



Team 1 RobotExpress

Testing Document

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Project: Obstacle track-racer – A competitive robot design project

Task: Design and construct a machine that can autonomously navigate to a race track on an island and complete as many laps as possible within a 5 minute period, eventually returning to its starting point.

Version Number: 6.0

Edit History

Version	Editor	Date	Operation
1.0	Junjian Chen	2021/3/11	The introduction, the table of contents, and the brief test timeline.
2.0	Junjian Chen, Shichang Zhang	2021/3/12	The test plan explanation, the general purpose, and test ideas of each test. Complete the initial test plan.
3.0	Junjian Chen, Shichang Zhang	2021/3/14	Classify tests by their stages, revise the table of contents, test timeline. Add Stage 1 Test Record
3.1	Dominic Chan	2021/3/14	Formatting and template of the document, test format.
3.2	Junjian Chen, Shichang Zhang	2021/3/21	Complete Odometer, Ultrasonic Localization, Light Localization, Navigation parts of unit test.
3.3	Junjian Chen	2021/3/21	Move the descriptions of tests to Part3.
4.0	Angelina Duan	2021/3/23	Separate tests to different documents and modify test plan and outline
5.0	Shichang Zhang Junjian Chen Lide Cui	2021/3/24	Complete Go over Overpass, Go under Overpass, Return back, Bridge Passer, Path Manager part of unit test.
5.1	Shichang Zhang Junjian Chen	2021/3/25	Complete Pre Beta Demo Test of system integration tests and complete Beta Demo test of complete system test.
5.2	Shichang Zhang	2021/3/28	Add test maps to Beta Demo Test, Return Back, Ultrasonic Sensor Test. Detailed the test report of unit tests and the Beta Demo Test.
5.3	Shichang Zhang	2021/4/1	Add Obstacle Avoidance unit test.

5.4	Shichang Zhang, Junjian Chen	2021/4/4	Add Go under Overpass unit test. Add Go over Overpass unit test.
5.5	Junjian Chen, Shichang Zhang	2021/4/5	Add Path Manager unit test. Add Bridge Passer unit test. Add Go under Overpass unit test. Add Go over Overpass unit test.
5.6	Junjian Chen, Shichang Zhang, Lide Cui	2021/4/6	Add Complete Testing Add Pre-Final Test Add Go over overpass unit test
5.7	Shichang Zhang	2021/4/9	Add Obstacle Avoidance Test
5.8	Junjian Chen	2021/4/10	Add Bridge Passer Test
5.9	Junjian CHen, Shichang Zhang	2021/4/11	Add Pre-Final Test Add Complete System Test
6.0	Shichang Zhang	2021/4/16	Improve test purpose description and add figure captions on individual testing documents

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1.0 TEST PLAN

The testing plan of our project is divided into four main stages: Sensor characterization, Unit Test of each component, Integration test on combinational functionalities, and complete system tests for beta demo and final demo. Each of these stages will occur step by step throughout the design process, ensuring that we have all data required by the design and all performances of the robot are met. To make all the tests easy to reach, we use this testing document as an index to each test, such that each test has its document. All tests could be found in the testing docs folder and its type folder. (For example, Ultrasonic sensor test is in Testing docs/Sensor Characterization folder)

For every test result, we mark them as Pass(**P**), Conditionally pass(**CP**), or Fail(**F**). If a test is marked as P if and only if it passes all trials of the test. Otherwise, if the test passes the

majority of the requirement but might cause specific errors, then the test will be marked as CP. If the test fails, then we mark it F and explain the reason and find out a way to improve.

1.1 TEST PLAN TIMELINE

Test type	Test name	Test date	Test author(s)
Sensor Characterization	Ultrasonic Sensor	Week of 3.14	Shichang Zhang
	Light Sensor	Week of 3.14	Shichang Zhang
Component unit tests	Odometer	Week of 3.22	Junjian Chen
	Ultrasonic Localization	Week of 3.22	Shichang Zhang
	Light Localization	Week of 3.14	Junjian Chen
	Localize bridge Across bridge (Bridge Passer)	Week of 3.22	Lide Cui
	Localize Horizontal bridge Across Horizontal bridge (Bridge Passer)	Week of 3.29	Lide Cui
	Path Manager	Week of 3.22	Lide Cui
	Go over overpass	Week of 3.22	Dominic Chan, Junjian Chen
	Go under overpass	Week of 3.14	Shichang Zhang
	Navigation	Week of 3.22	Shichang Zhang
	Obstacle avoidance	Week of 3.29	Shichang Zhang
	Return back	Week of 3.22	Shichang Zhang
System Integration tests	Pre-beta demo test	Week of 3.22	Junjian Chen
	Pre-final test	Week of 4.5	
Complete System	Beta Demo test	Week of 3.22	Shichang Zhang

tests	Complete testing for both teams	Week of 4.5	Shichang Zhang Junjian Chen
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2.0 SENSOR CHARACTERIZATION

