McGILL UNIVERSITY

ECSE 211: Final Design Project

Testing Document

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1 SUMMARY

This document is intended to indicate the object and the methodology of testing of our project as well as discussing the result of testing.

CONTENTS

2 TASK

Project: Design Principles and Methods Final Project: Capture the Flag - Team 15
Task: Design an autonomous robot that can play a one-on-one version of the Capture the Flag while navigating through an obstacle course.

3 EDIT HISTORY

a. Document Version Number

i. 0.0.1: Version presented to Prof. Ferrie on the 2017/10/27

ii. 0.0.2: Version presented to Prof Ferrie on the 2017/11/03

b. Edit History

i. Charles Huang, 2017/10/25 (4.30pm) - Created the document, designed the tests of the project

ii. Aliah Mohd Nazarudin, 2017/10/26 (1230pm) - Change the format of the document

iii. Charles Huang, 2017/10/29 (2.30pm) - Update hardware and software testing

iv. Aliah Mohd Nazarudin, 2017/11/2 (1.50pm) - Add conclusions and further actions taken for every test

v. Charles Huang, 2017/11/02 (2.30pm) - Update colored block testing

4 HARDWARE TESTING

4.1 Test 1: Large Motor vs NXT Motor

Hardware Version: 01

Software Version: Lab 4 code

Date: October 20 to 23

Objective: The LeJOS library provides serveral motor classes for controlling the EV3 motor, Large Motor and NXT Motor. This experiment was conducted with the hope of discovering which motor performed better for use in the navigation.

Methodology:
The robot will be made to navigate from a distance of 6 tiles using the Large Motor first and then the NXT motor. Ten trial runs will be conducted. The robot will be place at origin (0.0) and navigate to (0,6). During the experiment, record the behavior of two motors as well as the final angle error.

Results:
The results showed that the Large Motor performed better than NXT Motor. The robot with Large Motors is able to go straight with a final angle error smaller than 2 degrees. The NXT Motor, unlike the Large Motor, even though the speed of the left motor and right motor are set to same, the robot with NXT Motor is not able to go straight. The left motor of NXT Motor is always slow than the right Motor.

Conclusion&Action:
Since the Large Motor performed better than NXT Motor. Our team decide to use Large Motor for the wheel of the robot.

4.1 Test 2: Zip Line Traverlling

Hardware Version: 01

Software Version: Lab 5 code

Date: October 20 to 23

Objective: This experiment was conducted with the hope of discovering what is dismounting angle when the robot dismount from the zip line.

Methodology:
The robot will be made to travel zip line by using Lab 5 code. Five trial runs will be conducted.We will measure the dismounting angle after the robot dismount from the zip line.

Results:
The results showed that our robot is not balanced during the zip line traveling. The dismounting angle is always large 20 degree. The left wheel always touches the board first and the right wheel touches the board after when the robot dismounts from the zip line. It makes the dismount angle large.

Conclusion & Action:
The robot is not balanced during the zipline traveling which makes the dismount angle large. This test report should be send to the hardware team to review the hardware design of the robot especially the balance of the robot during the zip line traveling.

4 SENSOR CHARACTERIZATION TESTING

4.1 Test 3: Tests of the detection range of ultrasonic sensor

Hardware Version: 01

Software Version: Testing code 01

Date: October 27 to 30

Objective: The objective of the tests is to determine the detection range of ultrasonic sensor .

Methodology:

1. Write a program to fetch the data from the robot.
2. Place the robot at a fix position.
3. Place a block perpendicular to the ultrasonic sensor at certain distance, however, the ultrasonic sensor should not detect the block
4. Move the block slowly and perpendicular to the ultrasonic sensor
5. Record the angle when the ultrasonic sensor detect the wall.
6. Repeat steps 3-5 with different block starting position

Results:

The result shows that the detection range of ultrasonic sensor is like a cone. The ultrasonic sensor is able to detect a block provided the block surface is facing the robot within 10 degrees.

