**Design Budgets and Hardware Decisions**

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## Introduction

In this lab, we gain practical experience with choosing components of a design such that the overall design meets multiple budgetary requirements. This involves balancing many different features of the overall design, such as cost, weight, size, etc. This can be a difficult, as an improvement in one sense may require a trade-off in another. In this lab, we were to pick motors, sensors, and a battery that would fit within a set of weight, size, power, and cost requirements.

## Hardware Decisions and Budgets

*Motors*

The High Speed Continuous Rotation Servo (#900-00025) was chosen because of its fitting size, speed, and cost. To have a continuous rotation, modifications would need to be made to the servo to remove the usual 180 degree limitation. Speed was the most difficult constraint to match regarding motors because several factors needed to be taken into account. First, degrees per second of the motors was found from the data sheet, and this was converted to rpm. Then, calculations were made using the 3 inch diameter of the wheels which resulted in a top speed range of 26.18 - 39.27 inches per second (2). This is well above the constraint of 3 to 24 inches per second.

*Acoustic & IR Sensors*

Most of the sensors found for both the IR and Acoustic sensors were all relatively small, so the there wasn't much concern if they would fit within the dimensions or weight limit of the robot, and the IR sensors were fairly cheap, so most of the budget for the Sensors went mostly for the Acoustic sensor. The biggest difficulty when searching for the sensors was the operating range, in which both sensors work within the 5-30' range.

The sensors fit well within the frame of the robot, along with all the other parts. None of the parts chosen exceed the size of the frame included, and therefore we don't need to worry about ground clearance or height restrictions.

*Battery*

This part was chosen because it supplies a large amount of power for the robot while remaining fairly small and lightweight. Because power and weight were our primary concerns for the battery, a lithium ion battery was chosen. The main benefits of LiPo are the high power density and low weight, while the drawback is the expense. It was difficult to figure out a good way of measuring the battery life of the battery because the units given for most batteries are in milliAmpere-hours, while most of the parts measure their power usage in milliAmperes.

To calculate the total runtime of the robot, we calculated the energy contained in the battery in Watt-hours (1). We then divided by the total consumption of the components in Watts, leaving runtime in hours. We estimated that the battery would last for 3 hours and 36 minutes. The battery was a fairly significant portion of the total monetary budget, but we were still able to come in under budget.

*Tables*

| | Weight (oz) | Cost (USD) | Power (Wh) | Size (in) |
|---|---|---|---|---|
| Motor | 1.5 | $16.99 | -1.44 | 2.2x0.8x1.6 |
| Acoustic Sensor | 0.88 | $14.00 | -0.1 | 2x0.87x0.61 |
| IR Sensor | 0.02 | $9.95 | -0.22 | 0.2x0.1x0.05 |
| Battery | 4.0 | $29.99 | 22.2 | 4.1x2.2x0.5 |
| **Total** | **7.9** | **$87.92** | **1.5** | **Fits!** |

**Conclusions**

This project included self organization that was decided upon using scheduled team meetings and individual work preferences. During the first team meeting, we talked about what each person's responsibilities would be based on their own personal preference. Each person researched the part they liked the most, and found three datasheets for their chosen part. This proved to make the project more engaging once the second team meeting began, and finding multiple datasheets to compare to would make the final product have a higher quality.

Further decisions were made during the second team meeting on how to move forward. One datasheet from each part was chosen, their data was compared, and a final decision was made on the three parts that worked the best based on cost, weight, and size.

The final product fits all the design constraints, including cost, weight, size, speed, operational time, ground clearance, and maximum height.

**Bibliography**


1. "All About Batteries."Overview | All About Batteries | Adafruit Learning System, learn.adafruit.com/all-about-batteries?view=all.
2. "Mechanics: Circular Motion and Gravitation" | http://www.physicsclassroom.com/calcpad/circgrav