ECSE 211 - Design Principles and Methods

HARDWARE DOCUMENT

GROUP 11
John, Durham, Alex, Ian, Ethan

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Abstract

This document is intended to outline 4 hardware designs and the differences between them. It will cover the input components (ultrasonic sensors and color sensors), the output components (motors), and the ball launching mechanism. These designs will be evaluated, and ultimately a final design will be chosen, revised and refined in order to best complete the competition's task. As of *March 20, 2017*, Group 11 has adopted **design 4** as its final hardware design.

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1 EDIT HISTORY

- March 8th 2017:
  - **Ethan Lague:** Initial set up of document sections (including table of contents), completion of first draft of sections 1 through 7.
- March 9th 2017:
  - **Alex Lam:** General Re-Formating
- March 14, 2017
  - **Durham Abric:** Updated abstract and ball launcher sections to reflect progress and design decisions the team has made.
- March 23, 2017
  - **Ethan Lague:** Added **design 4**, the final hardware design to the document.

2 ULTRASONIC SENSORS

2.1 Design 1

The robot in design 1 uses 2 ultrasonic sensors for localization and obstacle avoidance. The first ultrasonic sensor is placed static horizontally facing the front. The second ultrasonic sensor is placed vertically on a motor where it will rotate to either face the left or right side. It will only be engaged once the first motor sees an obstacle and will turn either left or right to face the obstacle. Refer to Figures 1 through 4.

2.2 Design 2

The robot in design 2 uses 3 ultrasonic sensors for localization and obstacle avoidance. The first is placed static horizontally facing the front. The two others are placed static facing the left and right sides of the robot. Similar to design 1, the two sensors facing either side will only be engaged when in the process of obstacle avoidance. Refer to Figures 5 through 8.

2.3 Design 3

The robot in design 3 uses 2 ultrasonic sensors for localization and obstacle avoidance. Both sensors are placed horizontal with an angle of 90 degrees between them on a motor. One sensor will face the front, and that will be used for localization. During obstacle avoidance, the motor will rotate the sensors so that one is facing the front while the other is facing the side that the obstacle is on. Refer to figures 9 through 12.

2.4 Design 4: Final Hardware Design

The robot in design 4 uses 2 ultrasonic sensors. One is placed statically facing the front extending out from under the EV3 brick. This sensor is used for localization and to detect obstacles. The other ultrasonic sensor is placed statically facing a 90 degree angle to the left of the brick. This sensor is used to track obstacles as the robot travels laterally beside them. Refer to figures 13 through 16.

3 COLOR SENSORS

3.1 Design 1

The robot in design 1 uses 2 color sensors for odometry correction. The two sensors are placed adjacent to each other with respect to the robots velocity. they are placed vertically facing the ground with a gap of 3 mm. Refer to figures 1 through 4.

3.2 Design 2

The robot in design 2 uses 1 color sensor placed at the front of the robot facing the ground with 3mm of separation. Refer to figures 5 through 8.

3.3 Design 3

The color sensors in design 3 are placed the same as in design 1.

3.4 Design 4: Final Hardware Design

There are two color sensors in Design 4 placed laterally along the front of the robot, as close to each respective wheel as possible. Refer to figures 13 through 16.

4 MOTORS

4.1 Design 1

The robot in design 1 uses 4 Motors. 2 NXT motors are placed on either side of the robot each attached to a wheel for movement of the robot. 1 EV3 motor is used for the ball launcher. Another EV3 motor is placed horizontally in the middle of the robot for the rotating Ultrasonic sensor. Refer to figures 1 through 4.

4.2 Design 2

The robot in design 2 uses 3 Motors. 2 NXT motors are placed on either side of the robot each attached to a wheel for movement of the robot. 1 EV3 motor is used for the ball launcher.Refer to figures 5 through 8

4.3 Design 3

The robot in design 3 uses 4 Motors. 2 NXT motors are placed on either side of the robot each attached to a wheel for movement of the robot. 1 EV3 motor is used for the ball launcher. Another EV3 motor is placed horizontally at the front of the robot to turn the two ultrasonic sensors. Refer to figures 9 through 12.

4.4 Design 4: Final Hardware Design

The robot in design 4 uses 4 Motors. 2 NXT motors are placed on either side of the robot each attached to a wheel for movement of the robot.There are two EV3 motors placed horizontally on top of a tower built up vertically from the brick that are used in the ball launcher mechanism. Refer to section 5.2 and figures 13 though 16.

5 BALL LAUNCHER

5.1 Designs 1-3

The ball launcher is the same for the three initial designs. An EV3 motor is placed vertically towards the back of the robot. A long arm is extended from the motor with a claw like basket to hold the ball. The motor is oriented so that the arm rotates perpendicular to the robots velocity to increase the overall stability when firing. Refer to figures 1 through 12.