Conclusion & Action: The result shows that it the block is within 10 degree angle range to where the ultrasonic sensor is facing, the ultrasonic sensor can detect the block almost accurately. If the block is placed perpendicular to the sensor, the values returned by the sensors are nearly flawless. This test report should be sent to the software team so they can write the code accordingly.

4.2 Test 4: Tests of accuracy with ultrasonic sensor

Hardware Version: 01

Software Version: Testing code 02

Date: October 27 to 30

Objective: The objective of the tests is to test the accuracy of the three ultrasonic sensor and determine which ultrasonic sensor is most accurate so that we can use it for the final project.

Methodology:

1. Write a program to get ultrasonic sensor data from three different ultrasonic sensors.
2. Mount three different ultrasonic sensors in parallel on the robot.
3. Place a block 5 cm in front of the ultrasonic sensors.
4. Record each ultrasonic sensor's data from the program
5. Increase the distance between the ultrasonic sensors and the block to 10 cm
6. Record new data from each ultrasonic sensor
7. Repeat steps 5 and 6 and increase the distance between the ultrasonic sensors to 15 cm

Results:

Expected reading(cm)	**Actual reading of Ultrasonic sensor 1 (cm)**	**Actual reading of Ultrasonic sensor 2 (cm)**	**Actual reading of Ultrasonic sensor 3 (cm)**
5	**5**	**4.9**	**4.9**
10	**10**	**9.9**	**10.1**
15	**15**	**14.8**	**14.9**

Conclusion & Action: Different sensors tend to have different sensitivity level. Based on this experiment, ultrasonic sensor 1 is the most sensitive sensor we have, so the hardware of the robot is changed by placing ultrasonic sensor 1 to the robot.

4.3 Test 5: Gridline detection tests with light sensor

Hardware Version: 01

Software Version: Testing code 03

Date: October 27 to 30

Objective: The objective of the tests is to determine the changes of light intensity detected by light sensor when it detect the gridline.

Methodology:

1. Write a program to rotate the robot 360 degree and record the data from the light sensor.
2. The robot will be place on an open field.
3. The centre of rotation of the robot will be place at an intersection of grid line.
4. The robot will rotate 360 degree while continuously recording the value detected by the light sensor after a simple differential filter is applied.

Results:

