Individual Lab Report #1

Sensors and Motors Lab
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Team E: AACAS
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Individual Progress

Sensors and Motors Lab

In this lab I developed a microcontroller program and simple circuit consisting of a servo motor and an infrared distance sensor. The sensor output the measured distance to the microcontroller, which I converted to inches using a simple linear calibration. I used the sensor, after filtering the input, to command an angle in the servo between 0° and 180°. Using a button to change between modes, I also enabled the user to command the motor angle from the serial monitor. After developing my code, I compiled the code from my teammates for a single functioning system.

Motor

The servo motor required no setup beyond connecting the power, ground, and data wires. I tested the motor in a breadboard by connecting the 5V and ground wires to their respective side bars, and the data wire directly into the Arduino Digital 0 pin. Testing the motor showed it was a non-continuous servo with an operating range between 0° and 180°. The motor had problems repeating exact alignment to the extreme values but refused to attempt any commanded angle outside of this range.

Sensor

I used the SHARP GP2Y0A21YK infrared proximity sensor as my sensor for this lab. I selected this sensor because the AACAS project at its core must detect nearby objects, which must use some sort of distance sensor. This sensor's datasheet claims an accurate detection range between 10-80 cm (see Fig. 1). I tested the sensor and found the steep vertical region between 1-9 cm to be the most accurate. I converted the values using a linear calibration to produce the transfer function shown in Eq. 1.

$$d = 0.0149V - 3.516 \tag{1}$$

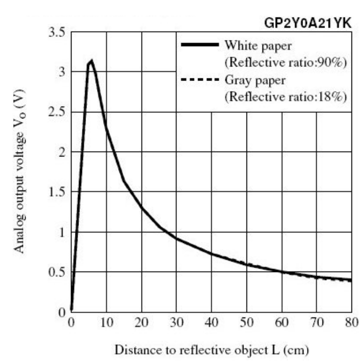

Fig. 1. Sharp IR proximity sensor transfer function.

Raw data from the sensor was very jittery. I implemented both median and mean filters to improve the data and smooth out the curve. The mean filter was much more effective, and I found an appropriate number of sample points to be 200.

Circuit and Code

I prototyped my circuit and initial code using TinkerCAD® by Autodesk®. Figure 2 shows the circuit I developed. I connected the sensor to an analog input, the servo motor to a digital input, and a pushbutton to another digital input. The pushbutton iterated between the different states when I prototyped on the physical circuit.

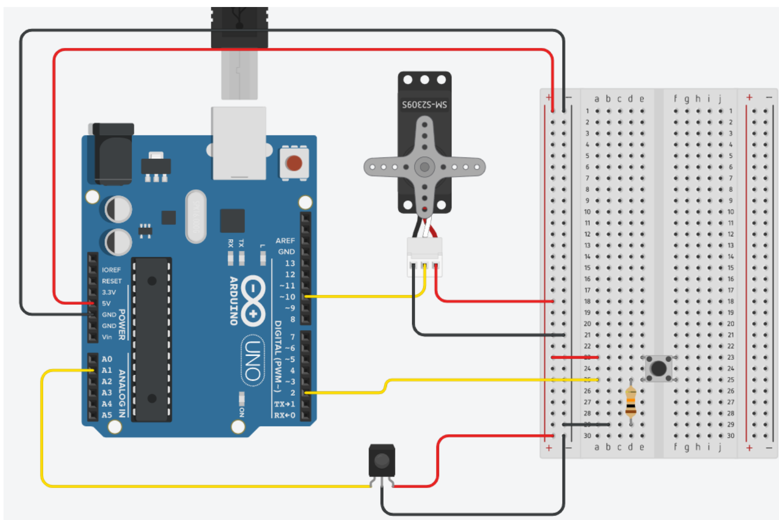

Fig. 2. Simulated circuit prototype for the servo and IR sensor sub-circuit.

Appendix A shows the final code for this lab. I wrote the code pertaining to the servo motor and IR sensor functionality. I also worked with Stefan to integrate the GUI with the microcontroller. As such, I also developed the code for overall program flow and state switching. Yellow highlighting in Appendix A shows the code I contributed.

