Project:

Design Method and Principles (ECSE-211) Team #6 Final Project

Task:

Construct an autonomous robot to play a one-on-one game that is a cross between soccer and basketball. The robot must be able to play either forward or defense and be capable of navigating the field without hitting obstacles. Instructions are received via Bluetooth radio prior to the game.

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*For this project, many different modules are combined to create a functional robot that can perform the desired routine as per the specifications; therefore a bottom-up strategy will be employed to help target the source of the error, which is especially important when the robot is running multiple threads at the same time. The test cases designed will try to minimize the chances of an error happening on D-Day, but also try to make sure it would not cause the testers to overspend its time budget on it.*

# *Test Items*

The following items will be the focus of the robot:

* Basic cases
  + Odometry
  + Navigation
  + Bluetooth
  + Ball launcher
  + Localization
  + Ball loading
* Intermediate cases
  + Obstacle avoidance (ultrasonic)
  + Obstacle avoidance (touch sensor)
* Advanced cases
  + Defender role
  + Attacker role
* Optional functions
  + Odometry correction

# *Test cases*

## Basic cases:

### Odometry

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| --- | --- |
| Test case ID | 1.1.1 |
| Case name | Rotate |
| Purpose | To determine if the robot can accurately know where it is pointing at after rotation is performed |
| Description | The robot will turn to various angles and see if it can turn back to its origin |
| Prerequisites | N/A |
| Steps | 1. Make sure the robot is pointed to the 0 degree for this test 2. Turn to 60 3. Turn to 180 4. Turn to 350 5. Turn to 80 6. Turn to 0 |
| Actual results |  |
| Expected results | Robot can point to the various points accurately, and also take the smallest angle to turn; odometry should properly reflect angles turned |

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| --- | --- |
| Test case ID | 1.1.2 |
| Case name | Walk straight |
| Purpose | To determine if the robot can accurately walk a predefined distance straight |
| Description | The robot will walk various amounts of distance, and see if it can keep it straight |
| Prerequisites | N/A |
| Steps | 1. Make sure the robot is pointed to the 0 degree for this test 2. Walk 30 units forward 3. Walk 30 unit forward |
| Actual results |  |
| Expected results | Robot can walk straight, so that its angle is perpendicular to where it started; the odometry reported should be reasonable accurate |

### Navigation

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| --- | --- |
| Test case ID | 1.2.1 |
| Case name | Travel To |
| Purpose | To determine if the robot can travel to desired location, facing the correct orientation |
| Description | The robot will walk various amounts of distance, and the offset from the origin will be used to determine if the robot is accurate enough. Also the robot needs to point at indicated angle when it is at the destination. |
| Prerequisites | N/A |
| Steps | 1. Make sure the robot is pointed to the 0 degree for this test 2. Walk to (0, 30) 3. Walk to (30, 15) 4. Walk to (30,30) 5. Walk to (0,15) 6. Walk to (0,0) 7. Turn and face 0 degrees |
| Actual results |  |
| Expected results | ???? |

### Bluetooth

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| --- | --- |
| Test case ID | 1.3.1 |
| Case name | Receive information over Bluetooth |
| Purpose | To determine if the robot can receive the Bluetooth coordinates using the given program |
| Description | The robot displays the received information transferred via Bluetooth |
| Prerequisites | N/A |
| Steps | 1. Start the Bluetooth program and robot 2. Transmit a pair of coordinates 3. Display it on LCD to acknowledge 4. Repeat one more time |
| Actual results |  |
| Expected results | Robot will display the information on the LCD |

### Ball launcher

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| --- | --- |
| Test case ID | 1.4.1 |
| Case name | Launch ball |
| Purpose | To determine if the robot can launch a ball through the target with a minimum of one bounce, from a range of given distance at line d1. It must bounce in the w1 x w2 area |
| Description | The robot will receive a pair of coordinates and shoot the ball to the target. The test will see if it can shoot when it is positioned when it is placed in front of line d1 at every 5 cm increments. |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results | Robot will shoot the ball into the target |

### Localization

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| --- | --- |
| Test case ID | 1.5.1 |
| Case name | Sonar falling edge case |
| Purpose | To determine if the robot can get an approximation of where north is and bring the robot to a position near (0,0) so it can detect the axis on the ground. Note that since the four corners require the same routine, only a brief test is needed for corners 2, 3 and 4. |
| Description | The robot will use the ultrasonic sensor to see where the walls are and find north. It will run it at several locations in the tile, with different orientation. At least one test case will include the robot starting as near as one of the wall as possible, as far as possible, and also if obstacles on the adjacent tiles will affect the performance (to be completed later). |
| Prerequisites | N/A |
| Steps | The tiles will be assigned a quadrant number, and the test will be run with the robot’s center inside the quadrant. Each quadrant will have at least 2 tests, one will the starting orientation facing the wall and one facing the open area.  For the quadrants 1 and 3, the robot will also be tested on if it is possible to start at a position very near the ball. For quadrant 4, it will be tested to determine if it can detect the walls at the maximum allowed location from the wall. |
| Actual results |  |
| Expected results | Robot can successfully find north and travel to a location that it can run the light localization routine. |

