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Group 7 Robotic Arm Project Report

Introduction

The goal of this project was to offer hands-on experience with the material discussed in Kinematics and Control of Robotic Systems. In order to complete this goal, a robotic arm was constructed using pre-designed parts and was coded to move. Robot arms can have many uses, but our goals included being able to control the robot from an app or terminal designed by our group and participating in a contest involving moving a rubber duck from one specified point to another.

Materials

For this project, we used the following to assemble our final robot:

1x Baseplate
- 2x Thin wooden sheet
- 4x #4x¾” screw

1x Printed arm kit
- 1x Foundation
- 1x Shoulder turntable
- 1x Base
- 1x Forearm
- 1x Wrist
- 2x Claw gear-levers
- 5x Claw struts
- 2x Claw pincers

1x 5V External Power Supply
1x Mega 2560 R3 Arduino Board
1x 5V Type A to Type B Data Cable
3x Hi-Torque Servo Kits
3x Micro Servo Kits
8x #4x¾” Screws
9x #4-40x1” Screws
22x Male-to-Male Jumper Wires

Methods

We were working with a 3D printed robotic arm with 6 degrees of freedom. We received the robot as freshly printed parts and had to remove the supports on the 3D-printed parts. Once the parts were clean, we started constructing the robot.

The robot was constructed from the "ground" up, starting with the baseplate. Two thin wooden sheets were stacked on top of each other before being screwed together, and the edge lengths of each board matched via a saw. The arm foundation was placed at the approximate center of the plate, and the motor installed after. The rest of the arm, being of a linear design, followed suit, starting with the turntable and shoulder and moving to the wrist and claw assembly. Our team exclusively used screws, washers, and nuts to assemble the robot. This caused the claw assembly to be prone to "rapid undesired disassembly", or falling apart as the current nuts loosen over time. This error was due to the lack of nyloc-insert nuts, which would have better locked onto the screws, stopping the unintentional unscrewing from occurring.

Once the robot was constructed, we got together and wired the robot to a breadboard and arduino as seen in the image below.

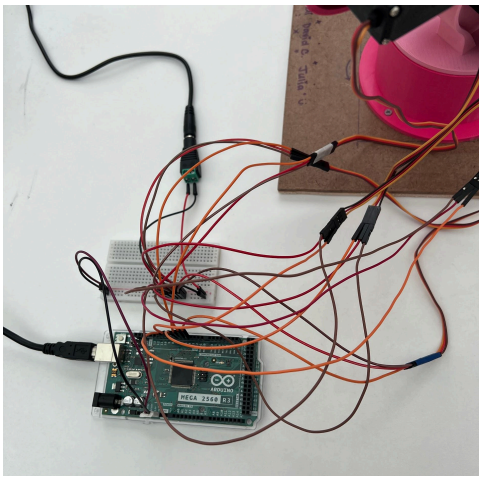

Figure 1. Robot Arm Wiring and Arduino

The servo motors were connected by using male-to-female wires to connect the positive and negative outputs of the servos to the breadboard terminals. A 5V external power source was connected directly to the positive and negative output terminals, in order to power the robot. The data wires of the servos were connected directly to the digital pins of the arduino board. The base servo was connected to pin 4, and each servo was connected in the next higher pin until the final servo, controlling the claw, was inserted into pin 9.

Once wiring was completed, a code was implemented to test each individual servo. The code used for the in-class competition was a modified version of Arduino Terminal Control Code

provided by Dr. Ngo. The code was modified to run automatically when “start” was entered by the user. This command would start a series of functions that smoothly moved the robot from picking up the duck off of the predetermined position to dropping the duck in the box. The trial would run for 60 seconds before automatically stopping the robot. The user could also manually end the trial, prior to the 60 second shut off, by entering “stop” into the command input on the serial monitor.

Analysis/Results

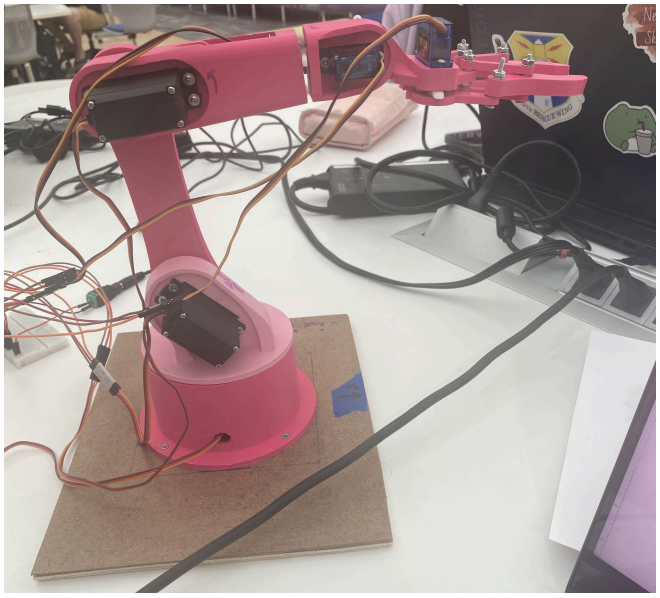

Figure 2. Robot Arm in Home Position

Our robot was able to move 11 ducks within a minute during the final in class competition. The robot did this smoothly and without any issues on the day of the competition. The smoothness of the movements can be attributed to the functions of the code that instructed the servo motors to move by single degrees, instead of jumping between positions.

Further improvement of this robot could be made in adjusting the physical aspects keeping the assembly together such as the screws and bolts. Implementing nyloc-insert nuts would only improve the function of the claw, as there would not be movement in the positioning and the ends of the claws would meet together consistently. Improvement could also be made by updating the code to promote quicker movements of the robot. If we focused more on moving a larger quantity of ducks during the given time period and less on the smoothness of the robot, we would have worked on creating a function that would cause larger step increases in the angles given to the server motos. Having a larger step between each angle would increase the robot's speed in moving, but it would sacrifice the overall smoothness which could introduce further issues.

Conclusion

Overall, our robot successfully completed its task. It was able to pick up and move 11 rubber ducks within 60 seconds. This resulted in us placing 2nd place in the class competition. It did its task smoothly and efficiently. The only issue we ran into was the nuts falling off of the screws after extended periods of the robot moving. If we were to redo this project in the future, we would be more conscious and select screws and nuts that would better secure the parts in order to ensure long term use of the robot.

GitHub

https://github.com/mcfadden-julia-e/Group-7-3D-Robot-Arm-Project

Acknowledgements

We believe this project would not have been possible without the efforts of our instructor/professor Dr. Hoan Ngo. His excellent classes gave us the kinematics knowledge we needed to determine our robot's kinematics, his clear enthusiasm for both teaching and engineering led us to put our best foot forward with our project, and his patience, helpfulness, and clear communication made sure we had a concrete understanding of the process and outcome of our project.

References

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