

Project Proposal - Team Tesseract

1. Overall strategy

To complete the quest the robot needs to have these major skills.

Physical skills

- I. Surface detection
- II. Color sensing
- III. Object lifting
- IV. Ramp Climbing

Algorithmic skills

- I. Line/Dotted line following
- II. Height/ Depth or distance calculation
- III. Proper path selection

So our goal is to empower the robot with these skills efficiently, accurately and precisely in order to complete without failures.

2. Robot mechanical design

A 3 wheeled robot with two powered rear wheels and a castor wheel at the front is the design we chose for the robot. Steering will be the differential drive. To pick up the rook and the 2 boxes in the secret chamber, we will use an arm with a gripper at the front of the robot. The action of the arm and the gripper will be controlled using servo motors.

3. Sensors

- I. **IR Sensors** - We have decided to use 3 IR sensors mounted at the front of the robot for line following and dotted line following tasks. IR sensors can be used to do the color sensing (red and blue) as well by changing the programming code.
- II. **HC-SR04 Ultrasonic sensors** - We are expecting to use two ultrasonic sensors mounted on the two sides of the robot for the segmented wall following task and to detect walls in the chess board area and secret chamber.

- III. **LIDAR sensor** - Lidar sensors are capable of providing an accurate high resolution 3D view of the surroundings. We will use it for following tasks:

- To identify chess pieces and cubes by their heights
- To detect bordering walls
- To identify the ramp and its angle
- To identify the bridge between the trench, its width

- IV. **Position Sensor** - We use it to measure the distance traveled by the robot starting from its reference position in the broken bridge task to detect the holes in the bridge and to place the cubes accurately.

4. Actuators

Main purpose of using an actuator is picking up the Rook chess piece and moving it, filling the broken bridge using cubes and crossing through it. Robot arm has 3 degrees of freedom.

- Arm can rotate forward and backward so that it can move up the cubes while going on the ramp.
- Another servo motor to rotate the gripper part on the vertical plane perpendicular to the earth surface. Using it, robot can put the cubes into the holes on the bridge
- At the end of the arm there is a servo motor with a slider mechanism connected to a gripper to grab the cubes.

5. Algorithms

I. Line following

We have placed 3 IR sensors in front of the robot as an array. IR sensors emit infrared rays and detect reflecting rays. Depending on the amount of rays getting back to the sensor, outputs of the sensors change. If the robot is

moving out of the line, 1 or 2 sensors output different voltage levels when compared to the 3rd sensor. It will be analyzed by the controller and turn the robot to the required direction.

II. Segmental wall following

When traversing through the segmented walls it has to move keeping the same distance between the walls. Then it will be always positioned in the middle of the walls. Ultrasonic sensors on the sides will detect the distance to the walls. When the wall is not detected it will go straight without steering to any side until it senses the wall again. Then it realigns itself between the walls.

III. Dotted line following

This uses the same IR sensor array, to detect the color of the line it uses the variation of output voltage levels in different colored surfaces. When following the dotted line, all sensors come out of the line at the end of the broken line. Then the robot will move straight until it finds the colored surface. If the robot won't align with the next line segment correctly, the algorithm that we used in the continuous line following task will be applied to correct the direction.

IV. Chess board area

When the robot enters the chess board it will take the black rook (black box) and move in the two perpendicular directions and find whether there is a king in that row by the height of the king (using lidar sensor). Then the robot will go towards the king and find whether it is white king or black king (using an IR sensor that has been mounted vertically). If it is white king it will go to its initial position and do the relevant move to checkmate the king..

V. Secret chamber

After checkmating the king by placing the rook in the suitable square, the robot will automatically go to the red floor area which is around the chess board arena. Then with the help of lidar and ultrasonic sensors that are

mounted on its chassis, it will find its way to the door of the secret chamber where the two boxes are placed. Inside the secret chamber room the robot has to identify a box using the sensors. After that it will use its actuator arm which is mounted in front of the robot body to grab the box and lift it. With the box, the robot will now follow the line which starts at the gate of the secret chamber in order to do the next task.

VI. Broken bridge

The robot will follow the line carrying the first box and will climb up the ramp also. Then it will detect the two holes at the top of the ramp using the lidar sensor and the position sensor can be used to reach the hole precisely since we know the dimensions of the bridge. The robot has the ability to slide the arm sideways and place the block into the hole. Then it will turn 180 degrees and go back to the chamber and pick up the next box. Then again it will follow the same steps and place the box at the other hole. Then the robot will be able to cross to the other side and move down the ramp and finish following the line.

6. Task delegation

Line following/Dotted line following - Shehan H M K (200601X)

Segmental wall following - Gamindu A G D (200179H)

Chess board area - Wanigathunga W A S S (200693D)

Secret chamber - Hewawitharana M I (200220D)

Broken bridge - Samaraweera D T (200564J)