Go Over Overpass

**Test 1**

**Date :** 23/03/2021

**Tester:** Dominic Chan,

**Author:** Dominic Chan

**Hardware version:** 1.1 (in Part 2.5 of [Hardware Document](https://docs.google.com/document/d/11jkA_S_xBqyCbcn2NyMuM-OMDEybDfRy/edit#))

**Software version:** 1.3 (in Part 7.0 of [Software Document](https://docs.google.com/document/d/19JaY5629aUu4Y4rjoQJ-jWyeQLqNSAcr/edit))

**Purpose:** To determine whether the robot can go up and down the slopes of the overpass successfully

**Procedure:**

1. The robot is placed on the front of the endpoint A of the overpass
2. Make the robot move forward
3. Observe and record whether the robot can pass the overpass successfully

**Expected Results:**

The robot can go up the bridge, arrive at the main body of the bridge, then go down successfully, without any stucks, turning over or falling over.

**Test Results:**

|  |  |  |
| --- | --- | --- |
| Trial | Pass/Fail | Comments |
| 1 | Fail | The robot gets stuck when trying to go up the bridge. |
| 2 | Fail | Same as trial 1. |
| 3 | Fail | Same as trial 1. |
| 4 | Fail | Same as trial 1. |
| 5 | Fail | Same as trial 1. |

**Test Report:**

The test was performed a total of 5 times, and for each time, the robot gets stuck when trying to get onto the slope of the bridge. The issue appears to be because in the front-end of the robot, the positions of the light sensors and solid are too low so that they get caught with the slope.

**Conclusion:**

Test failed as the robot is unable to make it across the bridge.

**Action:**

Adjust the light sensors and solid to higher positions.

**Distribution:**

Hardware Design Team

**Test 2**

**Date :** 23/03/2021

**Tester:** Junjian Chen

**Author:** Junjian Chen

**Hardware version:** 1.2 (in Part 2.5 of [Hardware Document](https://docs.google.com/document/d/11jkA_S_xBqyCbcn2NyMuM-OMDEybDfRy/edit#))

**Software version:** 1.3 (in Part 7.0 of [Software Document](https://docs.google.com/document/d/19JaY5629aUu4Y4rjoQJ-jWyeQLqNSAcr/edit))

**Purpose:** To determine whether the robot can go up and down the slopes of the overpass successfully

**Procedure:**

1. The robot is placed on the front of the endpoint A of the overpass
2. Make the robot move forward
3. Observe and record whether the robot can pass the overpass successfully

**Expected Results:**

The robot can go up the bridge, arrive at the main body of the bridge, then go down successfully, without any stucks, turning over or falling over.

**Test Results:**

|  |  |  |
| --- | --- | --- |
| Trial | Pass/Fail | Comments |
| 1 | Fail | The robot is able to go up the bridge but when going down the bridge it turns over. |
| 2 | Fail | Same as trial 1. |
| 3 | Fail | Same as trial 1. |
| 4 | Fail | Same as trial 1. |
| 5 | Fail | Same as trial 1. |

**Test Report:**

The test was performed a total of 5 times, and for each time,the robot can go up the overpass successfully. However, when it goes down the slope it turns over. The main reason for this is that the center of gravity is too high and lies in front of the robot so when it goes down the robot tends to tilt forward.

**Conclusion:**

Test failed as the robot is unable to make it across the bridge.

**Action:**

Adjust the solid to make the center of gravity down and back.

**Distribution:**

Hardware Design Team

**Test 3**

**Date :** 23/03/2021

**Tester:** Junjian Chen

**Author:** Junjian Chen

**Hardware version:** 1.3 (in Part 2.5 of [Hardware Document](https://docs.google.com/document/d/11jkA_S_xBqyCbcn2NyMuM-OMDEybDfRy/edit#))

**Software version:** 1.3 (in Part 7.0 of [Software Document](https://docs.google.com/document/d/19JaY5629aUu4Y4rjoQJ-jWyeQLqNSAcr/edit))

**Purpose:** To determine whether the robot can go up and down the slopes of the overpass successfully

**Procedure:**

1. The robot is placed on the front of the endpoint A of the overpass
2. Make the robot move forward
3. Observe and record whether the robot can pass the overpass successfully

**Expected Results:**

The robot can go up the bridge, arrive at the main body of the bridge, then go down successfully, without any stucks, turning over or falling over.

