**Team 1 Testing Document**

**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**

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| --- | --- | --- | --- |
| 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 tests | Beta Demo test | Week of 3.22 | Shichang Zhang |
| Complete testing for both teams | Week of 4.5 | Shichang Zhang  Junjian Chen |

### 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](https://docs.google.com/document/u/0/d/1Xphz0pFLyXfL1WPeHChSnvuMDo12tUraS5lzE2drNdY/edit) | 1 | F |
| [Light Sensor](https://docs.google.com/document/u/0/d/1byUl3CDZUlcCfzICoGWs6WNkK8MgZH9HYAJvwRZ9I9Q/edit) | 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](https://docs.google.com/document/u/0/d/117R2YlyTxwgqMCLdjMXxlnttLYPf0wbNThisRhWShSU/edit) | 2 | CP |
| [Ultrasonic Localization](https://docs.google.com/document/u/0/d/1i5zXX2RkZB1bQ5AKaqs2tCCyuTMWAq7WKUjmvhXXKrA/edit) | 1 | P |
| [Light Localization](https://docs.google.com/document/u/0/d/1hbvZ0sSDDTCPsYO7X7Va-bQugIbLqwHuVHMDkOEr22A/edit) | 2 | CP |
| [Bridge Passer](https://docs.google.com/document/d/1HXhk2NVZQiyL04iO67X-k8fGU7fTPP-oeA-g4N2eDpg/edit#heading=h.vjyb33t9a1lz) | 3 | P |
|
| [Path Manager](https://docs.google.com/document/d/1V8CPp8eeru93fGmg7rcfp7KrCV-6xI3YIUBbGyMM1wA/edit) | 5 | CP |
| [Go Over Overpass](https://docs.google.com/document/d/1ntKasrLQ6Y_eLAAidyk6L0FvTIGCx-GSZtqNbJkSr4E/edit) | 9 | F->CP |
| [Go Under Overpass](https://docs.google.com/document/d/1ApCq7hXxCLwaWe6oN9_eNqux0iLiI2UIqdQqZ_-585A/edit) | 3 | F->P |
| [Navigation](https://docs.google.com/document/d/1OZXy8YqvSSrNrOsIWyWCu_IZifpUpeZtN-kmQz0zkjM/edit#heading=h.ly5x7qkl04pg) | 1 | P |
| [Obstacle Avoidance](https://docs.google.com/document/d/1nVNL2kwVMP2fMCIHlCoy6-4sJ-4CjylEhkdfPrdmCog/edit) | 4 | F |
| [Return Back](https://docs.google.com/document/d/1FBtxROm1xwYeoYW5ALSHYr2V5moykrTor_v7g1cWxvg/edit) | 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](https://docs.google.com/document/u/0/d/1ON8UKJ_YReQTtxSYWl7Dh810YPmuWamyQt2pKF4q3a8/edit) | 3 | F->CP->P |
| [Pre-Final Test](https://docs.google.com/document/u/0/d/1e5TrdMCQe4JQ-I5-leSqKMaLrL5nBTCnS9Hacrcc3bU/edit) | 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](https://docs.google.com/document/u/0/d/1_cBBKc-2ap1MLJntkO9TeHmJczp5TSSxhR-7uMhMAg0/edit) | 3 | F->P |
| [Complete Testing](https://docs.google.com/document/u/0/d/11cJ9LEXmZj5XfFIPwTY_HlZErXgELCosv9kYrb96_S8/edit) | 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 FINAlDEMO

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.