Two major hardware components that we use in our design are the ultrasonic sensor and the light sensor. These two sensors will be characterized with the robot design in lab 5. The characterization test processes are shown in the following docs and their results are shown in the table. (The name of the test is the link to the document)

Table 1: Sensor characterization

Test name	# of Iterations	Result P-pass CP-Conditional Pass F - fail
Ultrasonic Sensor	1	F
Light Sensor	1	P

3.0 COMPONENT UNIT TESTS

We separate different robot phases and behaviors into several component unit tests to organize the design better. Once the tests have been done, the results will be reported to all team members and updated on this document. The component unit tests could be reached using the names of tests in the following table:

Table 2: Component unit tests

Test name	# of Iterations	Result P-pass CP-Conditional Pass F - fail
Odometer	2	CP
Ultrasonic Localization	1	P
Light Localization	2	CP
Bridge Passer	3	P
Path Manager	5	CP
Go Over Overpass	9	F->CP
Go Under Overpass	3	F->P
Navigation	1	P

Obstacle Avoidance	4	F
Return Back	4	F->P

4.0 SYSTEM INTEGRATION TESTS

We plan to complete the system integration tests before complete tests of the beta demo and final demo test. These tests make sure that no components will affect each other causing a failure and the code can run without any issues. Their results are shown in the following table:(modified when the test is done)

Table 3: System Integration Tests

Test name	# of Iterations	Result P-pass CP-Conditional Pass F - fail
Pre-Beta Demo Test	3	F->CP->P
Pre-Final Test	2	F

5.0 COMPLETE SYSTEM TESTS

Once the system is integrated, we need to make sure that the robot completes all its jobs of what clients need. We have the following complete system tests:(modified when the test is done)

Table 4: Complete System Tests

Test name	# of Iterations	Result P-pass CP-Conditional Pass F - fail
Beta Demo Test	3	F->P
Complete Testing	4	F

6.0 PERFORMANCE ANALYSIS OF BETA DEMO

In our beta demo, the ultrasonic localization and light localization went well and did not have errors. However, when the bridge passer calculates the start point and endpoint of the bridge wrongly. It is because, in the map of the beta-demo test, the tunnel is vertical. But in the actual beta demo, it is horizontal. We did not perform a test in the case that the tunnel is horizontal and our algorithm can only be valid if the tunnel is vertical. In this case, the bridge passer needs to be revised by the software team. For the future, the testing of the bridge passer needs to be performed in several different maps with various directions of tunnels.

7.0 PERFORMANCE ANALYSIS OF FINAIDEMO

In our final demo, we robot showed an unpleasant performance. The ultrasonic localization failed in round 1 and round 2. The localization failed in round 3. The path manager calculated wrong for round 4.

The ultrasonic localization failed because the robot was initially placed relatively distant from the corner on the corner square. Our parameter passed was wrong. We did not find this problem during the test because we usually placed the robot at the center of the corner square, then we tested whether our ultrasonic localization methods ran correctly for different initial angles. Besides, in our beta demo, our ultrasonic localization exhibited a perfect performance. So we just believe that this component was reliable and we did not apply unit test again on the ultrasonic localization.

For the failure in round 3, the localization failed. We wrongly set the odometer value. So the robot failed to correctly figure out its real position. We made a wrong assumption that red teams will start from the left and green teams' start regions will be on the right when we developed our project. During tests, we used maps that obey our assumption to test our robot functions, so we found our localization was perfect. But actually our assumption was wrong, so we failed in the round 3 of the final demo.

For the path manager's problem, during round 4, the overpass was placed horizontally and two waypoints are both on the same y-coordinates of the overpass, so the intersection of the line segment made by overpass endpoints and two waypoints was a line instead of a point. During our development, we told the robot that it should go overpass at the point if the line segment of current waypoints and next waypoints has an intersection point with the line segment made by the overpass. We tested the vertical overpass, horizontal overpass, overpass with positive/negative slopes, waypoints with the same x/y coordinates, but in these tests, we forgot to make the case that two line segments's intersection is a line instead of a point. So we did not find this fetal problem and finally failed due to this bug.

Overall, we personally made some wrong assumptions with the project so that our testings may lack some edge cases. For the future study, we should have better communication with clients and avoid personally making assumptions on the project.