Analysis of Final Prototype Performance

This project failed to meet the customer requirements. The main reason for this was that the electromagnet was not able to generate an electric field strong enough to pick up the washers at a distance of greater than 3 mm. During testing it was found that the electromagnet heated up considerably while still failing to lift the washer from any height greater than 3mm. This is likely due to either an internal fault with the device, or too much current being applied to the electromagnet. The electromagnet was also observed to have developed discoloration around the center where the screw is to be attached as seen in figure 11, this likely being due to overheating. Given the late stage in development that this issue was discovered, sufficient time to acquire the necessary components to correct the issue and test the robot again was unavailable. Even were the electromagnet to be replaced, the design criteria would not be met, as not all of the provided components would be used.

Figure 11: Electromagnet Discoloration

In addition, the camera was too far away from the gameboard, causing the background subtraction to work intermittently due to the large area that had to be processed, and rarely for the yellow washers. The inability for the background subtraction to work consistently could also be attributed to the color of the gameboard being white - a different color may have provided more contrast. The system had a difficult time differentiating between yellow and white since their RGB values were too similar.

The main cause of the problems with the electromagnet/washer interfacing and the game board's stability was a failure to create a detailed enough design. A more detailed design prototype should have been created as an intermittent step that would have evidenced problems like these, enabling sufficient time to be allotted for their correction. The height of the camera was caused by a lack of clear communication between group members. Detailed measurements should have been drawn up and used to place the camera over the gameboard.

Robot plays the game according to the rules.	The robot is able to simulate playing the game but it is unable to actually pick up the washers.
Uses game stage, including computer, electrical and mechanical interfaces	This device uses game stage, including computer, electrical and mechanical interfaces
Costs <$300	Total cost is $52 by the breakdown in the "Mechanical Components" section above
Use provided Arduino, camera, magnet, and motor	All of these devices are used in the final project
AC Power/ No batteries	An AC power supply was used with an AC-DC converter
Reliable	Background subtraction is only reliable for the red and green washers.
Durable	Glue/epoxy holding motor and board together comes apart after several uses.
Safe	Noise levels do not require hearing protection and there are no sharp corners.
Fast Solving Times	The total time from when the user input the desired final pattern to when the motor stopped moving did not

	exceed 1 minute for any test case used.
Easy to use/user-friendly	User is shown descriptive buttons and tables
Electric/electronic circuits built from off-the-shelf components	All components were off-the-shelf components
Runs automatically	After pressing start the device will ‘sort’ the washers with no human input.