5.2 Design 4: Final Hardware Design

As seen in section 4.4, the ball launching mechanism uses two motors placed horizontally. A sturdy tower was built vertically from the EV3 brick which supports the two motors. The catapult arm will rotate down perpendicular to the ground along the back of the robot. There, the ball can be loaded. The robot can travel with the ball since two small lego pieces are placed on the sides of where the ball is held.when launching, the motors rotate the arm to throw the ball over the top of the robot. Rubber bands are used around the throwing arm to add torque.

6 METHODOLOGY

Designs 1, 2, and 3 were the initial designs for the robot. Of those three, design 1 was the design we were leaning towards because it had ultrasonic sensors that could see a range of 180 degrees around the front of the robot, and it had two light sensors for correction. However after testing we found that one motor would have enough torque to throw a ball 8 tiles which may be necessary for the competition. We decided to scrap the three designs since the all used only one motor and developed design 4. Design 4 utilizes 2 motors to generate more power than the previous 3 designs; as a result both US sensors must be stationary, as one brick limits our design to 4 output ports.

7 FIGURES

Figure 1: Design 1 front

Figure 2: Design 1 back

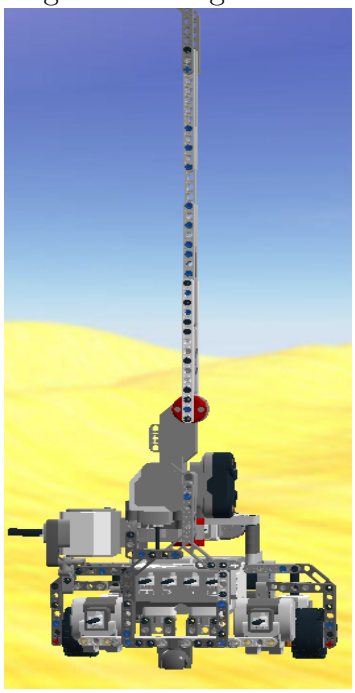


Figure 3: Design 1 side 1

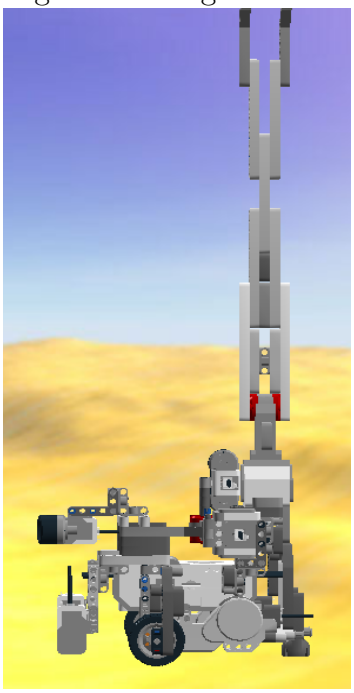


Figure 4: Design 1 side 2

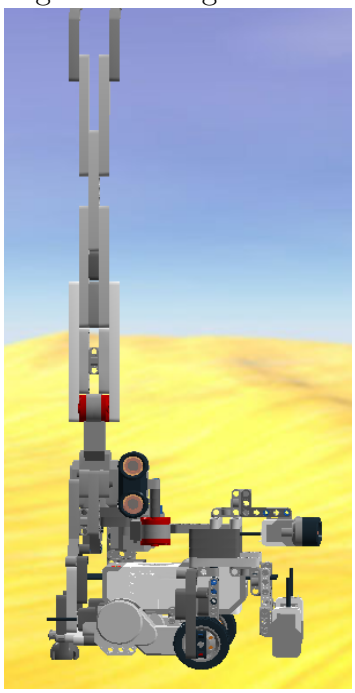


Figure 5: Design 2 front

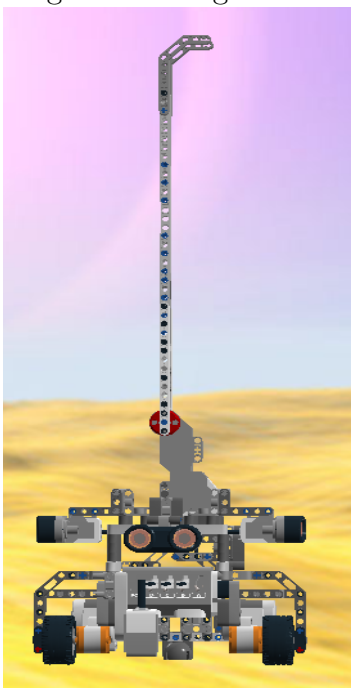


Figure 6: Design 2 back

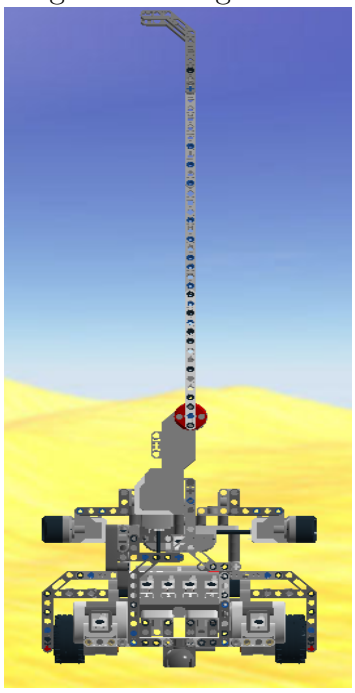


Figure 7: Design 2 side 1

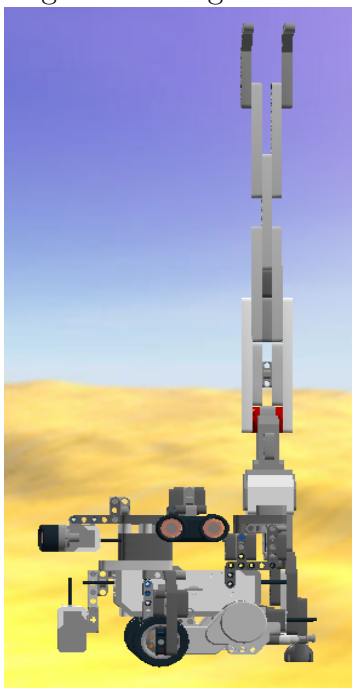