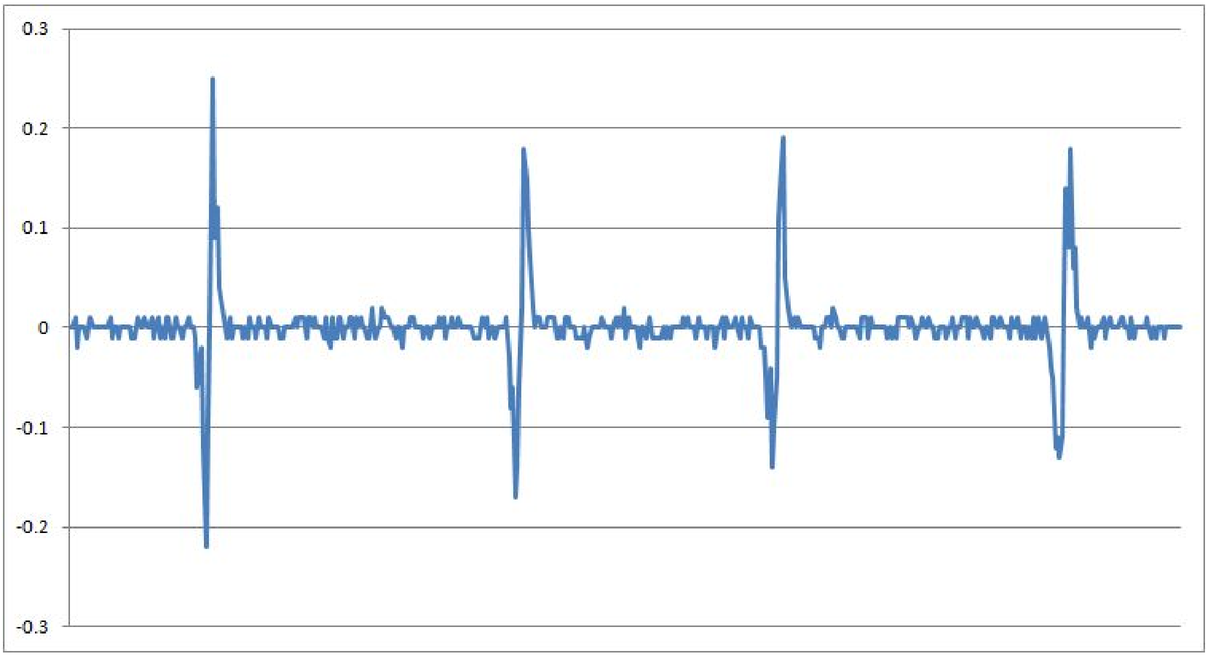

Figure 1: Gridline detection test data

Conclusion & Action: The differential filter used in this experiment shows that when the result is more than 0.1, it shows that the sensor is detecting the black line. This result is then been informed to the software team, for them to write the code accordingly.

4.4 Test 6: Colour block detection tests with light sensor

Hardware Version: 01

Software Version: Testing code 04

Date: October 27 to 30

Objective: The objective of the tests is to determine the changes of light intensity detected by light sensor when it detect different colored blocks at different distances.

Methodology: For the purpose of testing, the light sensor is placed at the left side of the robot.The test robot will be placed on an open field. The robot is programmed to pass by the four blocks.

1. The light sensor mode is set to RNB mode.
2. The four different colored blocks are arranged at the left side of the robot.
3. The order of the colored blocks is white, yellow, red and blue.
4. The distance between the blocks is made constant, which is 10 cm away from each other.
5. The distance between the light sensor and the colored blocks is set to 5 cm.
6. The experiment is repeated by setting the distance between light sensor and the colored blocks to 2 cm.

Results:

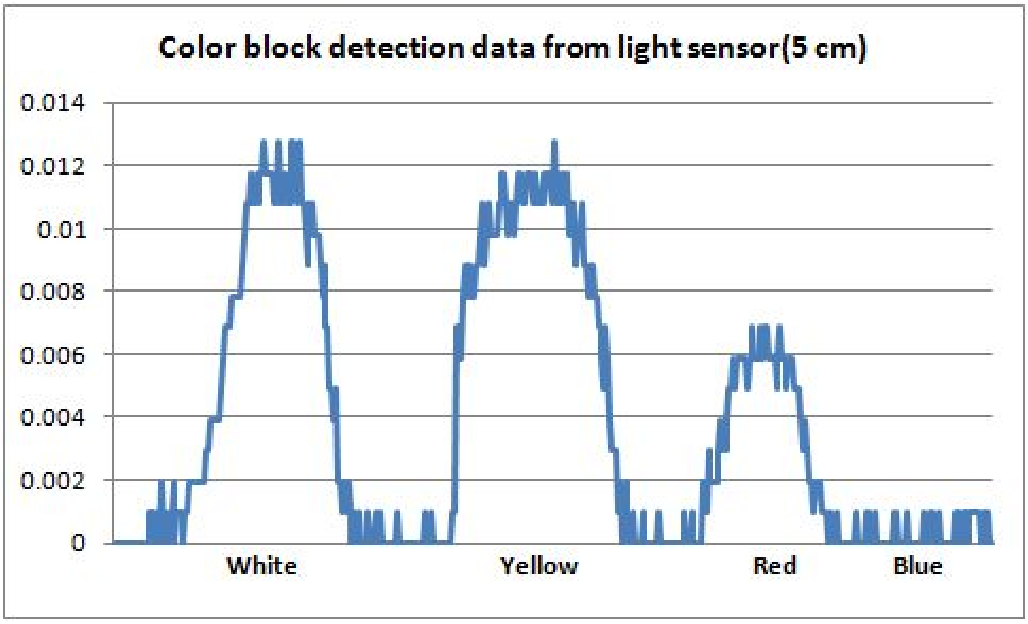

Figure 2:Color block detection data from light sensor with 5 cm difference from the light sensor and the colored block

