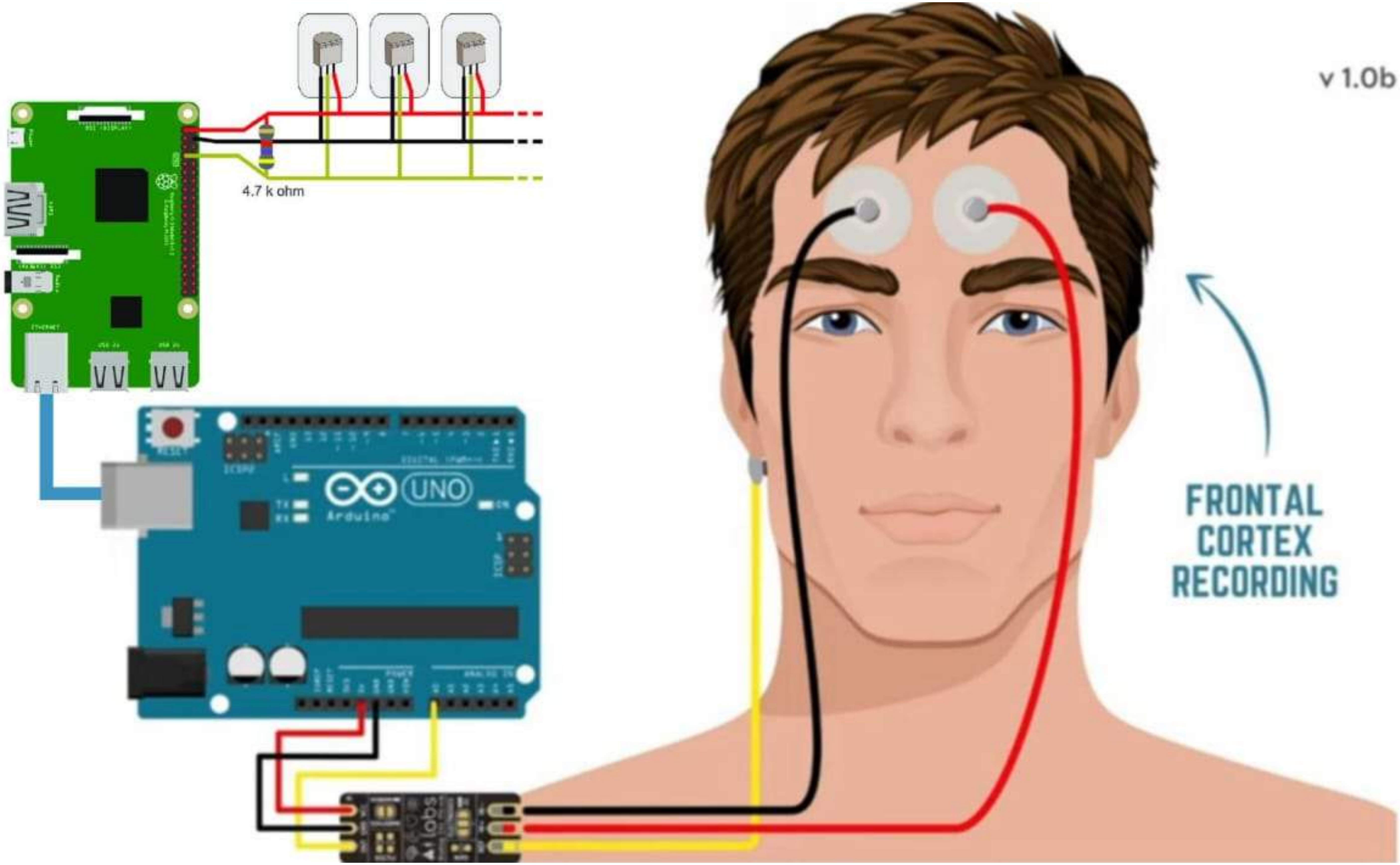
Why Choose the BioAmp EXG Pill for EEG-Operated Wheelchair?

