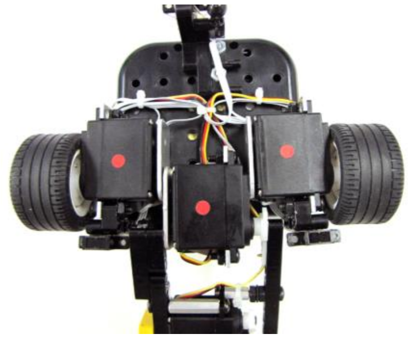
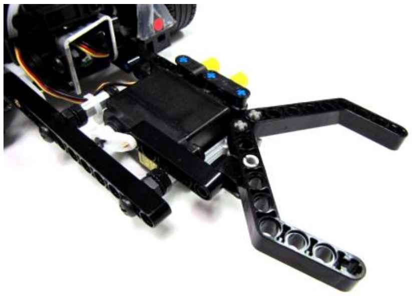
This document would score 96 points out of 96.

Mechanical Design Period 2



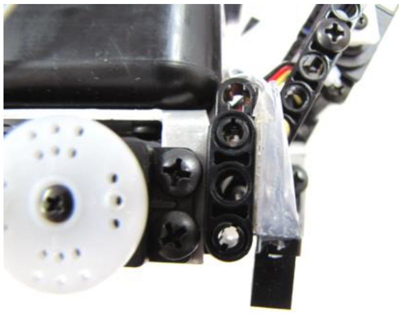
Drivetrain

The picture to the left shows the drivetrain of our robot. On each side of the robot a LEGO wheel is connected directly to a black gear motor with screws making this drivetrain a direct drive system. A direct drive system simplifies the construction, and will make programming the robot a straightforward process. We used the metal servo brackets to attach the motors directly to the bottom of the CBC case. We considered using a frame that the motors and CBC would attach to separately. A frame would allow for more mounting options for the motors, CBC, and effector. However, we decided mounting the motors directly to the CBC case would give the robot the lowest center of gravity and simplify the structure.



Effector

The effector on our robot (see picture on the left) is composed of a grabbing claw mounted to a lifting arm. We chose a claw design because it is the best way we could think of to pick up an object, raise it above the PVC, and place it in the scoring box. The claw features a servo that moves two angled LEGO beams that are coupled together with two gears. When the servo moves one beam the gears force the other LEGO beam to close at the same time. The first claw we built used one stationary LEGO beam and one moving beam. We scrapped the design because the claw would tip the scoring objects over when trying to clamp onto them. Our current claw design closes around both sides of the object, which lets the robot pick it straight up.



Sensor Mount

The picture to the left is a close-up of the mount for one of the top-hat sensors on the front of our robot. We built a small "platform" out of an L-shaped LEGO and a three-hole beam, and screwed it to the servo bracket. The platform created a smooth flat surface that we then attached the top-hat sensor to using Uglu. We tried to design a mount for the sensor that didn't require Uglu by using flat LEGO beams, axles, and connectors. However, every design we came up with was too bulky, and would get in the way of the arm. The Uglu is low profile allowing the sensor to sit right up against the servo bracket. The platform allowed us to use a long strip of Uglu, which makes the bond very sturdy. Since the sensor is tucked back between the wheel and the rest of the robot where it won't get hit we are confident the Uglu will continue to hold.

Commented [A1]: The section is titled Drivetrain, and it is clearly separated from the text. Meets requirement #2.

Commented [A2]: Picture: The drivetrain is the center of attention, and is in good focus. The picture was taken in good light against a contrasting solid color background. Meets requirement #3.

Commented [A3]: Describes the drivetrain. Meets requirement #4.

Commented [A4]: Gives a reason for using this drivetrain. Meets requirement #6.

Commented [A5]: Makes a comparison to a different drivetrain design, and further justifies the drivetrain used. Meets requirement #5 and provides more content for requirement #6.

Commented [A6]: Picture: The effector is the center of attention, and is in good focus. The picture was taken in good light against a contrasting solid color background. Meets requirement #8.

Commented [A7]: The section is titled Effector, and it is clearly separated from the text. Meets requirement #7.

Commented [A8]: Describes the effector Meets requirement #9.

Commented [A9]: Gives a reason for using this effector. Meets requirement #11.

Commented [A10]: Makes a comparison to a different effector design, and further justifies the effector used. Meets requirement #10 and provides more content for requirement #11.

Commented [A11]: The section is titled Sensor Mount, and it is clearly separated from the text. Meets requirement #12.

Commented [A12]: Picture: A wheel was removed to get a clear close-up macro picture of the sensor mount. Careful attention was taken to get the sensor mount in focus rather than the surrounding areas. The background is a solid contrasting color, and the picture was taken in good light. Meets requirement #13.

Commented [A13]: Describes the sensor mount. Meets requirement #14.

Commented [A14]: Compares the featured sensor mount to a different design. Meets requirement #15.

