EN2533

Robot Design and Competition

2022

Department of Electronic and Telecommunication Engineering
University of Moratuwa

Introduction

The task contains both simulation and physical tasks.

- **Simulation task**

  For the simulation, you are expected to design a virtual robot within limits specified, using the Webots Open-Source Simulator (https://cyberbotics.com). You should use the Webots R2021b version for the simulation. This task will account for 50% of your total marks.

- **Physical Task**
  You are expected to design a real robot within the limits specified for the physical task. This task will account for 50% of your total marks.

Simulation Task

The task consists of several subtasks.

- **Line Following**
  The robot has to follow a white line on a black surface. These paths may contain straight lines or curved lines.
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- **Segmented Wall Following**
  The robot has to follow a segmented wall. The segmented wall may have a straight or curved shape or both.

- **Dotted Line Following**
  After the wall-following task, the robot must follow a colored dotted line path. There will be two dotted lines from which you need to select the correct path based on the random color you receive at the beginning of the competition. These paths may have straight and curved dotted lines. At the end of both the dotted line paths, the robot will enter the chessboard area.

- **Chess Board Area**
  This task aims to find and deliver the checkmate for the black side. You will be playing as a black rook in the chess game. Your goal is to give the checkmate in **1 move** and open the secret chamber door. The robot will be entering the chessboard arena via **a7 square** (black) parallel to rows of the chessboard (Figure 1).

  The robot has to pick the black rook on the a7 square and it needs to find the only move which delivers checkmate in **one move**. The robot will not have any prior knowledge about the current chess game position.

Once the robot finds the square to deliver the checkmate, it needs to place the rook in the checkmate square, and it will open the chamber door. The chamber door will be opened as long as the rook is located on the checkmating square.

When the chamber door opens, the robot needs to use the two boxes kept in the chamber in order to fill in and complete the gaps encountered later.

The robot cannot enter the red carpet area until the checkmate is delivered. After checkmating, the robot is free to move through the entire arena without clashing with chess pieces.

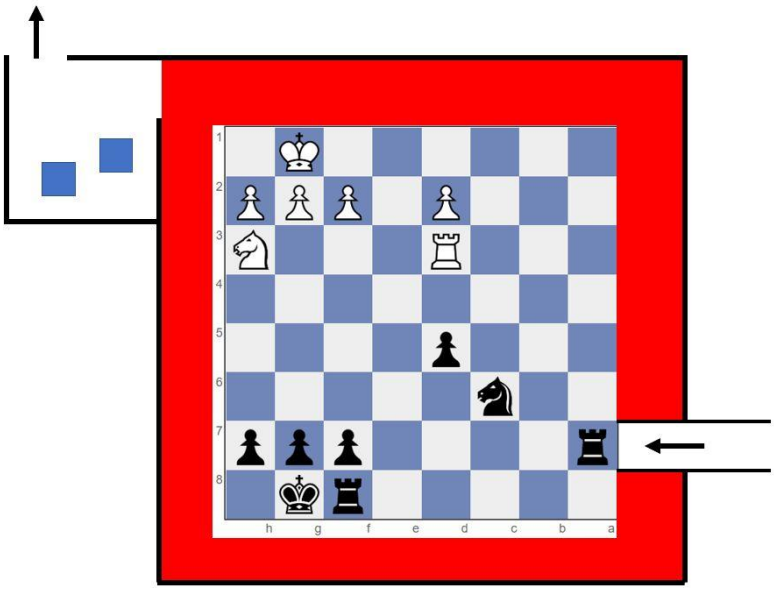

Figure 1: Layout of the chess board with a sample game instance

- **Broken bridge**

Once the robot has opened the secret chamber, it needs to carry the two roadblocks up to the bridge. The bridge will be broken in two places, having two holes on either side. The robot should place the two blocks to cover up the holes in order to pass through the bridge. Once the holes are covered, the robot will have a clear path to the destination square. To finish the task, the robot should stop inside the white destination square.

