HARDWARE DOCUMENT

Project: DPM Final Project
Task:

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[18/10/2018] Shaodi: Created Hardware document
[30/10/2018] Ayden: Added hardware design prototypes

1.0 Motors

There are total of three kinds of motors available in the kit: medium, Large NXT, Large EV3. Besides the Large NXT is older than Large EV3, the only difference between Large NXT and Large EV3 is the attachment points. The main difference between medium motors and large motors is power and precision, and that will be our premium concern when we decide what job that we will use them to perform. The large motors are more powerful but not the most accurate. In contrast, the medium ones are weaker and much more precise. So, the large motors are suitable for jobs like driving the entire robot around. And the medium motors can be used to perform smaller jobs liking moving a sensor back and forth for more precise detection. The motors will be attached on the top of brick through port A – D.

2.0 Sensors

The most important sensors available in the kit that we going to use are Ultrasonic sensor, Gyro sensor, and Light (Color) sensor. The ultrasonic sensor is used to measure distance by sending ultrasonic waves and measuring how long it takes the wave to echo back. It can be used to detect and avoid obstacles, navigation, and localization. But we will need to test to understand its functionality, and compensate in software for failure.

The color sensor, also referred to as a light sensor, has several modes: RGB, Color ID, etc. It determines color of objects when being placed at appropriate distance from the object. It is more reliable than the ultrasonic sensors if functions properly. It can be used to detect black lines on panel and identify ring colors.

The gyro sensor measures the angle and angular velocity of the robot. We did not use it yet, but we may use that when needed later.

All the sensors will be attached to the ports labelled 1-4 on the bottom of the brick.

3.0 Brick

The brick in the kit is an embedded system. The brick can be turned on by pressing on the ENTER button for one second or two, and turned off by pressing the ESCAPE button. The brick has features including: LCD screen for display, Speaker for making beeps (will be used in final

project when detecting rings), Micro-SD Card Slot for the SD card with leJOS on it, USB type-A for Wi-Fi adapter, USB mini-B for communication with laptop, Ports A-D for connecting motors, Port 1-4 for connecting sensors, and 6 Buttons. The buttons are Enter, Up, Down, Right, Left, and Back button. They can be used to interact with the code.

4.0 Other components

Other than brick, sensors, motors, the kit that we are being provided also include other components like wires, batteries, and various LEGO parts. The batteries we have include both AA batteries and a rechargeable battery pack. The battery level is displayed in the top left corner of display screen, the highest it can reach is 8.0V. For better performance, it is good to keep the battery level above 7.0V for all time. We also being provided with USB cables for connection and charging cables. The hardware parts that are available to us are, but not limited to the LEGO parts in the kit. We can also use 3D printer to print more components if needed. The parts will be used to assembly our robot.

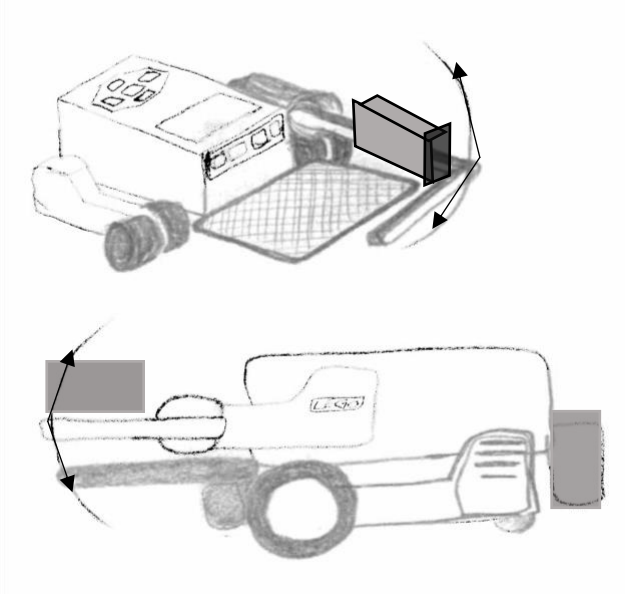
5.0 Design options

This section describes three of our designs, their sketches, and pros and cons. That will provide a clear overview of our design choices before reached a tentative final design.