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| --- | --- |
| Test case ID | 1.5.2 |
| Case name | Light sensor localization |
| Purpose | To determine if the robot can localize itself using the lines between the tiles at the four different corners. |
| Description | The robot will start at the four different corners, each corner will be tested at least twice.  If its possible, different ambient light level will be used to test the effectiveness of the sensor |
| Prerequisites | N/A |
| Steps | The robot will run the routine and then try to navigate to a point where it can be measure its accuracy, as well as orenitation. |
| Actual results |  |
| Expected results | Robot can successfully find its location on the board and adjust its odometer |

## Ball loading

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| --- | --- |
| Test case ID | 1.6.2 |
| Case name | Ball loading test |
| Purpose | To determine if the ball loading mechanism works reliably |
| Description | The robot will be retrieving a ball from the ball dispenser multiple times |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results | Robot can retrieve the ball form the dispenser multiple times |

## Intermediate cases

## Obstacle avoidance (ultrasonic)

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| --- | --- |
| Test case ID | 2.1.1 |
| Case name | Ultrasonic test |
| Purpose | To determine if the ultrasonic sensor works properly for obstacle avoidance at varying locations. It should also try to locate the blind spots of the ultrasonic sensor, as well as different angles that it will not be effective against |
| Description | The robot will detect the obstacle using its ultrasonic sensor and avoid it. It should avoid the obstacles it can detect |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results | The robot can avoid the obstacle without touching it and causing it to lose its odometer’s accuracy |

## Obstacle avoidance (touch)

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| --- | --- |
| Test case ID | 2.2.1 |
| Case name | Touch sensor-left |
| Purpose | To determine if the left touch sensor can successfully detect and avoid colliding with an obstacle at varying angles |
| Description | The robot will detect the obstacle using its touch sensor and will try to go avoid it |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results | The robot can avoid the obstacle without losing its odometer’s accuracy |

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| --- | --- |
| Test case ID | 2.2.1 |
| Case name | Touch sensor - right |
| Purpose | To determine if the right touch sensor can successfully detect and avoid colliding with an obstacle at varying angles |
| Description | The robot will detect the obstacle using its touch sensor and will try to go avoid it |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results | The robot can avoid the obstacle without losing its odometer’s accuracy |

## Advanced Cases

## Defender Role

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| --- | --- |
| Test case ID | 3.1.1 |
| Case name | Localization |
| Purpose | To determine if the localization routine works properly |
| Description | The robot will be placed on all four corners of the grid and will run the two localization methods to find its location  Different starting orientations and positions on the tile will be used. |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results |  |

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| --- | --- |
| Test case ID | 3.1.2 |
| Case name | Obstacle |
| Purpose | To determine if obstacle detection works properly when the robot is travelling to its target coordinates and stay within the boundaries. |
| Description | The robot will be tested on how well it can travel to its target coordinates. Several cases will be used, including:   * Obstacles in its obstacle avoiding path * Obstacles forming a “wall” * Obstacles in the ultrasonic sensor’s blind spots * Obstacles at varying angles   It will be evaluated by the time taken and the accuracy of the odometer. |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results |  |

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| --- | --- |
| Test case ID | 3.1.3 |
| Case name | Defend |
| Purpose | To determine if the robot can travel to the location needed to defend the goal |
| Description | The robot will travel to the goal and rise up its arm. Shots will be thrown from different angles to find the effective angle |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results |  |

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| --- | --- |
| Test case ID | 3.1.4 |
| Case name | Defense routine test |
| Purpose | To see if it can perform all the previous cases when strung together |
| Description | The robot will first localize itself and then successfully travel to the location to defend the ball. |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results |  |

## Attacker Role

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| --- | --- |
| Test case ID | 3.2.1 |
| Case name | Obstacle |
| Purpose | Refer to 3.1.2 |
| Description | N/A |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results |  |

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| --- | --- |
| Test case ID | 3.2.2 |
| Case name | Load and shoot |
| Purpose | To see if the robot can travel to the ball loading mechanism and load a ball from one of the possible initial positions |
| Description | This part will combine navigation, localization and ball loading. The robot should localize itself, navigate to the desired position and load the ball successfully. This process should succeed at each possible robot’s initial position. |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results |  |

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| --- | --- |
| Test case ID | 3.2.3 |
| Case name | Shoot and load repeated |
| Purpose | To determine if it is possible for the robot to reload after shooting multiple times. The ball shooting performance will not be as important in this part |
| Description | First, the robot will empty its load, and then it will try and travel to the ball dispenser and get another ball. (while avoiding obstacles). This will repeat several times. |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results |  |

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| --- | --- |
| Test case ID | 3.2.3 |
| Case name | Ultimate attacking test |
| Purpose | To see if the previous successful methods can combine together and successfully get the goals |
| Description | The robot will simulate the real process by combining all small pieces together and see if it can successfully scores without any problems. This test will try and create as many possible scnenarios as possible, such as starting positions, obstacle locations and also different coordinates. |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results |  |

## Optional cases

Odometry correction

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| --- | --- |
| Test case ID | 4.1.1 |
| Case name | Odometry correction |
| Purpose | To determine if the odometry correction code functions well when it is navigating the field |
| Description | The robot will first travel in a spiral pattern from the center and then in a square around the field. It will then travel back to center to see if it is accurate |
| Prerequisites | N/A |
| Steps |  |
| Actual results |  |
| Expected results |  |