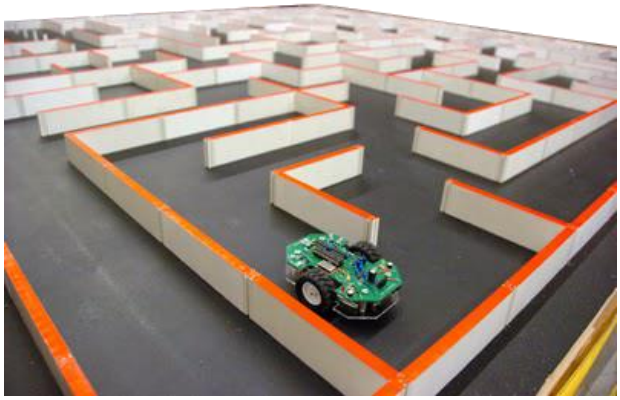
Department of Electrical Engineering
University of Moratuwa

Maze Solver Challenge Project 2025



Maze solving is an event where a small robot solves a maze. It began in the late 1970s. Events are held worldwide and are most popular in the UK, U.S., Japan, Singapore, India, and South Korea and becoming popular in subcontinent countries such as Sri Lanka. The maze is made up of a grid of cells, each 225 mm square with walls 100 mm high. The robots are completely autonomous and must find their way from a predetermined starting position to the End. The robot needs to keep track of where it is, discover walls as it explores, map out the maze, and detect when it has reached its goal. The floor is typically black-colored and at the goal, a white color floor can be found. Having reached the goal, the robot will typically perform additional searches of the maze until it has found an optimal route from the start to the finish. Once the optimal route has been found, the robot will run that route in the shortest possible time.

MAZE SOLVER

The challenge is to build a small self-contained autonomous robot to negotiate a maze in the shortest possible time. The Robot which will start on the START tile and reach the FINISH tile in the shortest time will be nominated as winner.

The Robot

Construction:

- All teams should use the motors, wheels, motor driver, microcontroller, and sensors that are given by the university. Any team that uses alternatives for the above components will be immediately disqualified.
- The chassis of the robot must be 3D printed using the facilities available in the department. The design and construction must be primarily the original work of the team.
- The robot must be controlled autonomously with no human aid.
- The robot shall not leave any part of its body behind while navigating the maze.

- The robot shall not jump over, fly over, climb, scratch, cut, burn, mark, damage, or destroy the walls of the maze.
- The controller unit should be embedded in the robot and cannot be placed outside the robot.

Dimensions: The following size limitations apply to each robot

Width – maximum 18 centimeters
Length – maximum 18 centimeters
Height – 18 centimeters

Power Source:

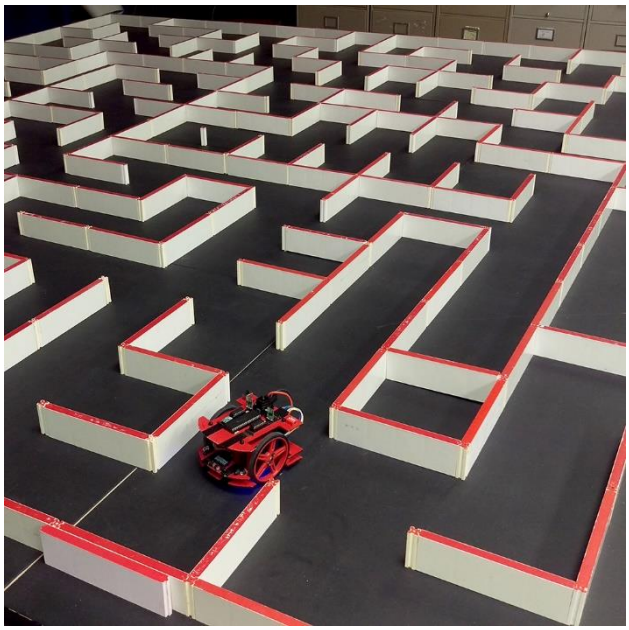
- The robot must be powered by a power source such as a battery (12V Max) fixed on the robot. The Robot cannot be powered by a stationary power source connected to the robot by a cord.