**Test Results:**

|  |  |  |
| --- | --- | --- |
| Trial | Pass/Fail | Comments |
| 1 | Fail | The robot is able to go up the bridge but when going down the bridge it turns over. |
| 2 | Pass | The robot passes the test but it is observed that the robot looks unstable when going down the slope. |
| 3 | Fail | Same as trial 1. |
| 4 | Fail | Same as trial 1. |
| 5 | Pass | Same as trial 2. |

**Test Report:**

The test was performed a total of 5 times. For trial 1,3 and 4, the robot fails as we observed in Test 2. For trial 2 and 5, it passed the test. However, the robot does not go down in a constant velocity, which is observed to be unstable. The possible reason for it is that the forward speed we set is too high.

**Conclusion:**

The possible reason of failure:

1. The center of gravity of the current hardware design is still too high
2. The forward speed when going down the slope is too high

**Action:**

Adjust the solid to make the center of gravity down and back.

Perform the test with different forward speed to get a safe velocity to go down.

**Distribution:**

Hardware Design Team, Software Design Team

**Test 4**

**Date :** 23/03/2021

**Tester:** Junjian Chen

**Author:** Junjian Chen

**Hardware version:** 1.4 (in Part 2.5 of [Hardware Document](https://docs.google.com/document/d/11jkA_S_xBqyCbcn2NyMuM-OMDEybDfRy/edit#))

**Software version:** 1.3 (in Part 7.0 of [Software Document](https://docs.google.com/document/d/19JaY5629aUu4Y4rjoQJ-jWyeQLqNSAcr/edit))

**Purpose:** To determine whether the robot can go up and down the slopes of the overpass successfully

**Procedure:**

1. The robot is placed on the front of the endpoint A of the overpass
2. Make the robot move forward
3. Observe and record whether the robot can pass the overpass successfully

**Expected Results:**

The robot can go up the bridge, arrive at the main body of the bridge, then go down successfully, without any stucks, turning over or falling over.

**Test Results:**

|  |  |  |
| --- | --- | --- |
| Trial | Pass/Fail | Comments |
| 1 | Fail | The robot slides down the slope when trying to go up. |
| 2 | Fail | Same as trial 1. |
| 3 | Fail | Same as trial 1. |
| 4 | Fail | Same as trial 1. |
| 5 | Fail | Same as trial 1. |

**Test Report:**

Pass Rate:0%

All the trials fail. The robot slides down when going up the slope since we increase the weight of the solid of the robot to adjust the center of gravity in hardware version 1.4. However, the weight is too high and it makes the robot unable to climb the slope.

**Conclusion:**

The test fails since it is unable to pass the overpass.

**Action:**

Abundon the hardware verison 1.4.

Use hardware version 1.3 to test the robot at different speeds when going down the slope.

**Distribution:**

Hardware Design Team, Software Design Team

**Test 5**

**Date :** 24/03/2021

**Tester:** Junjian Chen

**Author:** Junjian Chen

**Hardware version:** 1.3 (in Part 2.5 of [Hardware Document](https://docs.google.com/document/d/11jkA_S_xBqyCbcn2NyMuM-OMDEybDfRy/edit#))

**Software version:** 1.3 (in Part 7.0 of [Software Document](https://docs.google.com/document/d/19JaY5629aUu4Y4rjoQJ-jWyeQLqNSAcr/edit))

**Purpose:** Determine a safe forward speed to go down the overpass

**Procedure:**

1. The robot is placed on the front of the endpoint A of the overpass
2. Make the robot move forward with 5 different forward speed
3. For each different speed, repeat 5 times
4. Observe and record whether the robot can pass the overpass successfully

**Expected Results:**

The robot can go up the bridge, arrive at the main body of the bridge, then go down successfully, without any stucks, turning over or falling over.

**Test Data:**

|  |  |
| --- | --- |
| Trial | Forward Speed |
| 1 | 50 |
| 2 | 100 |
| 3 | 150 |
| 4 | 200 |
| 5 | 300 |

**Test Results:**

|  |  |  |
| --- | --- | --- |
| Trial | Forward Speed | Pass/Fail |
| 1 | 50 | P/P/P/P/P |
| 2 | 100 | P/P/P/P/P |
| 3 | 150 | P/P/F/P/P |
| 4 | 200 | P/P/F/F/F |
| 5 | 300 | F/F/F/F/F |

**Test Report:**

The test was performed with 5 different forward speeds when going down the overpass. As we can see from the test results, only trial 1 and 2, which are corresponding to forward speed at 50 and 100 pass the test for 5 times. We can observe the tendency that the lower the forward speed, the higher the possibility of success. At the speed of 50, it costs too much time to go down so we will use 100 as our speed for going down.

