EN2533 ROBOT DESIGN AND COMPETITION 2022

DEPARTMENT OF ELECTRONIC AND TELECOMMUNICATION ENGINEERING
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Story

Harry was a little boy. After murdering Harry's parents, James and Lily Potter, the evil Lord Voldemort puts a killing curse on Harry, then just a baby. The curse inexplicably rebounds, defeating Voldemort and searing a lightning-bolt scar in the middle of Harry's forehead. Harry is then left at the doorstep of his boring but ruthless aunt and uncle, the Dursleys.

On his 11th birthday, Harry receives a letter inviting him to study magic at the Hogwarts School of Witchcraft and Wizardry. Harry then discovers that he is not only a wizard but also a famous one. He meets two best friends at Hogwarts, Ron Weasley and Hermione Granger.

Perusing the restricted section in the library at Hogwarts, Harry discovers that the Sorcerer's Stone hidden in the highly protected chambers of Hogwarts produces the Elixir of Life, which gives its drinker the gift of immortality. In June 1992, Harry Potter, Ronald Weasley and Hermione Granger enters a challenging quest to prevent the theft of the Sorcerer's Stone by a servant of the evil Lord Voldemort.

The Chessboard Chamber was the location that held the fourth obstacle, also known as the Human Chess Game, guarding the Sorcerer's Stone in the 1991–1992 school year. The chamber resembled a giant-sized chess set, and was enchanted by Professor McGonagall, with the human-sized chess pieces being alive. The trio then proceeded to play an impressive game but which was particularly brutal even by the usual standards of Wizard's Chess; by far the most lethal player was the White Queen, who personally took out at least three of the black pieces and nearly won the game in white's favor. In the end, Ron sacrificed himself to the white Queen to allow Harry to checkmate the opposing King and win the game of chess.

After a long time, now it's your turn to enter the modern version of the challenging quest. This time, the challenges will be even harder for you and your teammates.
Good luck!!

Introduction

The task contains both simulation and physical tasks.

- **Simulation task**

For the simulation, you are expected to design a virtual robot within the 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.

- **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 (black box)** 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.

Note: There will be only one check in the given position and it will be checkmate. (you don't need to worry about multiple checks and figuring out the checkmate.)

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 but is free to move anywhere within the chessboard as long as it doesn't clash with pieces.. After checkmating, the robot is free to move through the entire arena without clashing with chess pieces.

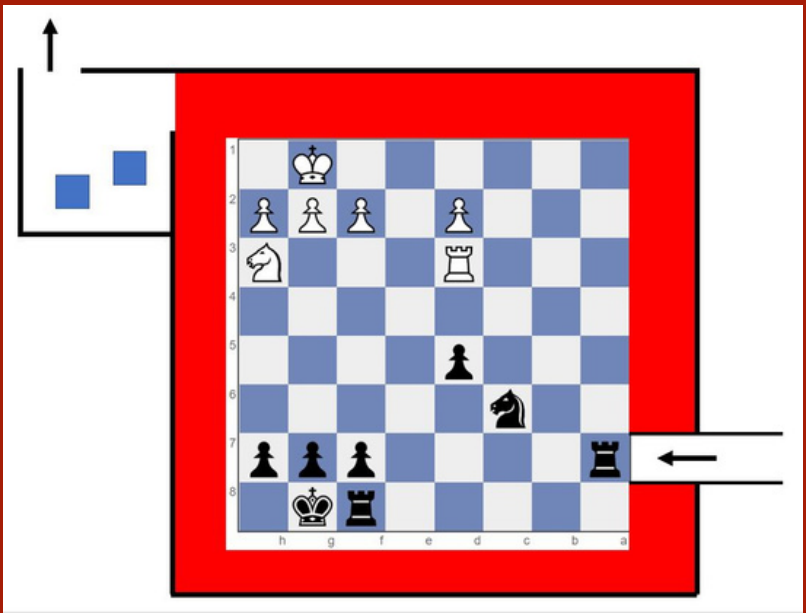


Figure 1: Layout of the chess board with a sample game instance

- **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.