The Field (Arena)

- The COMPETITION FIELD consists of 22.5cm X 22.5cm unit square. The walls of the maze are 10 cm high and 1 cm thick (assume 5% tolerance for mazes). The maze comprises up to 16 x 16-unit squares, for a total maze size of up to 3.6*3.6m^2. The outside wall encloses the entire maze.
- The sides of the maze walls are white, and the floor is black. The maze is made of Rigi Foam. WARNING: Do not assume the walls are consistently white, or that the floor is consistently black. **Fading may occur**; Parts from different mazes may be used. Do not assume the floor provides a given amount of friction. It is simply painted plywood and may be quite slick.
- The maze floor may be constructed using multiple sheets of plywood. Therefore, there may be a seam between the two sheets on which any low-hanging parts of a robot may snag
- The start of the maze is located at one of the four corners. The start square is bounded on three sides by walls.
- The starting square orientation shall be such that when the open wall is to the “north,” outside maze walls are to the “west” and “south.”
- The start line is located between the first and second squares. That is, as the robot exits the corner square, the time starts. The destination goal is bounded on three sides and has a **white** floor.

- Multiple paths to the destination square are allowed and are to be expected. The destination square will be positioned so that a wall hugging robot will NOT be able to find it.

Note: Actual track design may vary from the one shown in the image below and is subject to change before the event commences.



Gameplay

- **Race clock**: When the robot starts from the START tile, the timer starts to count the race time. As the robot reaches the FINISH tile, the timer stops, and the recorded time value is saved.
- **Trials:** Every team will have a maximum of 3 trial runs. After the trials are over, the fastest time achieved during those trials will be chosen for the team. One trial should not last more than 5 minutes. After the trial time is over, the TIME-UP BUZZER will sound, and the team will be asked to remove the robot from the COMPETITION FIELD. If the robot is on the field halfway and operating during the TIME-UP BUZZER sound, the team will be given 1 more minute, so the robot's operation is not interrupted.
- Contestants have 20 minutes of total access time to the track. Any time used to adjust a robot between runs is included in the 20 minutes. Maximum 3 attempts are allowed for each team and the best time out of these 3 trials will be the official runtime of the robot. Each run (from the start cell to the end zone) in which a robot successfully reaches the destination square is given a run time. The minimum run time shall be the robot’s official time. The winner will be the robot with the shortest official time. The second goes to the next shortest, and so on. NOTE, again, that the 20-minute timer continues even between runs. Robots that do not find the end will be ranked by the maximum number of cells they consecutively transverse without being touched. All robots who enter the end within 20 minutes are ranked higher than those who do not

enter the end position. If no robots (or less than 3) finish their runs in under 20 minutes, the ranking will be determined by the sole discretion of the judges. Robots that do not enter the end will be ranked by the maximum number of cells they consecutively transverse without being touched. However, judges are not required to give any rankings to robots who do not finish and may declare no winners or declare less than 3 winners at their discretion.

- Each run shall be made from the starting cell. The operator may abort a run at any time. If an operator touches the robot during a run, it is deemed aborted, and the robot must be removed from the maze. If a robot has already crossed the finish line, it may be removed at any time without affecting the runtime of that run.
- Two timers are used for each contestant. One for the 20-minute total time, and a separate timer for each run within the total time.
- After the maze is disclosed, the operator shall not feed information on the maze into the robot however, **switch positions may be changed** to change programs within the robot (changing algorithms is allowed. Entering info on the maze is not allowed and does not constitute “changing algorithms.).
- Beware: Do not make any assumptions about the amount of sunlight, incandescent light, or fluorescent light that may be present at the contest site.
- The run timer will start when the front edge of the robot crosses the start line and stops when the front edge of the robot crosses the finish line. The start line is at the boundary between the starting unit square and the next unit square clockwise. The finish line is at the entrance to the destination square.
- Every time the robot leaves the start square, a new run begins. If the robot has not entered the destination square, the previous run is aborted. For example, if a robot re-enters the start square (before entering the destination square) on a run, that run is aborted, and a new run will be deemed begun, with a new time that starts when the starting square is exited.
- The robot may, after reaching the destination square, continue to navigate the maze, for as long as their total maze time allows.
- If a robot continues to navigate the maze after reaching the destination square, the time taken will not count toward any run. Of course, the 20-minute timer continues to run. When the robot next leaves the start square, a new run will start. Thus, a robot may and should make several runs without being touched by the operator. It should make its way back to the beginning to do so.
- The judges reserve the right to ask the operator for an explanation of the robot. The judges also reserve the right to stop a run, declare disqualification, or give instructions as appropriate (e.g., if the structure of the maze is broken by continuing operation of the robot).
- A contestant may not feed information on the maze to the robot. Therefore, changing ROMs or downloading programs is NOT allowed once the maze is revealed. However, contestants can:

- Change switch settings (e.g., to change algorithms (for example from left-turning to right-turning – again, entering data on maze size or content is NOT inclusive of this rule.)
- Replace batteries between runs
- Adjust sensors
- Change speed settings
- Make repairs

Scoring

- The fastest-reaching robot to the finish line, will be considered as winner. Maximum 3 trials will be given to a team. The best time out of 3 trials will be considered. No human touch is allowed once the robot activation button is pressed.