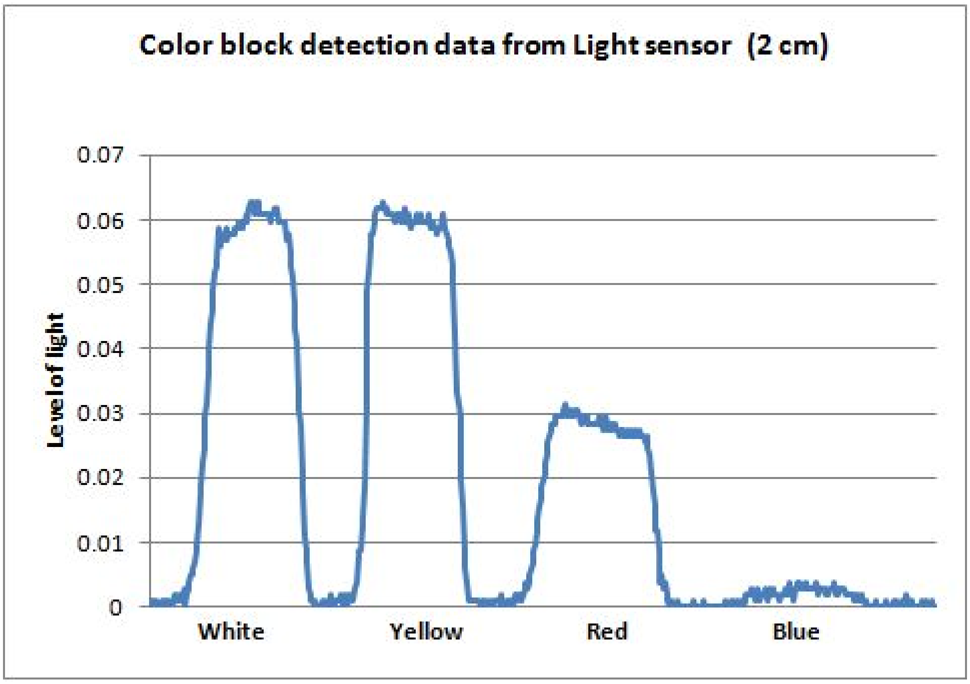

Figure 3:Color block detection data from light sensor with 5 cm difference from the light sensor and the colored block

Conclusion & Action: Figure 2 shows that the level of light changes according to different colored blocks. Since the blue colored block can absorb the most light, therefore, the level of light does not really change when the light sensor detects it. When the light sensor detects the white colored block and yellow colored block, the behavior of the change of light intensity is similar. The test team may need to do more test for these two colored blocks. According to the Figure 2 and Figure 3, the behavior of change of light intensity is similar for different colored blocks. However, the value of light intensity for different colored blocks are different when the distance between the light sensor and the blocks differ. The result shows that the light sensor is more accurate when the its distance with the blocks are minimal. More tests need to be done by varying the distances between light sensor and the blocks to get most accurate color intensity. This result is then informed to the software team, for them to write colored block detection code accordingly.

6. Software testing

5. Hardware testing

5.1

6 UNIT TESTING

Test number	**Category**	**Description**	**Pass/Fail**	**Comments**
1	**Odometry**			
2	**Navigation**			
3	**Zip line traveling**			
4				
5				
6				
7				

7 INTEGRATING TESTING

Test number	Category	Description	Pass/Fail	Comments
1				
2				
3				
4				
5				
6				
7				

7 SYSTEM TESTING