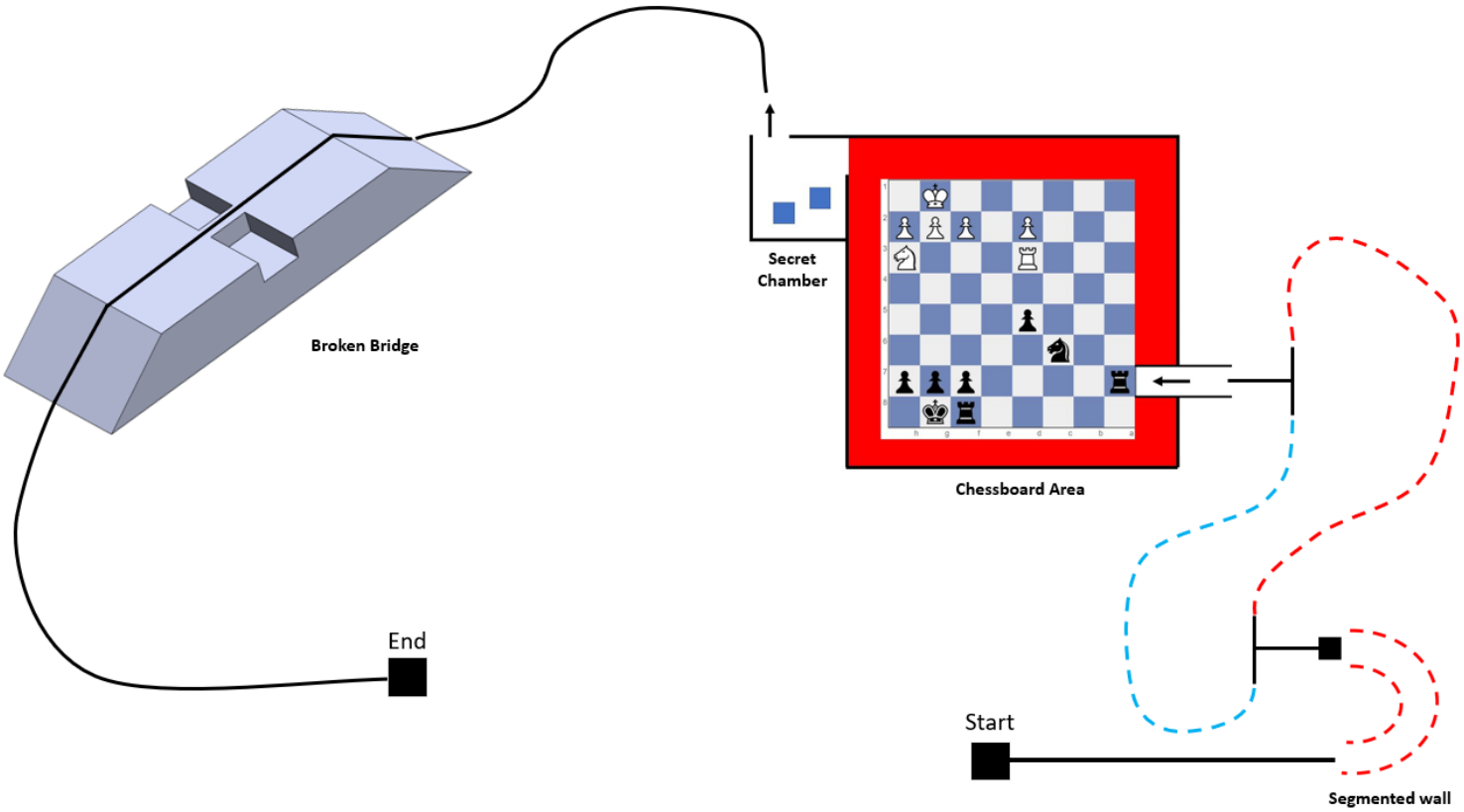

Figure 2: Sample Task Overview

Simulation Arena Specifications

- **Chess Board Area**
  - The chess board will consist of 8 x 8 black and white squares. You will be first entering a black square.
  - The size of a chess square will be 25cm x 25cm
  - The arena will be surrounded by black walls. The gap between the chess board and walls is 30cm, and the surrounding floor will be 30cm wide.
  - The secret chamber is near the h1 corner with the entrance facing parallel to the rows.
  - The exit of the arena will be located at the far end on the right wall of the chamber.

- **Chess piece specifications**
    - All the chess pieces will have standard shapes and their base will not exceed 25cm in diameter.
    - Both white and black queens will not be present in the chess position you will be given.
    - Heights of the pieces are as follows: (Actual measurements will be provided later)

King	9.5 units
Bishop	7 units
Knight	6 units
Rook	5.5 units
Pawn	5 units

- **Broken Bridge**
    - The width of the bridge will be 40cm with two holes having 11cm*15cm with shorter side parallel to the guide line and a depth of 10.5cm.
    - The two cubes will have the dimensions of 10cm*10cm*10cm

Robot specifications

- The robot should fit within 25cm * 25cm starting square.
- Wheel diameter of the robot should not exceed 5cm.

Physical task

The physical task will consist of 4 subtasks.