Fair Play

- Robots that cause deliberate interference with other robots or damage to the field will be disqualified
- Students that cause deliberate interference with robots or damage to the field will be disqualified.
- It is expected that all teams aim to play a fair and clean game.

All decisions about scoring, game play and timing are made by the juries. Teams should completely respect their vote and decisions. Members of the jury will be from staff members.

Components Provided by the University

Component	Description	Quantity
Microcontroller	Microcontroller board (Arduino Uno) for controlling the robot.	1
Motors	DC motors for driving the wheels of the robot.	2
Wheels	Standard wheels are compatible with the provided motors.	2
Caster Wheel	Free-spinning caster wheel for balance and support.	1
Motor Driver	H-bridge motor driver module for controlling motor speed and direction.	1
Voltage Regulator	Voltage regulator to ensure a consistent power supply to the components.	1
ultrasonic sensors	ultrasonic sensors for detecting walls and obstacles.	3
IR sensors	For detecting the finish tile	1
Wires & Connectors	Standard wires and connectors for assembling the circuit. Male set and Female set.	2
Buzzer	For producing Interactive sounds and debugging	1
Breadboard	For debugging	1
Chassis (3D printed)	The chassis must be designed and 3D printed by the team using department facilities.	N/A

- *If students require any additional equipment not listed above, they must obtain prior approval from the course instructor.*

Evaluation Criteria

1. First Inspection: Movable physical robot (10 Marks)
2. Mid Evaluation (25 Marks)

Criteria	Description	Marks
Basic Wall Following	The robot can successfully follow walls without significant errors.	10
Turning at Corners	The robot can accurately detect and execute turns at maze corners.	10
Autonomy and Stability	The robot operates autonomously without human intervention and is stable.	5
Total		25

3. Final Evaluation (65 Marks)

Criteria	Description	Marks
Maze Navigation	The robot can navigate through the maze efficiently and without errors.	20
Path Optimization	The robot can find the optimal path to the finish after multiple attempts.	10
Autonomy and Stability	The robot operates autonomously without human intervention and is stable.	10
Design & Innovation	The creativity and effectiveness of the robot's design, including 3D-printed parts.	10
Code Quality	The quality of the embedded system code and algorithms.	10
Viva	Students demonstrate an understanding of their robot's design, algorithms, and performance during a viva session. Questions will cover design decisions, programming challenges, and optimization strategies.	5
Total		65

4. Bonus Points

- Completion Bonus (+10 points): Awarded if the robot successfully finds the finish.
- Ranking Points: Awarded based on the final standings:
    - 1st Place: +35 points
    - 2nd Place: +25 points
    - 3rd Place: +15 points

Maximum attainable marks: 100 points.

Submission Requirements

Mid-Evaluation Submission (25 Marks)

1. Project Files:
   - Submit the complete Arduino project folder containing all necessary code and configuration files.
   - Ensure the code is properly structured, commented, and adheres to good coding practices.
2. Short Video (1-3 minutes):
   - Record a video demonstrating the basic functionalities of the robot, such as wall following, turning, and movement within the maze.

Final Evaluation Submission (75 Marks)

1. Project Files:
   - Submit the complete and final Arduino project folder containing all code necessary for the robot's final functionality.
   - Ensure the final version reflects any improvements made after the mid-evaluation and is fully documented.
2. Short Video (4-7 minutes):
   - Record a video demonstrating the robot solving the maze and showcasing any advanced functionalities implemented after the mid-evaluation.
   - Explain the overall design, control logic, and improvements made from the mid-evaluation.
   - The video must include footage of the robot solving the maze in its final version..

General Submission Instructions

- Only one person from each group is responsible for submitting the project.
- Platform: All submissions must be uploaded to the course LMS as a compressed zip file named as your team ID (Group_XX).
- File: The zip file should contain all the required files, including the Arduino project folder and video
- Deadline: Ensure submissions are made before the specified deadlines for both the mid and final evaluations. Late submissions will incur penalties.