5.0.1 Arm and basket mechanism

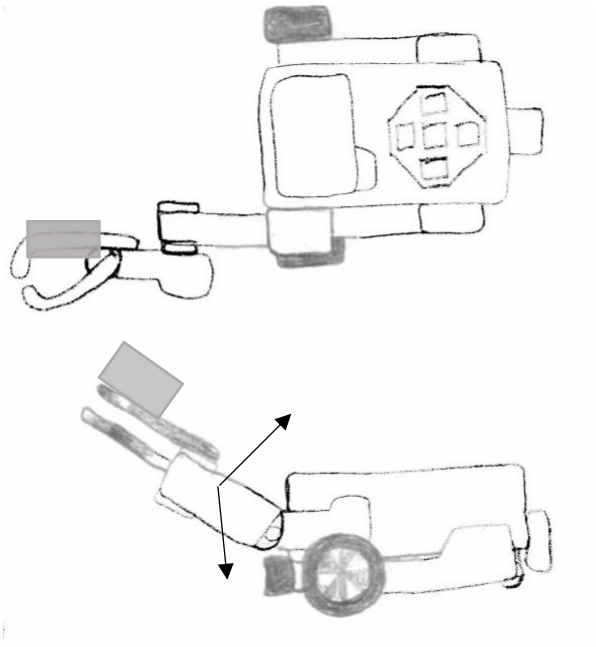
Our first prototype consists of a long arm that can go around the ring and 'hug' it. Upon reversing, the ring falls into the basket placed in front of the robot. There is a light sensor placed on the arm to detect the color of the ring.

It includes an Ultrasonic sensor mounted at the front, underneath the basket, for US localization and a light sensor at the back for light localization.



Pros of Design 1	Cons of Design 1
Can catch all the rings in one journey.	Getting the arm to go around the ring would require a lot of precision.
Very wide, help lower the center of gravity.	The size of the basket has to be big so that it can accommodate all the rings but with a basket that size, it would be almost impossible to localize since we need to take 360° turns.
The mechanism can grab rings at all heights provided.	Hard to navigate through the tunnel due to increase width

