

Research Plan

Engineering Project with Prototype Testing by Human Participants

- For the purpose of pre-college research, a **Human Participant** is defined as a living individual about whom a researcher obtains (1) data or samples through intervention or interaction with the individual(s) or (2) identifiable private information.

Working Title

Mind-Controlled Robotic Arm using wearable EEG Headset

Rationale (Problem)

A few sentences to summarize your background research that supports your research problem and the need for a solution.

(Prompts: *Why is this problem worth solving? Is there a global or societal need for this prototype/product?*)

The objective of this project is to build a brain-computer interface by prototyping a mind controlled Robotic arm. The project has future practical applications in scenarios where a disabled person can use their thoughts to control a robotic arm, which could potentially be used to translate their intentions into sign language gestures. The system aims to bridge communication barriers and enhance the interaction between individuals with different abilities. The scope of this project is just to prove the ability to mind control some basic movement of a robotic arm.

Engineering Goal

What is the prototype or product that you hope to develop and the expected outcome(s) from it?

(Prompt: *What are the design criteria and constraints for your project?*)

The project uses commercially available EEG headsets and build the interface to a robotic arm controlled by a microcontroller board. This involves building a robotic arm that could be mobilized by a servo motor and controlled by the Arduino controller. The inputs to the Arduino controller are by capturing the brainwave info from the human subject using a EEG headset worn by the subject. In this case the human subject would be me.

Prototype Development

- Review [pages 12-14 of the MSEF manual](#) to see if there are specific guidelines, safety, or forms related to the **materials** you are using or the **equipment** you are using.
- Review [pages 15-18 of the MSEF manual](#) to see if there are specific guidelines, safety, or forms related to the human participants you are using.
- If you determine that anything you are planning is listed as “**requires pre-approval**”, you will be prompted to complete an electronic version of the form(s) below. *If you have completed this template, most of the required information will be ready for you to copy and paste when you create your project in zFairs!*
- ◆ [Risk Assessment Form 3](#) (preview-only)
 - ◆ [Human Participants Form \(4\)](#) (print and have signed in hard copy to upload)

This portion can be subdivided into the sections below:

Materials & Equipment

Include, in list format specific names and concentrations of chemicals, equipment used, locations, how materials are obtained, etc.

Hardware :

EEG headset (Yet to choose a headset that is most apt for my need).

Components of Robotic Arm

Arduino Controller

Servo Motors

Jumper Wires

Breadboard

Software :

Arduino IDE

EEG headset SDK

Python (for data processing and communication)

Design & Construction

Sequentially numbered steps that cover the production of the prototype from beginning to end. The steps should be detailed enough for someone else to be able to replicate from your directions. Identify any **potential risks** and how they are addressed/minimized in your methods. Refer to all safety equipment used, including, but not limited to, goggles, gloves, closed toe shoes, working conditions (fume hood, fire extinguisher if combustion is possible) and supervision.

Design Steps:

Brainwave data capturing and interfacing with Arduino

- 1) Research and choose an appropriate EEG headset
- 2) Establish and integrate the communication between EEG headset and the Arduino controller

Robotic arm control

- 3) Choose the appropriate components for the robotic arm, with degrees of motion etc.
- 4) Select the servo motors to achieve the motion in robotic arm.
- 5) Assemble and build the robotic arm
- 6) Establish and integrate the communication between the Robotic arm and the Arduino controller

Software development:

- 7) Develop Arduino code to interface with the EEG Headset SDK.
- 8) Capture and process brainwave data from the headset.
- 9) Develop Arduino code to control the robotic arm based on the processed brainwave data.

Prototype Testing

Describe the steps and measurements involved in the testing of the prototype. Include a description of the **design criteria** that will be employed to analyze and discuss the results of the prototype testing. A detailed guide to designing this type of study with human participants is provided in this [Risk Assessment Guide](#).

Human Participants

→ Describe age range, gender, racial/ethnic composition of intended participants

- Identify vulnerable populations (minors, pregnant women, prisoners, mentally disabled, or economically disadvantaged) that will or will not be participating
- How will you recruit your participants?

The project will be tested by me. Below are the steps to test

- 1) Inspect the connection between the EEG headset and the Arduino controller
- 2) Inspect the connection between the Arduino controller and the Robotic arm.
- 3) Wear the headset and power on the headset and the robotic arm.

Mind control testing :

- 1) Begin mind-controlled testing.
- 2) Focus on a specific mental state (e.g., concentration) and observe the corresponding robotic arm movement.
- 3) Test different mental states and assess the consistency of arm movements.
- 4) Yet to define test acceptance criteria.

Create an Informed Consent Form

**This is a sample [Human Informed Consent Form](#) that you can use as a guide to create your own detailed consent form.*

Describe how you will **inform participants** about ALL of the following areas before they consent to participate in your study by including (but not limited to) the following information on your form:

1. Purpose of the study.
2. What they will be asked to do.
3. Potential Risks and Benefits.
4. Statement that their participation is voluntary; and they have the right to stop at any time.
5. Where will the signed informed consent forms be stored, by whom and for how long.

Not sure if consent form is needed if I am testing on myself

Methodology & Risk Assessment

Sequentially numbered steps that cover the procedure from beginning to end. The steps should be detailed enough for someone else to be able to replicate the study from your steps. Include:

- Copies of all surveys, questionnaires, or tests (*if applicable*).
- Frequency and length of time involved per participant.
- Are there any risks to the participants (physical, psychological, time involvement, social, legal, etc.)?
- How will you minimize any risk?
- Refer to all safety equipment used, including, but not limited to, goggles, gloves, closed toe shoes, working conditions (fume hood, fire extinguisher if combustion is possible) and/or adult supervision.
- Are there any benefits to the participants or to society?

Test methodology

The project will be tested by me. Below are the steps to test

- 1) Inspect the connection between the EEG headset and the Arduino controller
- 2) Inspect the connection between the Arduino controller and the Robotic arm.
- 3) Wear the headset and power on the headset and the robotic arm.

Mind control testing :

- 1) Begin mind-controlled testing.

- 2) Focus on a specific mental state (e.g., concentration) and observe the corresponding robotic arm movement.
- 3) Test different mental states and assess the consistency of arm movements.

Data Analysis & Protection of Privacy

Include a description of the data being collected and the techniques or statistical tests that will be used to analyze and discuss the results of the experimentation. Include:

- Will identifiable information be collected?
- Will data be anonymous and how will anonymity be protected? If it is not anonymous, will data be confidential and how will confidentiality be safeguarded?
- Where will data be stored?
- Who will have access to the data and what will happen to the data after the study?

NA

Clean-up and Disposal

NA

Bibliography

Key sources on your topic, from your literature review and/or background research, that helped you write this plan. *APA format is recommended.*

Johns Hopkins Medicine. (n.d.). Electroencephalogram (EEG). Retrieved from <https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/electroencephalogram-eeeg>

NeuroSky. (n.d.). MindWave Mobile and Arduino Integration. Retrieved from https://developer.neurosky.com/docs/doku.php?id=mindwave_mobile_and_arduino

Science Buddies Staff. (2023, December 6). Motorizing a Robotic Hand. Retrieved from https://www.sciencebuddies.org/science-fair-projects/project-ideas/Robotics_p003/robotics/build-motorized-robot-hand

Summary or Addendum

This section is only necessary if experimentation changed through the course of the research. If additional SRC or IRB approval was needed, you must also provide a letter from the SRC, explaining the changes, which is then signed and dated.