- Versatile & Precise: Records high-quality biopotential signals (EEG, ECG, EOG, EMG).
- Highly Compatible: Works with various MCUs and SBCs (e.g., Arduino, ESP32, Raspberry Pi).
- High Input Impedance: $10^{12}\Omega$ ensures clean, accurate signals.
- Configurable: Supports different biopotentials and electrode setups (default: EEG, 3 electrodes).
- Open Source: Customizable hardware and software.
- Compact Size: Small and lightweight (25.4 x 10.0 mm).

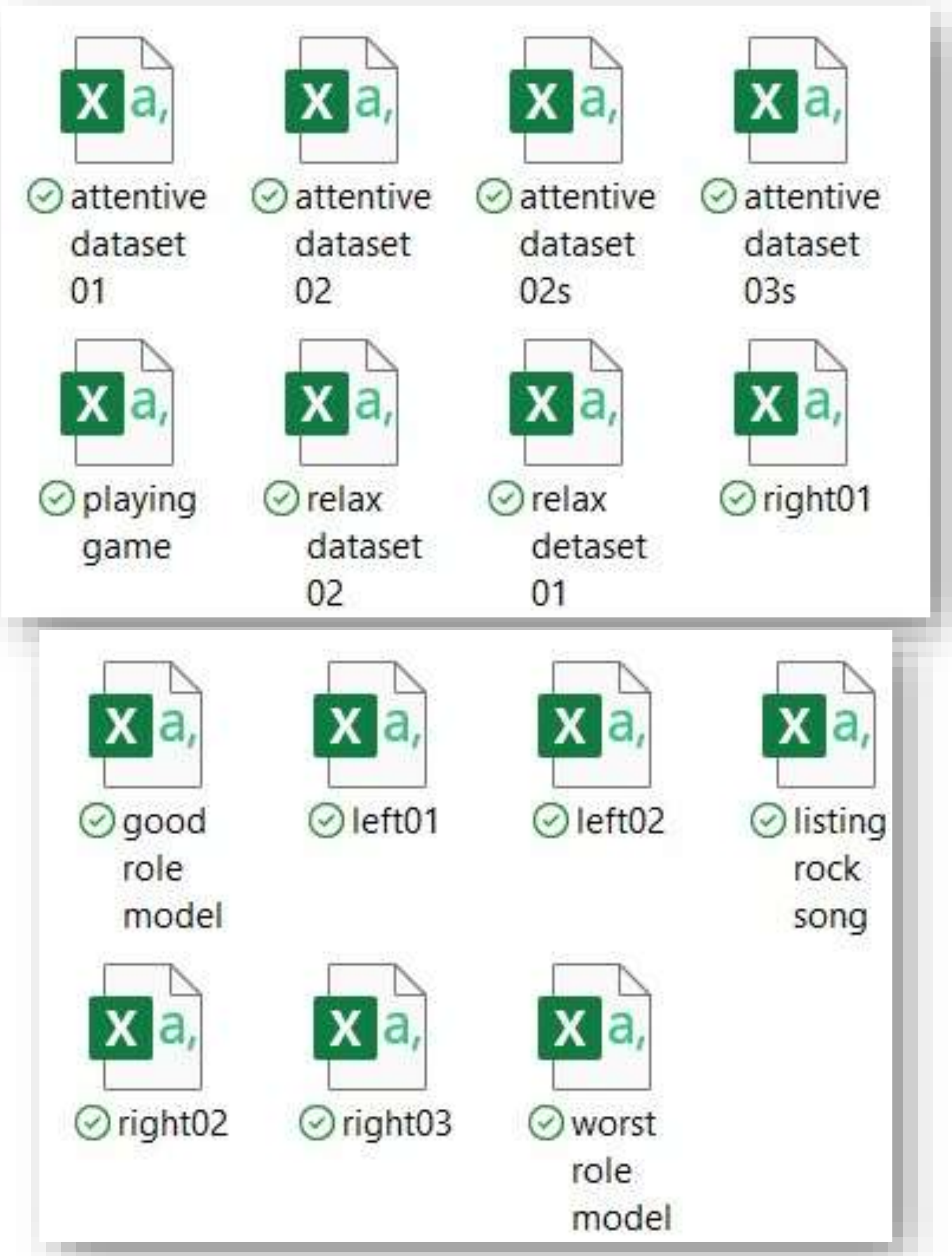
CIRCUIT DIAGRAM



Collecting Data using Python script

```
import serial
import csv
import time
import datetime

COM_PORT = 'COM5' # Arduino's COM port
BAUD_RATE = 115200 # Must match the Arduino's BAUD_RATE

# Open the serial connection
ser = serial.Serial(COM_PORT, BAUD_RATE)

# Create a CSV file to save the data
with open('signal.csv', 'a', newline='') as csvfile:
  csvwriter = csv.writer(csvfile)

  # Set the maximum duration of the data collection (in
seconds)
  max_duration = 180

  start_time = time.time()

  print("Collecting data...")

while time.time() - start_time < max_duration:
# Read a line of data from the Arduino (until a newline character)
data = ser.readline().decode("latin-1").strip()

# Get the current timestamp
current_time = datetime.datetime.now().strftime('%Y-%m-%d %H:%M:%S.%f')

# Split the data into a list of values using the comma as a delimiter
values = data.split(',')

if len(values) > 0 and values[0].isdigit():
# Save the data to the CSV file along with the timestamp
csvwriter.writerow([current_time, values[0]])

ser.close()
```

Datasets



Datasets Generation

	26:50.1	519
0	26:50.1	507
1	26:50.1	502
2	26:50.1	483
3	26:50.1	506
4	26:50.1	492
...	...	...
159994	06:49.7	785
159995	06:49.7	678
159996	06:49.7	780
159997	06:49.7	796
159998	06:49.7	784