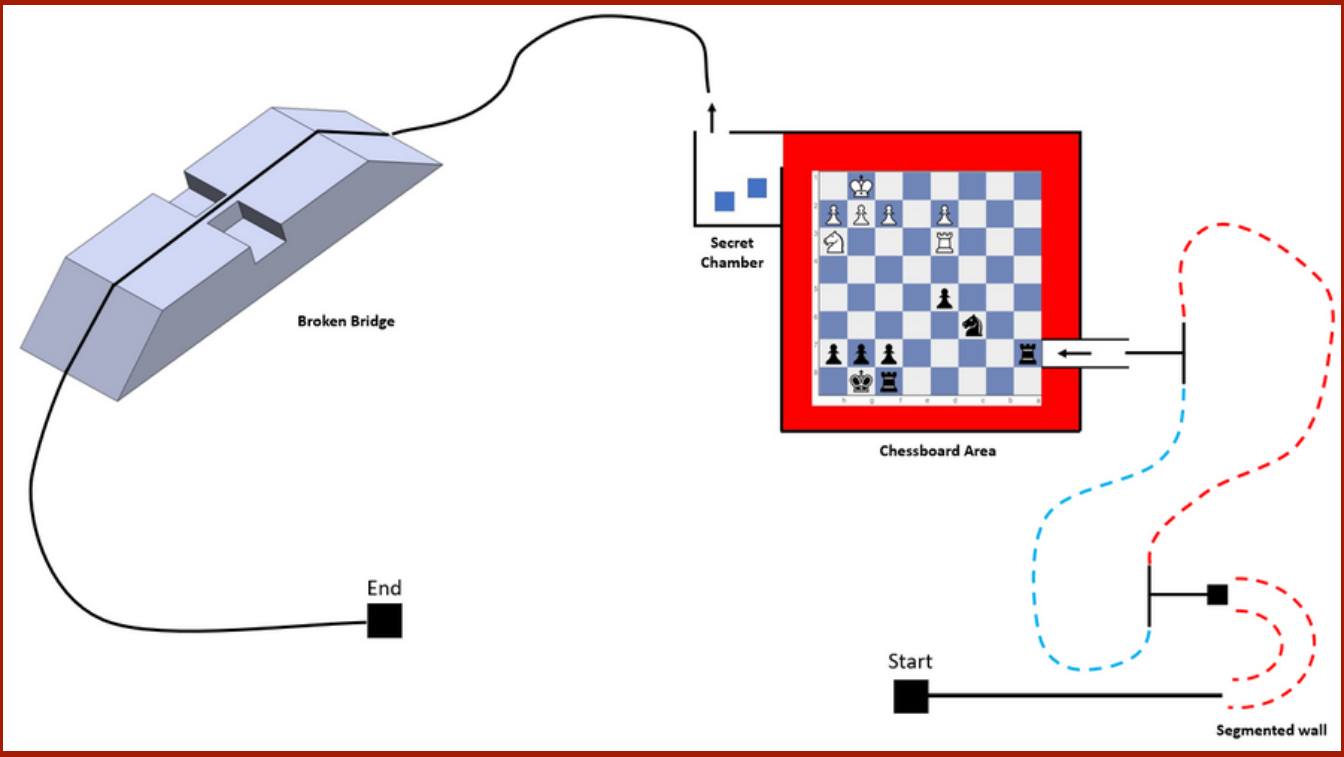


Figure 2: Sample Task Overview

Simulation Specifications

- **Normal Line and Dotted Line Specifications**
  - All line parts including on top of the bridge will be white lines on a black floor/surface
  - **Li**ne width will be 30mm.
  - The gap between two line segments of the dotted line is 30 mm - 50 mm.