Project AACAS

My work on the project since the start of the semester has revolved around the physical drone. George Kantor lent us a DJI M600 pro but did not know its condition. In exchange, he asked us to ensure it is functional and train him and his students in its use at the end of the project. I began the semester by ensuring the mechanical frame assembly, battery health, and electrical power connections.

After confirming the exterior seemed in good condition, I connected the drone to the DJI Assistant 2 software to run software diagnostics. The software checked the IMU and GPS connections, motor connectivity, and firmware version. Assistant 2 also had a simple simulator to test the remote controller's connection to the drone. I used this simulator to become familiar with the drone controls. We finalized the drone diagnostics by completing a successful test flight. Shaun helped extensively in this process.

My next, and current efforts have focused on designing the sensor mount for the drone. I designed a simple mount using a series of flat plates connected with standoffs to mount directly to the underside of the drone. The current design has accommodations for the lidar, lidar interface box, RealSense camera, Jetson Xavier, and room for a power board. I am fabricating the in preparation for PR1.

In the background, I have also been developing the software architecture and tools with Stefan. I wrote a simple ROS package using Python and C++ nodes to give example code to the team. I also have been helping Stefan with his first ROS nodes to receive data from the Lidar. While I wait for the finished power board dimensions, I am setting up the Jetson Xavier.

Challenges

Sensors and Motors Lab

The only major challenge I had was receiving good sensor data from the IR sensor. Depending on the sensor's orientation and lighting, distances beyond about 5 inches registered around -3.5 inches. I solved this issue by introducing a distance cap at 5 inches and set any reading below -0.5 to be 5 inches. I did a similar bounding at 0.5 inches to remove erratic values from too close a measurement. I tried to smooth out the rest of the noise using a mean filter of 100 consecutive data readings. This method smoothed the readings, but still made the motor jitter considerably.

Project AACAS

The major problems I have had with the project relate to setting up the Jetson and fabricating the sensor mount. There are no commercial mounts for the Jetson Xavier, so I designed my own. I tried to 3D print the mount several times, but it has failed each time. For the Jetson, I have not been able to find the resources to run the setup process. I could not find a keyboard with a dongle or an HDMI cable. The team supplied several components from home to supplement the other items I could not find in the lab.

Teamwork

Sensors and Motors Lab

Table 1 shows each team member's contributions to the Sensors and Motor Lab.

Table 1: Sensor Motor Lab teammate contributions.

Name	Sensor	Motor	Contribution
Braden	IR Range	RC Servo	Servo and IR sensor implementation. Mean filter design and implementation. Arduino sketch flow and Arduino-GUI interface implementation.
Shaun	Ultrasonic	DC Stepper	Stepper motor control and ultrasonic input. Debug GUI and oversee integration.
Angela	Potentiometer	DC Motor	DC Motor code integration in the Arduino sketch. Potentiometer integration.
Stefan	GUI		GUI implementation and GUI-Arduino interface design.

Project AACAS

Table 2 outlines each team member's efforts on the MRSD project.

Table 2: Team progress on the AACAS project.

Name	Work Description
Braden	Oversee drone diagnostics. Design preliminary sensor mount. Create example ROS package.
Shaun	Design power board. Project Manager and team meeting leader. Help with drone diagnostics.
Angela	Develop vision pipeline. Experiment with YOLO and TinyYOLO.
Stefan	Begin lidar integration. Establish software architecture. Train the team on proper GIT use.

Plans

Project AACAS

In the next few weeks I will be working on the sensor pod and ROS DJI connectivity. For the sensor pod I am going to prototype the Xavier casing using 3D printing. I plan to make the mounting plates using laser cut acrylic. Laser cutting the acrylic versus machining aluminum should reduce weight and machining time while maintaining the structural strength the design requires. After setting up the Xavier, which I expect to work on up until PR1, I will begin interfacing with DJI's Onboard SDK. Though I have done research in connecting to the drone, I expect this task will take considerable time.