Objective:
The goal of this project is to construct a robot that takes an object and sorts it to a location based on that object’s color. This mechanism of sorting is useful in a variety of applications to efficiently sort heavy objects of perform meticulous sorting tasks, including sorting car parts, sorting pills in a pharmaceutical setting, and sorting/serving food plates in a restaurant. The team chose to sort Legos due to their low cost and weight.

Theory of Operation:
In order to transport the objects, the team uses a mechanical claw as a grabbing mechanism. This claw is operated with a servo, which is attached to an aluminum rod. On the other side of this rod is a joint that is also powered by a servo that is similar to an elbow. Attached to this servo is another aluminum rod which is connected to a third servo that functions as a shoulder joint. The entire arm structure is attached to a lazy-susan, which is powered by a fourth servo and allows the arm to turn on 180 degrees.

The other half of the project involves identifying the object’s color. Completing this task requires external hardware to obtain useable data for a microcontroller and software to compare the data and make the decisions. A filtered photodiode array is used to generate red, green, and blue frequency values based on colors of light absorbed by the different photodiodes.

The frequencies are then read into an Arduino for comparison. The lower the frequency, the more of that color is present on the object. Colors are determined by comparing the frequencies to one another or setting certain threshold values based on ambient lighting. For example, white objects are detected when all three color frequencies are below a certain threshold value. As another example, for a red object, red would be the lowest frequency compared to the green and blue frequencies.

Design Alternatives:
The first design of the LSRA utilized four HS-422 servos. This design was thought to be ideal, because all servos would have the same power and torque.

A design that utilized all “L-brackets” for movement was considered. This design would rely on the brackets being connected face-to-face and would provide a high degree of motion.

Key Points for Selecting Your Design:
Originally LSRA had four HS-422 servos. In experimentation it was found that these servos were not strong enough in the “Shoulder” and “Elbow” joints. To correct this two more powerful servos were brought in to account for the extra torque required to operate the arm.

The all “L-brackets” design ultimately was not chosen, because regardless of the flexibility of this design, it’s not viable due to the reach it is missing out on compared to our aluminum rod design.

Constraints from Regulating Bodies on the Project:
Although most regulations are for industrial applications, the team followed the restrictive envelope of worker approach guideline to minimize the chance of user injury/error

Discussions of the Experimental Results:
During real-time operation, LSRA sorts Legos effectively under standardized conditions. While running several tests, the team discovered that the color sensor is quite sensitive to the ambient lighting in the room. This meant that every time the environment lighting changed or the Lego shifted, the microcontroller could misread the Lego colors. The team fixed a dark colored hood over the photodiode array and moved the color sensor closer to the Lego’s pick up location on the ramp, which increased the accuracy of its readings. In future iterations of the project, however, a different implementation of the color sensor and Lego loading process should be designed to improve accuracy in different locations.

Conclusions:
The team was successful in creating robotic, servo-powered arm to sort an objects based on that its color. This project is a relevant exercise in system integration involving multiple hardware and software components. The project can be applied to numerous settings that require an automated sorting component. In future designs, careful attention should be paid to optimize the color sensor location in order to receive the best readings possible in different settings.

Related Patents:
1. US 13/209,181
2. US 13/178,684
3. US 07/237,794

References