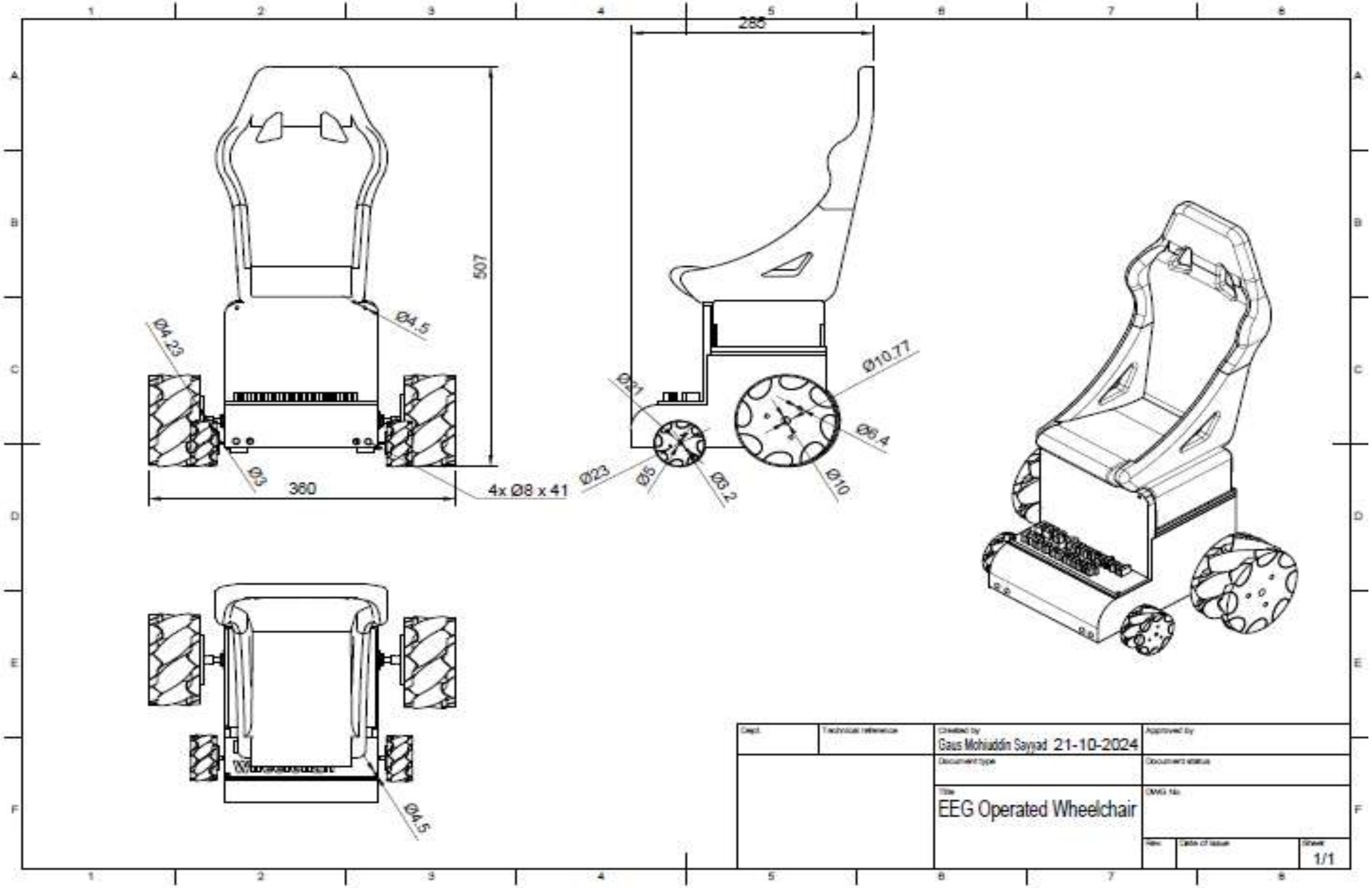
159999 rows × 2 columns

Raw Data

	519	label
0	507	0.0
1	502	0.0
2	483	0.0
3	506	0.0
4	492	0.0
...	...	...
159994	785	3.0
159995	678	3.0
159996	780	3.0
159997	796	3.0
159998	784	3.0

