

# INTEGRATION TEST

GROUP 4

29th November 2016  
Version 1

## Abstract

This test is designed to measure the capabilities of the robot as a whole. The tests showed us that all the methods worked to some degree. The most reliable methods were localization, object detection and object pick-up. The least reliable methods included avoidance and search. The accumulated errors in avoidance and search caused inaccuracies in the odometer which resulted in stacking failure or unstable stacked towers.

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# 1 BACKGROUND

## 1.1 Edit History

**Jake Zhu:** 2016-10-28, Initial set up

**Mamoun Benchekroun:** 2016-11-11, Added abstract section

**Richie, Mamoun and Jake:** 2016-11-19, Edited Goal, Procedure, Expected Result and Set Up Tables.

**Kareem Halabi:** 2016-11-20, Minor Grammatical Fixes, changes to utilize LaTeX references.

**Richie, Mamoun and Jake:** 2016-11-29, Edited Test Report, Conclusion, Action, Distribution and Abstract.

## 1.2 Test Information

**Tester:** Mamoun Benchekroun, Richie Piyasirisilp

**Author:** Mamoun Benchekroun, richie Piyasirisilp

**Hardware Version:** 3.03

**Software Version:** f3b423d

# 2 GOAL

To prove that all components previously tested individually will work as a whole.

# 3 PROCEDURE

**Setup/Assumptions:**

1. Assume that the robot is built and functional.
2. Assume that there is code written to accomplish all the tasks.
3. Ensure that the Server IP is correct in the code

**Test:**

1. Place the robot in a corner of the arena.
2. Set up a random pattern of blue and wooden blocks for testing. The pattern should be rearranged every time to test different scenarios.
3. Connect to the WiFi network and verify that an IP address was assigned.
4. Upload Main.java onto the EV3 brick.
5. Push the button to start the integration test.
6. Verify the robot can localize within 30 seconds.
7. Check whether or not the robot can avoid obstacles.
8. If obstacle avoidance is successful, on the next test run, rearrange/place more obstacles on the path to the green zone.
9. When the robot has reached the green zone, verify the odometer readings.
10. Observe whether or not the robot can find the nearest block.
11. Check whether it is able to identify the colour of the block. If it is a wooden block, the robot should back up and avoid it.
12. If it is a blue block, observe whether or not the robot is able to pick up the block successfully.
13. The robot should now move towards the green zone. Check for any errors in navigation, odometry and obstacle avoidance while the block is contained in the grabber.
14. Stacking should commence once the robot reaches the green zone. Make sure it is able to stack more than one block on the towers.
15. The robot is going to restart steps 10-14 until the five minutes are up.
16. Record how many towers were built and how many blocks were stacked on each.
17. Repeat the previous steps 4 more times.

## 4 EXPECTED RESULT

We expect the robot to:

- Localize in under 30 seconds
- Navigate to the green zone with correct odometry and avoid some obstacles
- Detect the nearest block
- Successfully identify the block
- Move towards the detected block

- Pick up the block if it is blue
- Avoid some, but not all, obstacles.
- Bring the block back to the Green Zone
- Stack the blocks (Expected max height of two blocks).

**NOTE:** Our avoidance is not working perfectly.

## 5 TEST REPORT

### 5.1 Localization

| Trial | Time |
|-------|------|
| 1     | 24.8 |
| 2     | 25.2 |
| 3     | 24.3 |
| 4     | 25.6 |
| 5     | 23.7 |

### 5.2 Navigation/Avoidance (to Green Zone before search)

| Trial | Reached | Avoidance |
|-------|---------|-----------|
| 1     | True    | True      |
| 2     | True    | True      |
| 3     | True    | True      |
| 4     | False   | False     |
| 5     | True    | True      |

”The 4th test’s avoidance failure caused error in the odometer which resulted in the robot driving past the green zone by half a tile. ”

### 5.3 Search

| Trial | Detected | Avoidance |
|-------|----------|-----------|
| 1     | True     | True      |
| 2     | True     | False     |
| 3     | True     | False     |
| 4     | True     | True      |
| 5     | True     | True      |

## 5.4 Object Detection

| Trial | Identified |
|-------|------------|
| 1     | True       |
| 2     | True       |
| 3     | True       |
| 4     | True       |
| 5     | True       |

## 5.5 Pick-Up

| Trial | Successful |
|-------|------------|
| 1     | True       |
| 2     | True       |
| 3     | True       |
| 4     | True       |
| 5     | True       |

## 5.6 Navigation to Green Zone (With Block)

| Trial | Reached | Avoidance |
|-------|---------|-----------|
| 1     | False   | False     |
| 2     | True    | False     |
| 3     | True    | True      |
| 4     | False   | False     |
| 5     | True    | True      |

## 5.7 Stacking

| Trial | Stacked | Towers | Blocks/Tower |
|-------|---------|--------|--------------|
| 1     | False   | 1      | 1            |
| 2     | True    | 1      | 2            |
| 3     | False   | 1      | 1            |
| 4     | False   | 2      | 1            |
| 5     | False   | 1      | 1            |

# 6 CONCLUSION

The bumper localization method has a success rate of 100 percent. Our navigation to the Green Zone before search can be unreliable when the robot fails to avoid obstacles on its way

but when the avoidance is successful, the robot can reach the green zone. The search method can always find an object but has difficulties avoiding obstacles on the way of detecting the object. the robot was always able to identify the colour of objects. If the objects were detected as a blue block, the robot would pick it up and bring it to its zone. If the objects were detected as obstacles, the robot would back away and travel back to its original search position to try again. When the robot picks up a blue block, its length increases dramatically and thus makes obstacle avoidance very difficult when going back to the Green Zone to drop the grabbed block. In most cases, the robot was not able to collect two blocks within the 5 minute time limit but it was always able to collect one. However, when the robot was able to ccollect two blocks, there was a 50 percent chance of stacking because of the error accumulated during navigation and avoidance inbetween the two collections.

## 7 ACTION

- Try to improve odometry to reduce error
- Improve efficiency and reduce duration of search method
- Improve avoidance for different objects at various positions

## 8 DISTRIBUTION

Software team