- Line Maze
- Curved wall
- Blind box
- Line following

Line Maze

The line maze will be handled in two stages.

1. Exploration stage

   The robot will start from the starting square (white) and it will get the opportunity to explore the maze. The exploration stage will end when the robot reaches the white checkpoint square on the opposite side of the maze. There will be no loops in the maze, and only 90-degree turns will exist.

2. Speeding stage

   The robot will have to calculate the shortest path using the data taken in the exploration stage and find its way back to the starting square from the checkpoint through the shortest path. Marks allocation for this stage will depend on how fast the robot will return to the starting square.

Curved Wall

Once the robot reaches the starting square after completing the line maze, it has to follow a curved wall to the left of the robot to reach the blind box (Figure 3). The robot should not touch or go beyond the red line while following the curved wall. If the robot crosses the red line, a penalty will be imposed. The wall will be parallel to the entry point to the maze, and the gap between the starting square of the maze and the start of the wall is less than or equal to 100mm. The entrance to the blind box is located at the end of the wall, and the robot should enter the blind box.

Blind box

Blind box will contain three openings. One is the entrance, another opening will be the wrong exit and the final opening will be the correct exit. A line will be located on the floor near the correct exit. The robot must come out of the box via the correct exit and should follow the line to reach its final destination square. If the robot hits the blind box walls, which will be evident from the motion of the blind box, a penalty will be imposed.

Line Maze Dimensions

- Starting square and ending square are 25cm x 25cm.
- The width of the line is 30mm.

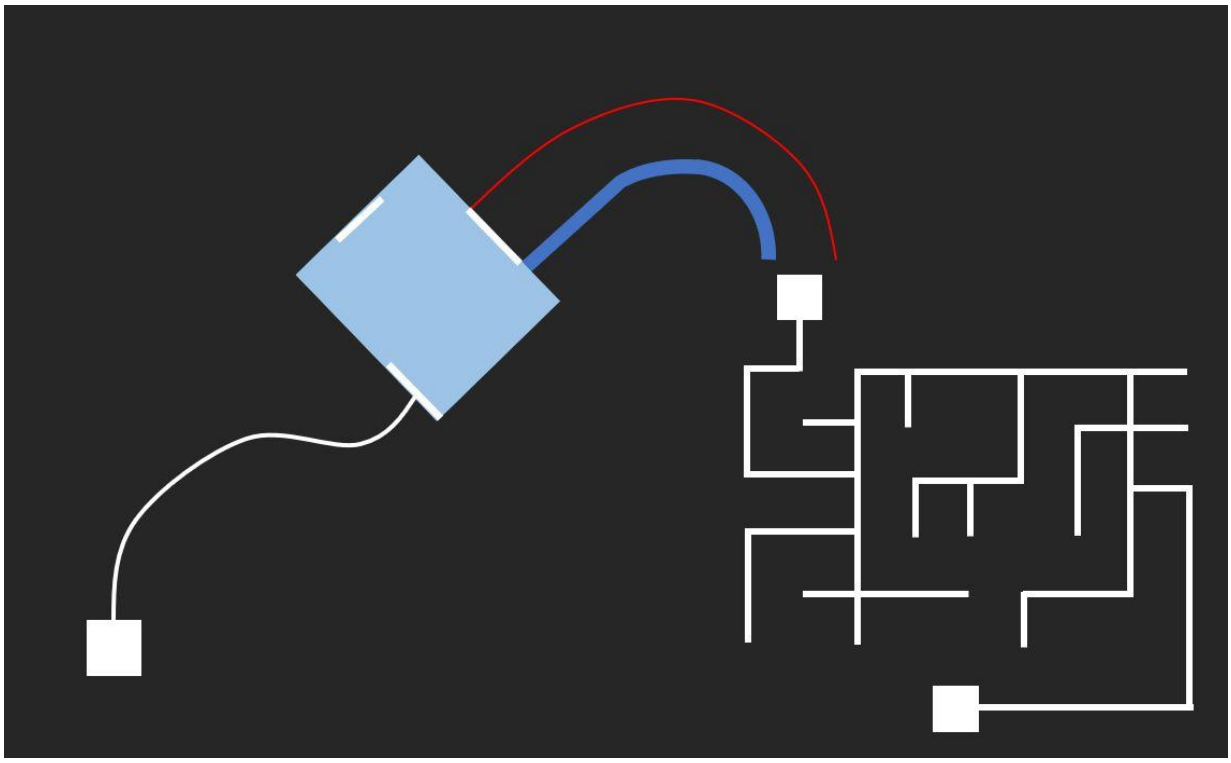

Figure 3: Sample layout of the physical task