Clean Labeled Data

CAD Designing



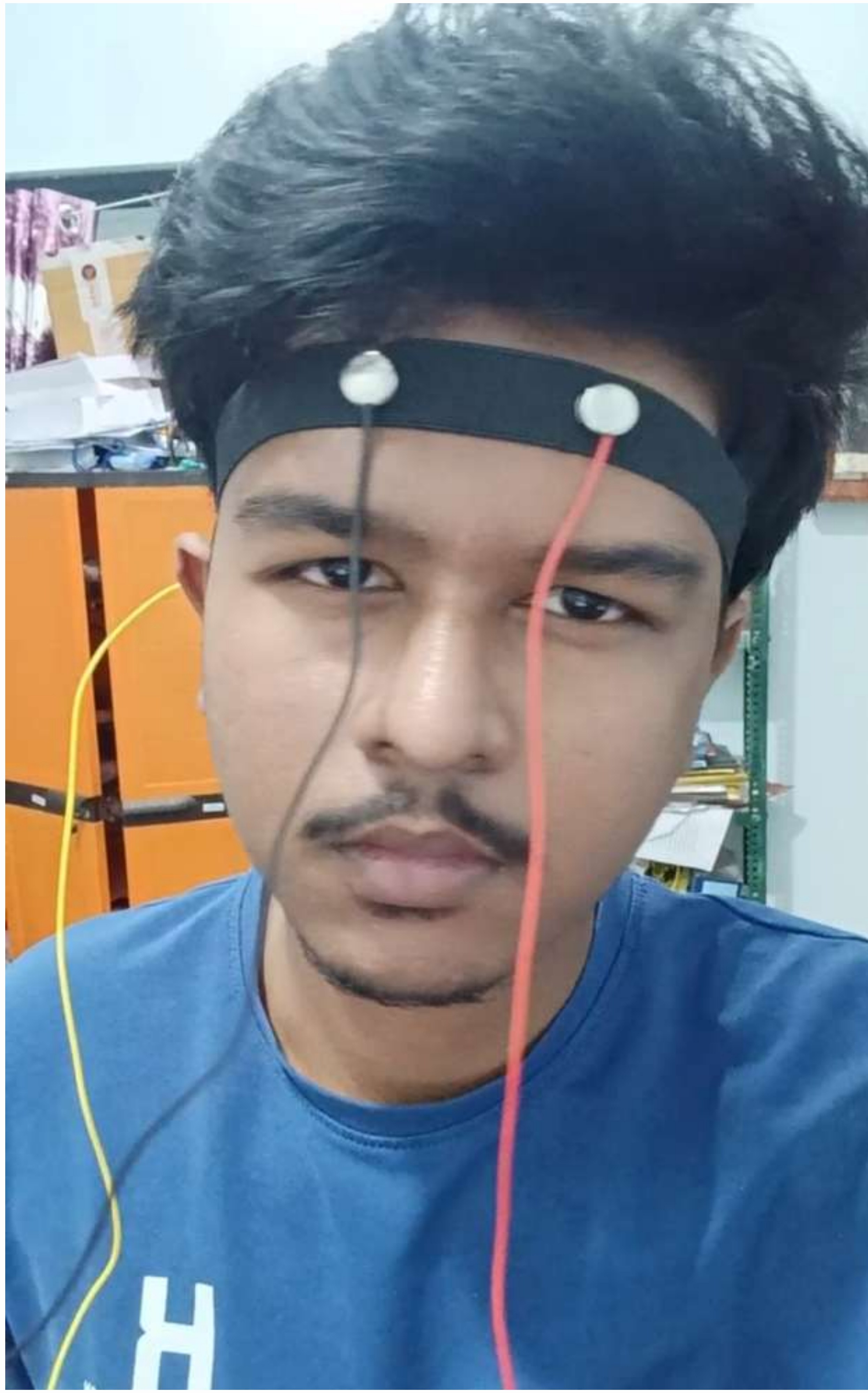
Brain Wave Data Collection

Directional Thinking:
Subject think left, right, back, and front for 20 minutes each, repeated 3 times.

Activity-Based Data:
Brain waves recorded during activities like:

- Playing games
- Listening to pop music
- Listening to devotional songs