**Conclusion:**

The test successes when the speed is 50 and 100, but fails at the speed of 150,200 and 300.

**Action:**

Set the forward speed to 100 when the robot goes down the overpass.

Perform more trials at the speed of 100 to examine the reliability of it.

**Distribution:**

Software Design Team, Testing Team

**Test 6**

**Date :** 24/03/2021

**Tester:** Junjian Chen

**Author:** Junjian Chen

**Hardware version:** 1.3 (in Part 2.5 of [Hardware Document](https://docs.google.com/document/d/11jkA_S_xBqyCbcn2NyMuM-OMDEybDfRy/edit#))

**Software version:** 1.4 (in Part 7.0 of [Software Document](https://docs.google.com/document/d/19JaY5629aUu4Y4rjoQJ-jWyeQLqNSAcr/edit))

**Purpose:** Determine the rate of passing the overpass successfully at the speed of 100

**Procedure:**

1. The robot is placed on the front of the endpoint A of the overpass
2. Make the robot move forward at the speed of 100
3. Repeat 1,2 for 10 times
4. Observe and record whether the robot can pass the overpass successfully

**Expected Results:**

The robot can go up the bridge, arrive at the main body of the bridge, then go down successfully, without any stucks, turning over or falling over.

**Test Data:**

|  |  |
| --- | --- |
| Trial | Forward Speed |
| All | 100 |

**Test Results:**

|  |  |  |
| --- | --- | --- |
| Trial | Forward Speed | Pass/Fail |
| 1 | 100 | Pass |
| 2 | 100 | Pass |
| 3 | 100 | Pass |
| 4 | 100 | Pass |
| 5 | 100 | Pass |
| 6 | 100 | Pass |
| 7 | 100 | Pass |
| 8 | 100 | Pass |
| 9 | 100 | Pass |
| 10 | 100 | Pass |

**Test Report:**

Pass Rate:100%

At the speed of 100, all trials pass the test. The robot can pass the overpass steadily.

**Conclusion:**

100 is a safe speed for the robot to pass the overpass.

**Action:**

Set the forward speed to 100 when the robot goes down the overpass.

**Distribution:**

Software Design Team

**Test 7**

**Date :** 24/03/2021

**Tester:** Junjian Chen

**Author:** Junjian Chen

**Hardware version:** 1.5 (in Part 2.5 of [Hardware Document](https://docs.google.com/document/d/11jkA_S_xBqyCbcn2NyMuM-OMDEybDfRy/edit#))

**Software version:** 1.6 (in Part 7.0 of [Software Document](https://docs.google.com/document/d/19JaY5629aUu4Y4rjoQJ-jWyeQLqNSAcr/edit))

**Purpose:** Determine whether the robot of hardware can pass the overpass at the speed of 100.

**Procedure:**

1. The robot is placed on the front of the endpoint A of the overpass
2. Make the robot move forward at the speed of 100
3. Repeat 1,2 for 10 times
4. Observe and record whether the robot can pass the overpass successfully

**Expected Results:**

The robot can go up the bridge, arrive at the main body of the bridge, then go down successfully, without any stucks, turning over or falling over.

**Test Data:**

|  |  |
| --- | --- |
| Trial | Forward Speed |
| All | 100 |

**Test Results:**

|  |  |  |
| --- | --- | --- |
| Trial | Forward Speed | Pass/Fail |
| 1 | 100 | Pass |
| 2 | 100 | Pass |
| 3 | 100 | Pass |
| 4 | 100 | Pass |
| 5 | 100 | Pass |
| 6 | 100 | Pass |
| 7 | 100 | Pass |
| 8 | 100 | Pass |
| 9 | 100 | Pass |
| 10 | 100 | Pass |

**Test Report:**

Pass Rate:100%

At the speed of 100, all trials pass the test. The robot can pass the overpass steadily.

**Conclusion:**

The robot of hardware version 1.5 is reliable.

**Action:**

None.