Figure 8: Design 2 side 2

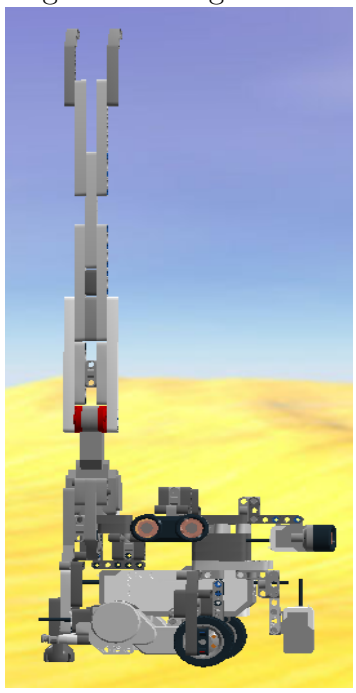


Figure 9: Design 3 front

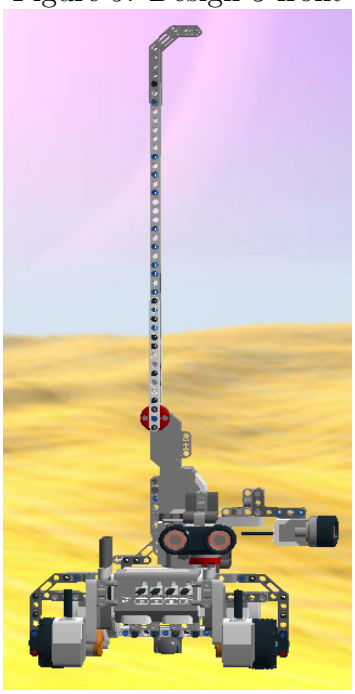


Figure 10: Design 3 back

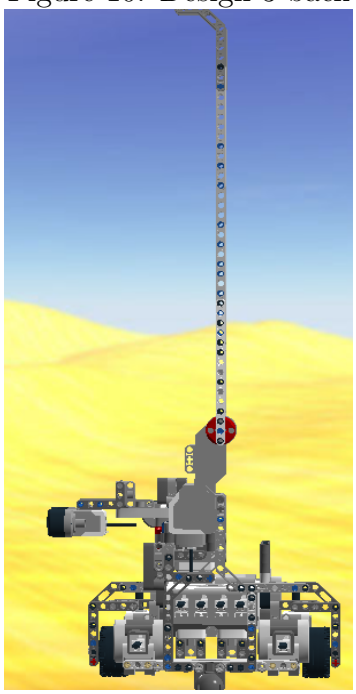


Figure 11: Design 3 side 1

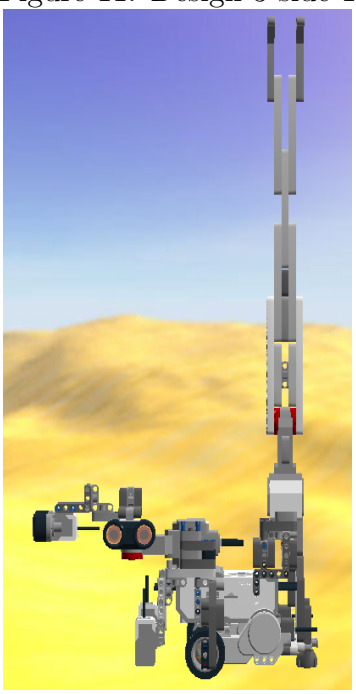


Figure 12: Design 3 side 2

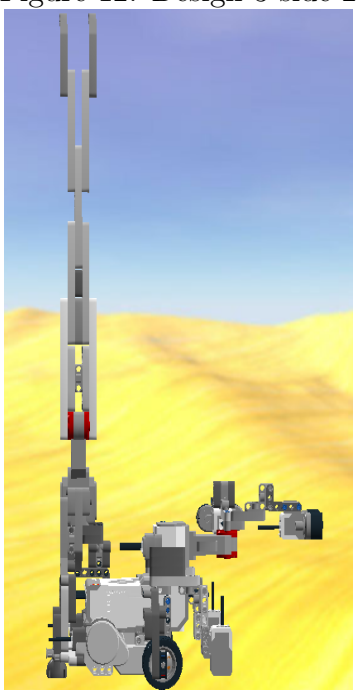


Figure 13: Design 2 front

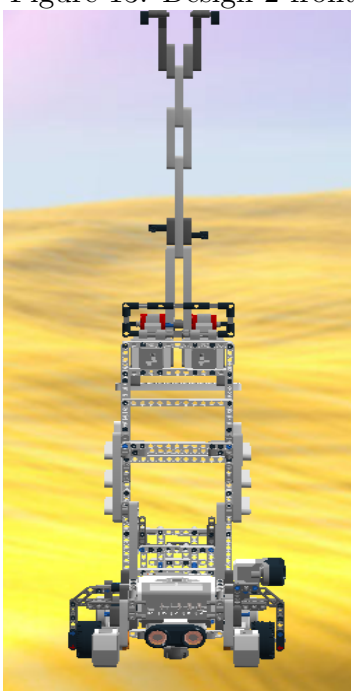


Figure 14: Design 2 back

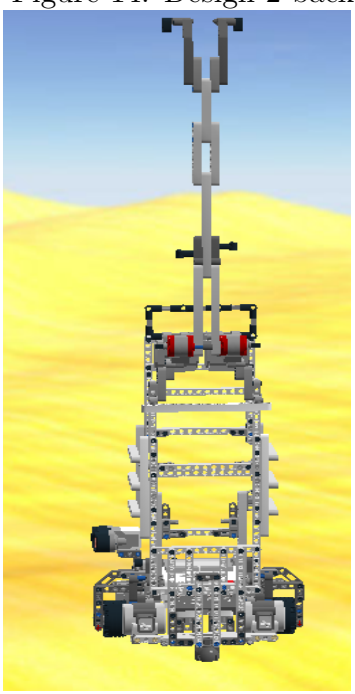


Figure 15: Design 2 side 1

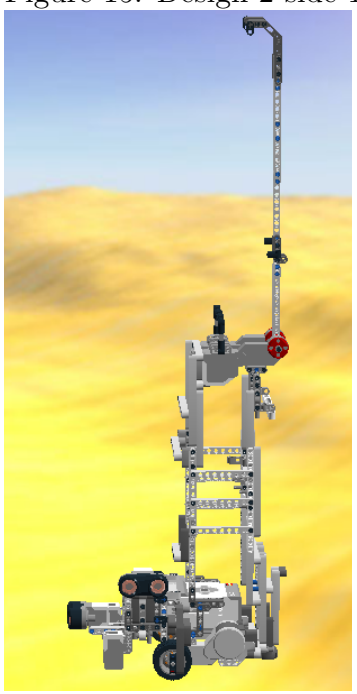
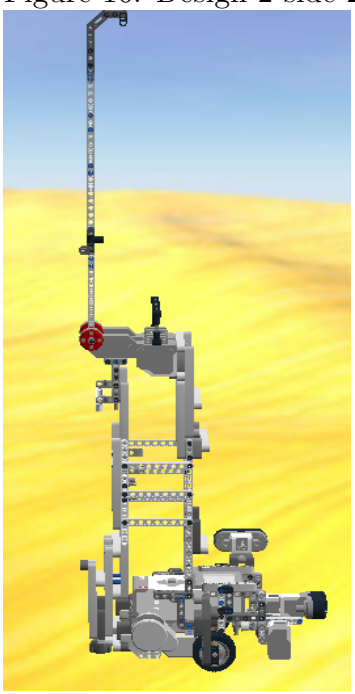


Figure 16: Design 2 side 2



8 GLOSSARY OF TERMS

- Ultrasonic sensor: A sensor which emits sound waves to pick up its proximity to an object.
- Color Sensor: A sensor which picks up on the color of an object which given the black lines on the field can help the robot know where it is.