- Thinking about an ideal character
- Thinking about a bad character (e.g., enemies)

Data Collected: 1,18,98,816 instances



Data Processing & Model Training

Challenge: Large dataset of 1,18,98,816 instances.

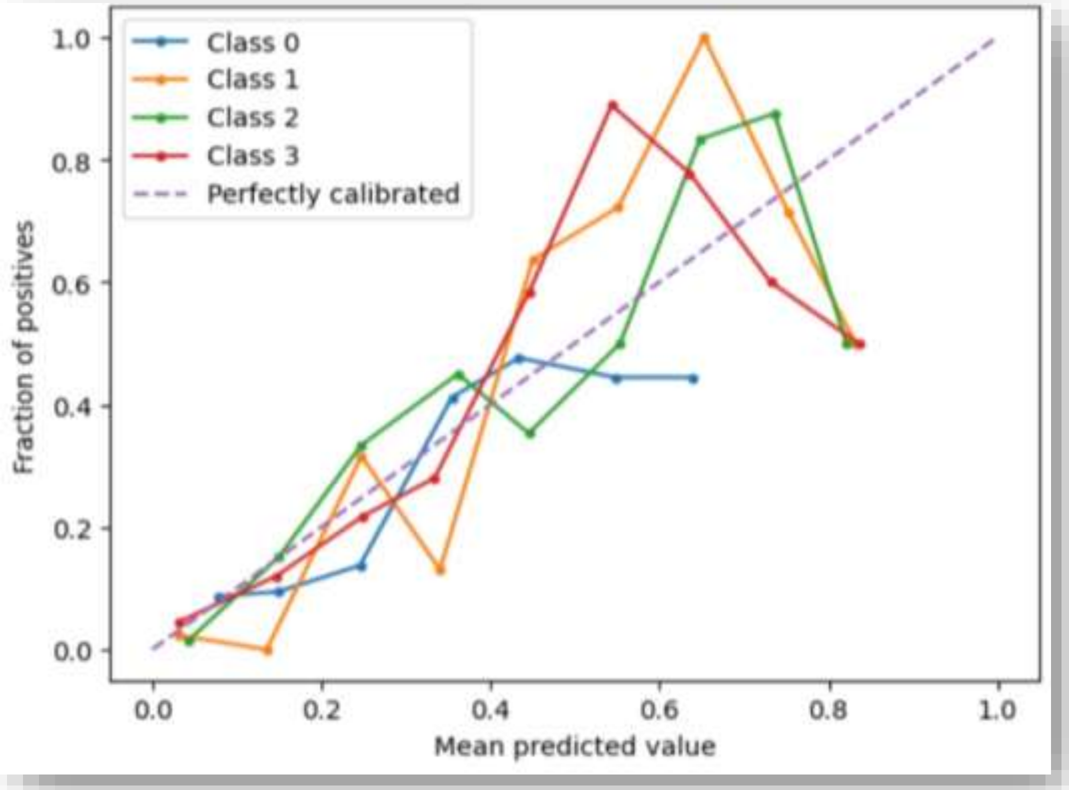
Solution: Train a machine learning model to differentiate thinking patterns.

