*ECE 1000 Final Report: Lite Arm I2 Robotic Arm*

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***Abstract -* The Lite Arm 2, the automated robotic arm detailed in this report, offers a comprehensive platform for exploring** **electrical, mechanical, and microcontroller engineering. Controlled by a Raspberry Pi Pico WH, the arm utilizes servo motors to execute a range of movements, guided by a joystick interface. Real-time feedback for each servo motor is provided through an OLED display. This report delves into the design, functionality, and the significant impact it has had on our personal growth within each engineering discipline.**

1. INTRODUCTION

Inspired by our shared interest in electronics and robotics, we chose to construct a robotic arm as a multidisciplinary engineering project. This endeavor allowed us to integrate electrical engineering, microcontroller programming, and mechanical engineering concepts into a single, challenging task. By collaborating effectively as a team, we pushed the boundaries of our knowledge and skills, ultimately enhancing our understanding of these disciplines. This report delves into the intricate details of the Lite Arm 2's design, functionality, and the significant impact it has had on our personal growth within each engineering discipline.

1. BACKGROUND

While developing our Robotic Arm, we pulled from a diverse range of resources. YouTube tutorials guided us through wiring and Raspberry Pi programming, while datasheets provided specific component information to tweak our components accordingly. GeeksforGeeks proved invaluable for refining our servo motor code, and Thingiverse offered open-source repositories for 3D printed designs. A detailed citation section is included below to acknowledge our sources and to maintain transparency.

1. PROJECT DESCRIPTION AND FORMULATION

Materials:

1. Raspberry Pi Pico WH: Serves as the central processing unit that is responsible for executing code and acting as an intermediary for our input and output devices.
2. Smraza Micro Servo Motor SG90: Responsible for converting electronic signals into angular displacement. Gives arm 180° range for x and y axis movement.
3. Dual Axis Analog Joystick: Primary input device for controlling the arm. Allows the user to provide two-dimensional control with x and y motion. It sends analog signals to our Raspberry Pi.
4. SSD1306 OLED Display: Provides a visual output of the x and y axis coordinates for each servo motor in the arm.
5. Screws and Bolts: Used to secure the various components, ensuring structural integrity and stability during operation.

**Diagram:**

The diagram illustrates the electronic components used to control the design, excluding primary power and ground pins from the breakout board. Similar signal representations maintain diagram clarity. The Raspberry Pi, running Python code, acts as the central control hub for joystick input and servo motor and OLED output.

A computer drawing of a circuit board

Description automatically generated*Figure 1: Wowiki simulated System*

*A diagram of a circuit board

Description automatically generatedFigure 2: Schematic design – excluding joystick due to the component not being available on tinker cad*.

*Figure 3: 3D design of the assembled arm.*

A group of plastic parts on a table

Description automatically generatedA grey mechanical arm with arms

Description automatically generatedA transparent robotic arm

Description automatically generated*Figure 4: Printed 3D components*

The 3D print was sourced from user Armatec on Thingiverse.

**Full System:**

Our 3D-printed robot arm is now complete. While we successfully assembled it using screws, bolts, and super glue for minor adjustments, we encountered some limitations due to part availability. For future projects, we'll prioritize standardized design and materials to enhance durability and ease of assembly.

Figure 5: Fully assembled arm

A robot arm on a table

Description automatically generated

**Functionality**:

The Raspberry Pi serves as the brain of this robotic arm, processing the signals from the analog joystick and controlling the two servo motors. The joystick's X and Y axes are used to control the arm's horizontal and vertical movements, respectively.

The Raspberry Pi's analog-to-digital converter (ADC) on pins GPIO26 and GPIO27 translate the continuous analog signals from the joystick into discrete digital values. These digital values are then processed by the Pi to calculate the desired angular positions for the servo motors.

The Pi subsequently transmits control signals to the servo motors connected at GP 15 and GP16, instructing them to rotate to their specified angles. This coordinated movement of the servos results in the precise positioning of the robotic arm.

The SSD1306 OLED display provides real-time visual feedback of the arm's position. It displays the current X and Y coordinates, allowing for precise monitoring and control of the arm's movements.

1. DISCUSSION AND RESULTS

Overall, the team believes the project was a success and are satisfied with the outcome. The arm was able to execute a horizontal and vertical range of motion, which met expectations. However, challenges in sourcing suitable ball bearings impacted its functionality, leading to movement that was less seamless than originally envisioned. By obtaining the appropriate tools in the future, modifications can address these issues and enhance performance.

In future recreations, the team could consider expanding the arm itself to contain more motors to resemble a human hand more closely, with additional range of movement for the various extremities, or a wireless joystick clean up the control system and provide control from a larger distance. The project itself was not seamless but did push the team to go outside of their comfort zone to understand and learn about concepts not previously brought up in class. Coding and learning more about 3D printing will serve to be valuable skills that can be further expanded upon in personal and school related projects.

In terms of individual contributions:

Melisa Garica oversaw the programming of the input and output controls. Tweaking and modifying it so that X and Y axes on the joystick were configured to their corresponding servo motors, while outputting current position on the SSD1306 OLED. Additionally, extra time was spent on her behalf to perfect the restarting motion of the servos once the joystick was released, which proved to be a tougher feat than originally believed.

Sidney Delgado oversaw the sourcing of physical hardware for the 3D printed design. She was also responsible for the overall arm assembly and conducted the initial research for the wiring of the project. She contributed greatly to the overall performance of arm through her determination despite our various setbacks.

Angelica Romero sourced the original design from thingiverse, assisted with delegating tasks, planning and stepped in to help her fellow team members as needed. She assisted by learning how to edit STL files for printing after various pieces from the IMaker space were returned off-centered, greatly compromising functionality, and jumping in to make modifications to already printed designs to hold the motors in place, while keeping documentation during the entire process.

By working together, each team member identified a new area of interest within their field and built upon previously acquired concepts, contributing to the overall success of the project.

1. CONCLUSION

The Raspberry Pi Pico proved to be a valuable single board computer that facilitated the entire project by limiting the amount of hardware required to make this arm a reality. By requiring use of just a couple of servo motors, a joystick and an OLED.

The Servo motors ease of use and interaction with the joystick make the overall transition and movement of the arm seamless despite our lack of materials and the joystick created a beginner friendly interface with the OLED providing instant feedback on movement.

The Robotic Arm represents a seamless combination of electrical, mechanical, and microcontroller engineering coming together to create a novice friendly introduction into the world of engineering for any individual who wants to learn and expand their knowledge.

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