**Distribution:**

Software Design Team

**Test 8**

**Date :** 5/4/2021

**Tester:** Junjian Chen

**Author:** Junjian Chen

**Hardware version:** 1.3 (in Part 2.5 of [Hardware Document](https://docs.google.com/document/d/11jkA_S_xBqyCbcn2NyMuM-OMDEybDfRy/edit#))

**Software version:** 1.8 (in Part 7.0 of [Software Document](https://docs.google.com/document/d/19JaY5629aUu4Y4rjoQJ-jWyeQLqNSAcr/edit))

**Purpose:** Determine whether the robot is able to pass the overpass in Software Version 1.8.

**Procedure:**

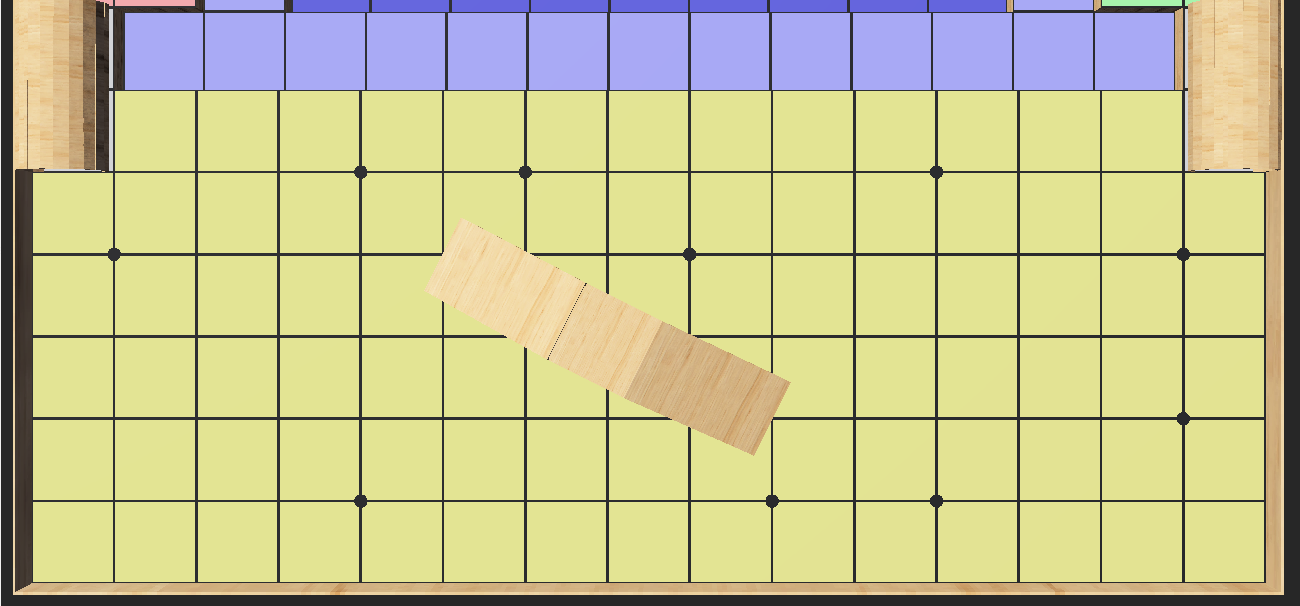
1. The robot is placed at point (6,5) where the robot is going to go on the overpass.
2. Make the robot navigate to the point to the next waypoint (9,1) by using travelTo() method in Navigation class.
3. Observe and record in which process while navigating the robot successes or fails.

**Expected Results:**

Before going up the overpass, the robot arrives at (4,4.5) which is “overpassStartLocalizationPoint” calculated by the path manager. The robot can go up the bridge, arrive at the main body of the bridge, then go down successfully, without any stucks, turning over or falling over. Then the robot can localize to (10,1) by the light localization. Finally, the robot arrives at (9,1).

**Test Data:**

**Map:**



**Test Results:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Trial | Arrive at (4,4.5) | Pass the overpass | Localize to (10,1) | Arrive at (10,1) | Comment |
| 1 | Pass | Pass | Pass | Pass | The robot has small oscillations while going up. |
| 2 | Pass | Pass | Pass | Pass | Same as trial 1. |
| 3 | Pass | Pass | Pass | Pass | Same as trial 1. |
| 4 | Pass | Pass | Pass | Pass | Same as trial 1. |
| 5 | Pass | Pass | Pass | Pass | Same as trial 1. |
| 6 | Pass | Fail | Fail | Fail | The robot oscillated and fell down the bridge. |
| 7 | Pass | Pass | Pass | Pass | Same as trial 1. |
| 8 | Pass | Pass | Pass | Pass | Same as trial 1. |
| 9 | Pass | Pass | Pass | Pass | Same as trial 1. |
| 10 | Pass | Pass | Pass | Pass | The robot has large oscillations while going up. |

**Test Report:**

Pass Rate:90%

Most of the trials pass the test. However, all of them have oscillation while going up the overpass. 8 of the trials have slight oscillations and 2 of them have large oscillations. Among them, trial 6 falls because the angle of the robot is affected by the oscillation and it makes the robot move in a wrong direction hence falling down. The rest of them pass since the robot turns back to the correction direction after oscillation.