Tools Used:

- NumPy: Numerical operations
- SciPy: Scientific computing
- Pandas: Data manipulation
- PySerial: Serial communication
- PyAutoGUI: GUI automation
- Scikit-learn: Machine learning algorithms
- Embedded C: Motor Controls

Final Results

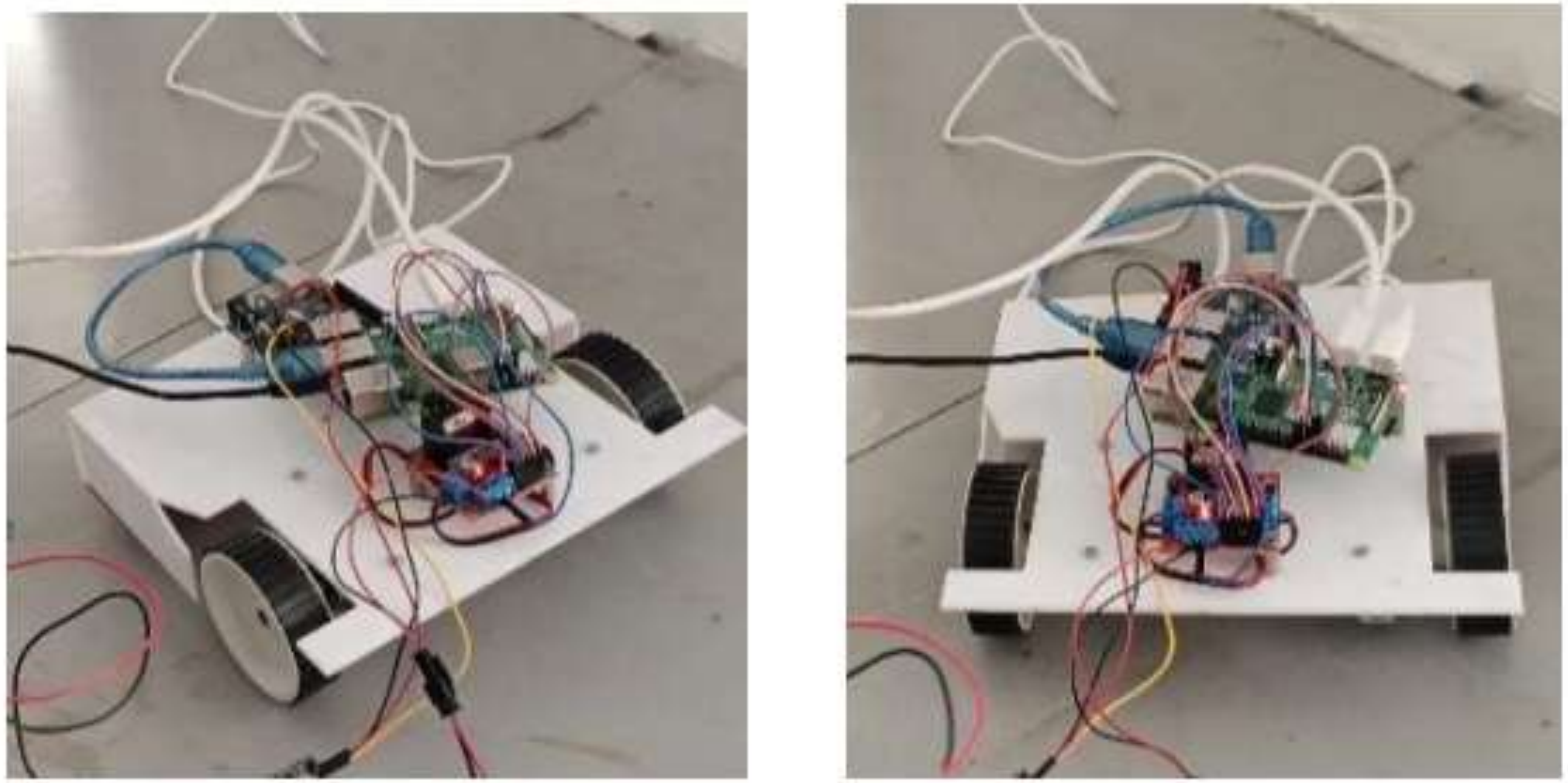
	E_alpha	E_beta	E_theta	E_delta	alpha_beta_ratio	peak_frequency	spectral_centroid	spectral_slope	label
count	623.000000	623.000000	623.000000	623.000000	623.000000	623.000000	623.000000	623.000000	623.000000
mean	8.826992	26.035070	3.360518	17.462140	0.391292	6.484926	12.494754	-10.750196	1.492777
std	8.789737	21.978750	3.966043	23.737435	0.298327	8.362149	3.453279	0.464050	1.118190
min	0.335261	3.880288	0.100366	0.120896	0.014671	0.000000	3.490535	-13.058867	0.000000
25%	3.356193	11.130909	1.046485	3.783032	0.196005	0.998051	10.001617	-11.006133	0.000000
50%	5.850757	17.813897	2.001234	9.007126	0.310454	0.998051	12.839840	-10.705366	1.000000
75%	10.649203	30.530237	3.965997	22.288495	0.485042	13.473684	15.308600	-10.418100	2.000000
max	63.977757	144.413950	40.652637	183.388871	2.511795	29.941520	19.627692	-9.870829	3.000000




```
{'E_alpha': 8.768172935724877,
 'E_beta': 50.78264896539114,
 'E_theta': 6.201978579936563,
 'E_delta': 2.5951045195096842,
 'alpha_beta_ratio': 0.1726608027419064,
 'peak_frequency': 15.968810916179336,
 'spectral_centroid': 15.88220569284006,
 'spectral_slope': -10.111986467222136}
```

```
Accuracy: 0.8150
Precision: 0.8269
Recall: 0.8190
F1 Score: 0.8230
Confusion Matrix:
[[77 18]
 [19 86]]
Classification Report:
              precision    recall  f1-score   support

           0       0.80      0.81      0.81        95
           1       0.83      0.82      0.82       105

    accuracy                           0.81       200
   macro avg       0.81      0.81      0.81       200
weighted avg       0.82      0.81      0.82       200
```

Prototype Stage



Initial Prototype

Final Prototype

Conclusion

Our EEG-operated wheelchair project has been successfully tested and completed. We collected data from patients and utilized machine learning to identify and train on different patterns. Each pattern was rigorously tested under various circumstances to enhance accuracy.

As a result, we have achieved precise control over different actions including moving forward, backward, turning right, turning left, and stopping. This project demonstrates significant advancements in assistive technology, offering improved mobility and independence for individuals with limited physical capabilities.