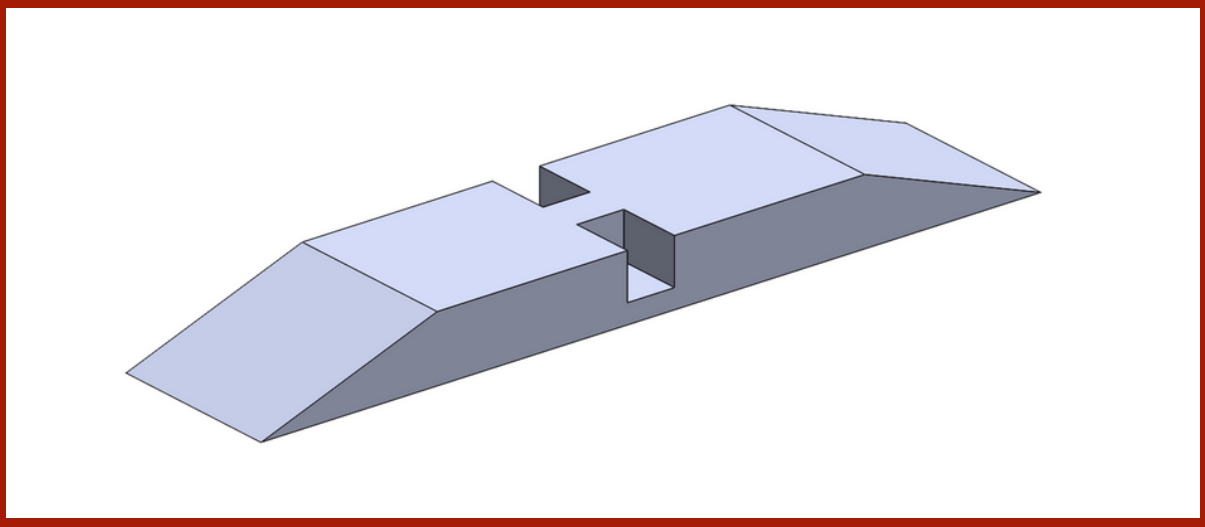
- **Segmented Wall Specifications**
  - Wall width is 10mm and height is 300mm
  - Gap between two walls is 400mm
  - Gap between two wall segments will be within 30-50mm

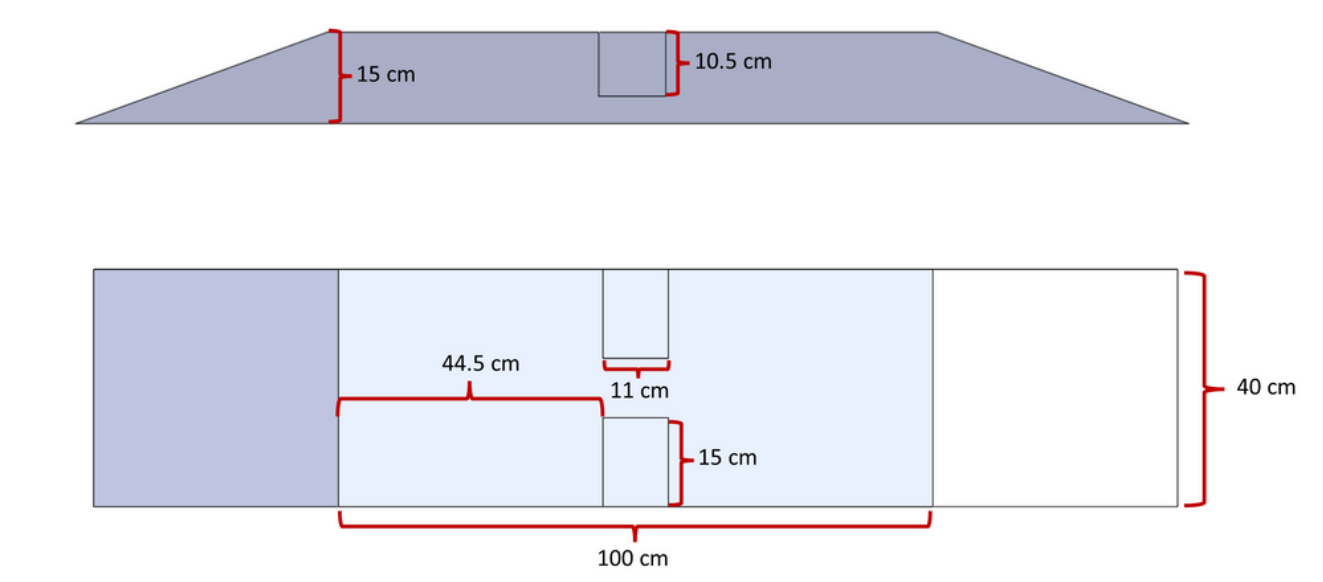
- **Chess Board Area**
  - The chess board will consist of 8 x 8 dark brown and light brown squares. You will be first entering a dark brown square.
  - The size of a chess square will be 37.5cm x 37.5cm
  - The arena will be surrounded by black walls. The gap between the chess board and walls is 40cm.
  - 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.
  - The black rook(black key) will be 10cm x 10cm x 10cm and will weigh 150g

- **Chess piece specifications**
  - All the chess pieces will have standard shapes and their bases will be 20cm 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:

King	63 cm
Bishop	50 cm
Knight	50 cm
Rook	48 cm
Pawn	40 cm

- **Broken Bridge**
  - The width of the bridge will be 40 cm with two holes having 11 cm x 15 cm with shorter side parallel to the guide line and a depth of 10.5cm.
  - The two cubes will have the dimensions of 10 cm x 10 cm x 10 cm and will weigh 150g each.
  - angle of the slope 20 degrees.
  - length of the top part will be 100 cm.