Commented [A15]: Justification as to why the featured sensor mount was chosen. Meets requirement #16.

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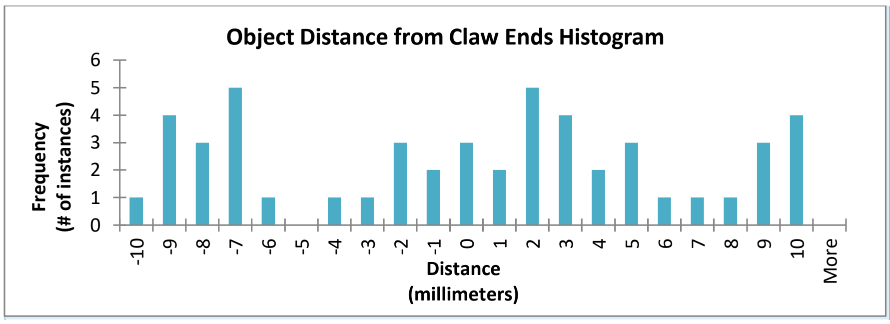
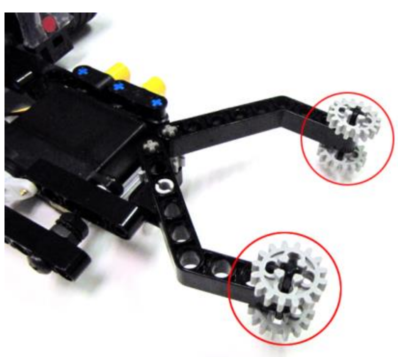
Data

To gather data we coded our robot to drive straight towards a scoring object. By using the ET sensor we coded the robot to stop when the center of the object was between the tips of its claw. When the robot stopped we measured how far the centerline from claw tip to claw tip was from the center of the object. A positive number represents the distance from the claw tips in the direction away from the CBC (i.e. object too far away to grab). A negative number represents the distance from the claw tips in the direction towards the CBC (i.e. too close to grab).



Data Evaluation

From the data we realized that the robot is not very consistent in stopping an exact distance away from an object. The only consistency we found is that the robot reliably stops ±10mm (±1cm) from the object. The problem is that if the ends of the claw are not within ±4mm from the center of the object there is a high chance of the object falling right out of the claw's grasp. By looking at the graph you can see that (23 / 50 x 100 = 46%) almost half our attempts were within ±4mm, which is considered successful. However, we need as close to 100% accuracy as possible from our claw if we want to score the most points. We plan to modify our claw in order to improve its ability to grasp an object when grabbed off-center. When designing we will keep in mind that the claw needs to be able to grab and hold an object when it is positioned ±10mm from the center of the claw ends.



Modified System

After a lot of testing we decided our robot picked up the scoring objects very well with the geared claw design, but it would often drop the objects on the table when driving it to the scoring area. We had to do something to help the robot get a better grip. When approaching the problem we knew the goal we had to design for based on the data from our testing trials: the claw needs to able to hold onto an object when it is grabbed a maximum of ±10mm from the center. After a lot of trial and error with designs we found a surprisingly simple solution that meets our goal. We attached two 16-tooth gears with a short axle to each end of the claw (see the picture above and to the left). The teeth on the gears hook into the object allowing the claw to hold it tightly instead of slipping off. We plan to run our robot on its regular programmed route, and watch carefully to make sure scoring objects do not slip out of the claw. If we have time we might even do trials where the robot drives up to a scoring object, closes the claw, picks up the object, and drives away. We could do another fifty trials and graph the data to make sure the claw holds objects consistently.

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Commented [A16]: The section is titled Data, and it is clearly separated from the text. Meets requirement #17.

Commented [A17]: Explains how the data was gathered, and explains what the data represents. Meets requirement #20.

Commented [A18]: Chart: The chart has a descriptive title, axis labels with units, and 50 data points. Meets requirements #18 and #19.

Commented [A19]: The section is titled Data Evaluation, and it is clearly separated from the text. Meets requirement #21.

Commented [A20]: Draws a conclusion from the data. Meets requirement #24.

Commented [A21]: Uses descriptive data analysis to explain trends in the chart or graph. Meets requirement #23.

Commented [A22]: Clarifies how the data and conclusion relate to the robot. Meets requirement #22.

Commented [A23]: Gives a general idea of how the robot will be modified on account of the conclusions drawn from the data. Meets requirement #25.

Commented [A24]: The section is titled Modified System, and it is clearly separated from the text. Meets requirement #26.

Commented [A25]: Picture: The modified item is the center of attention, is circled in red, and is against a contrasting solid color background. The photo was taken in good light, and the modified item is in good focus. Meets requirement #27.

Commented [A26]: Explains why changes needed to be made. Results from the Data Evaluation section are restated. Meets requirement #29.

Commented [A27]: Describes the changes that were made. Meets requirement #28.

Commented [A28]: Outlines how the modified system will continue to be tested, and offers an optional testing strategy. Meets requirement #30.