5.0.2 Claw mechanism

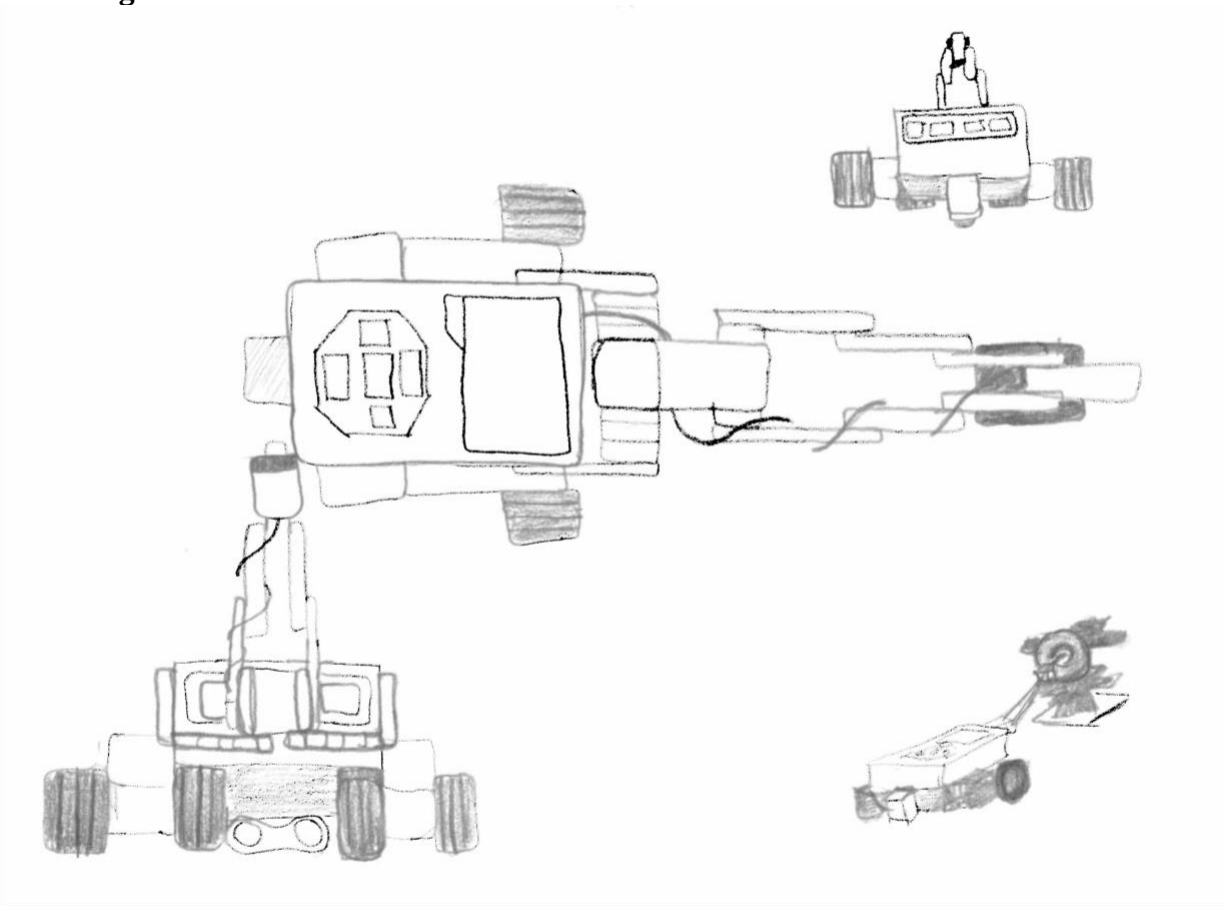


The second prototype consists of the same basic mechanical and hardware design of the robot is very similar to the design used in previous labs. The sketch shows a long arm that can fold over the robot and extents forwards to detect the colour of rings placed on the tree at various heights using a light sensor.
Another color sensor is placed at the back of the robot, facing downwards for Light localization. Unlike previously, the ultrasonic sensor is placed between the wheels facing forwards for US localization and obstacle avoidance.

This prototype consists of a claw that has one degree of freedom. It can move up and down to grab a ring. Once it grabs one ring it can move take it back to the starting position and come back to grab another one.

Pros of Design 1	Cons of Design 1
Probability of grabbing the ring in the first try is high	With 2 motors at the front, it would, by default move the center of gravity higher and forward.
Too much weight at the front of the robot by default thus moving the center of gravity higher and forward.	Would take a lot of time to accumulate all the rings. The more distance the robot travels, the more error is accumulates
Easy to navigate due to a compact design	More rounds would reduce battery life so that would increasing change the performance of the EV3.

5.03 Long armature mechanism



The basic mechanical and hardware design of the robot is very similar to the design used in previous labs. The sketch shows a long arm that can fold over the robot and extents forwards to detect the colour of rings placed on the tree at various heights using a light sensor.
Another color sensor is placed at the back of the robot, facing downwards for Light localization.
Unlike previously, the ultrasonic sensor is placed between the wheels facing forwards for US localization and obstacle avoidance.
To retrieve a ring, the arm with go into the ring and lift up slightly and the ring should fall into the arm.

Pros of Design 1	Cons of Design 1
The armature can move anywhere we want it. Vertical motion using the motor it is attached to and horizontal motion by changing the heading of the robot.	If too many rings are added the robot becomes too heavy at the front of the wheels and it pivot at the line of the wheels base.
Very easy to localize since the armature can be folded over the robot, reducing the footprint of the machine.	Would require very precise calculation to make sure the arm goes into the ring.
Easy to navigate through the course especially the tunnel.	A long arm like this could increase the chances of a collision.