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

- **Webots Specifications**
  - Contestants should use the Webots **R2021b** version for the simulation.
  - Contestants should complete all Webots programming in C/C++ languages.
  - All sensors, actuators, and other components (e.g., batteries etc.) used in the robot should correspond to a real-world element (model number and datasheet should be available). All parameters of the simulated sensor/actuator should be configured to be very close to the real-world element.
  - For evaluation purposes the basicTimeStep field of the WorldInfo node will be set to 16ms.
  - The lighting of the arena (e.g., using Directional Light nodes) will be defined in the sample testing arena that will be provided and will not be changed during evaluation.

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.

◦ 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.

◦ 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.

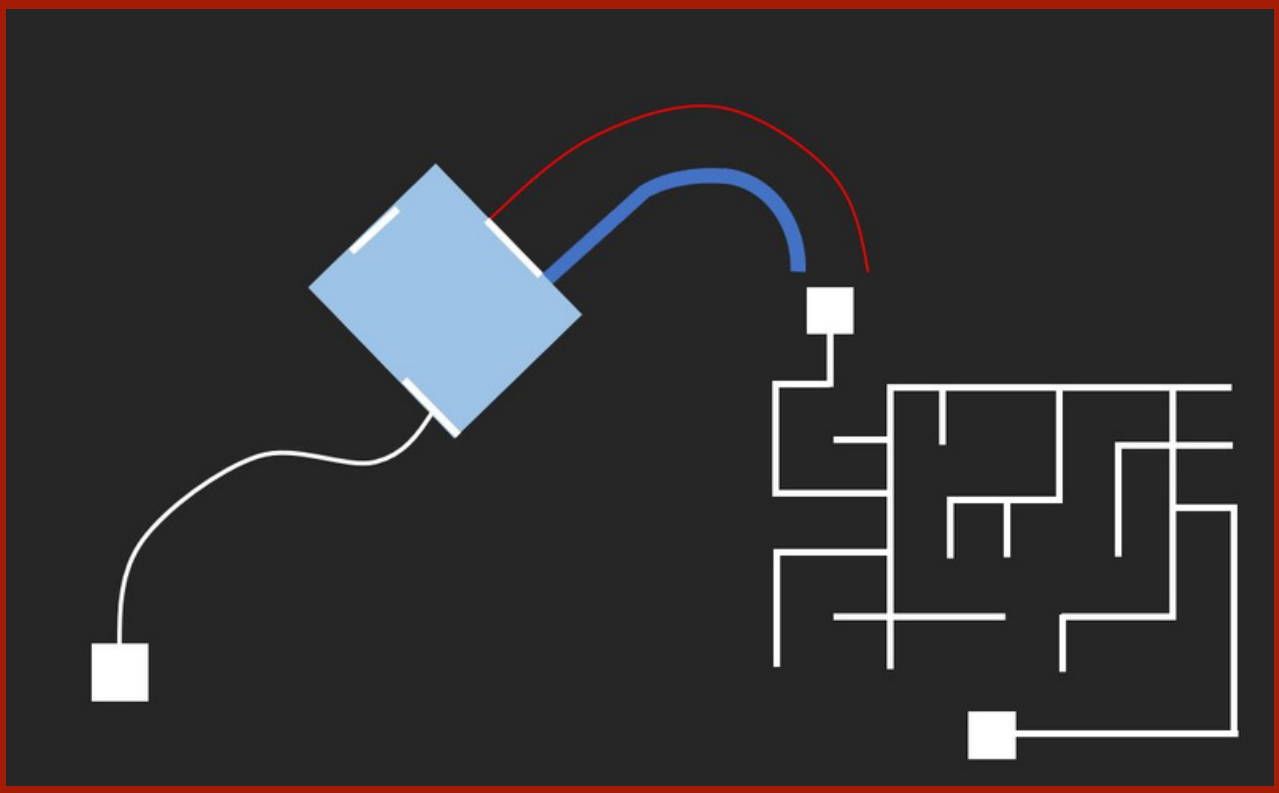


Figure 3: Sample layout of the physical task

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