Although the pass rate is high, in different situations the robot may fail to go up the slope. The hardware of the robot may still need to be adjusted to eliminate the oscillation.

**Conclusion:**

The test conditionally passes.

**Action:**

Modify the hardware design to eliminate the oscillations.

**Distribution:**

Hardware Design Team

**Test 9**

**Date:** 6/4/2021

**Tester:** Shichang Zhang

**Author:** Shichang Zhang

**Hardware version:** 1.5 (in Part 2.5 of [Hardware Document](https://docs.google.com/document/d/11jkA_S_xBqyCbcn2NyMuM-OMDEybDfRy/edit#))

**Software version:** 2.0 (in Part 7.0 of [Software Document](https://docs.google.com/document/d/19JaY5629aUu4Y4rjoQJ-jWyeQLqNSAcr/edit))

**Test Purpose:**

To find out the threshold slope of the overpass the current hardware design can handle.

**Test Procedure:**

1. Create overpasses with ramp length of 2m, and input heights.
2. Place the robot at the endpoint of the overpass
3. We will run 5 times on each height.
4. Make the robot forward with speed 200 along the overpass direction.
5. Observe and record whether the robot can go up and down the overpass

**Test Data:**

|  |  |  |  |
| --- | --- | --- | --- |
| Trial# | Overpass Height (m) | Slope | Picture of the Overpass |
| 1 | 0.85 | 0.425 | Figure 9.1 The overpass with slope 0.425 |
| 2 | 1.0 | 0.500 | Figure 9.2 The overpass with slope 0.5 |
| 3 | 0.93 | 0.465 | Figure 9.3 The overpass with slope 0.465 |
| 4 | 0.95 | 0.475 | Figure 9.4 The overpass with slope 0.475 |
| 5 | 0.75 | 0.375 | Figure 9.5 The overpass with slope 0.475 |
| 6 | 0.65 | 0.325 | Figure 9.6 The overpass with slope 0.325 |
| 7 | 0.5 | 0.250 | Figure 9.7 The overpass with slope 0.250 |

**Expected Result:**

The robot is able to go up and down the slopes of all overpasses.

**Test Results:**

|  |  |  |
| --- | --- | --- |
| Trial# | Pass/Fail | Comment |
| 1 | Pass | The robot stably climbed and went down the overpass every time. |
| 2 | Fail | The light sensors in the front of the robot would hit the overpass first. The robot’s move forward action would be influenced. It was still trying to climb the overpass, but mostly with errored angles. So the robot was likely to deviate from the straight path and fell down the overpass. |
| 3 | Pass | At most times the robot stably climbed and went down the overpass. But in one of five tests, the touch sensor hit the overpass first and influenced the robot’s angle. However, although the robot deviated from the straight path, since the error was small, the robot still successfully climbed and went down the overpass. |
| 4 | Conditional Pass | Two of five iterations the robot stably climbed and went down the overpass. In other three iterations the light sensors hit the overpass first and influenced the robot’s state. The robot was still able to climb and go down the overpass, but would deviate from the straight path. |
| 5 | Pass | The robot stably climbed and went down the overpass every time. |
| 6 | Pass | The robot stably climbed and went down the overpass every time. |
| 7 | Pass | The robot stably climbed and went down the overpass every time. |

**Test Report:**

We designed 7 tests for different overpass slopes. We found that it is difficult for the robot to go over overpasses with large slopes and it is easy for the robot to go over overpasses with small slopes. From the test output, we found that when the overpass slope is high, the light sensors in the front of the robot will hit the overpass first and the robot motion will be influenced, Then the robot usually climbed the overpass with an errored angle so it is possibly for the robot to fall down the overpass and fail to go down the overpass. Moreover, from the test output, we found that when slope is lower than 0,45, the robot performs favorably. When slope is higher than 0.475, the robot’s pass rate decreases considerably. Overall, our robot can handle the slope of the overpass in the range of 0 to 0.45.

**Conclusion:** Therobot can handle the slope of the overpass in the range of 0 to 0.45.

**Action:** None

**Distribution:** Hardware Design