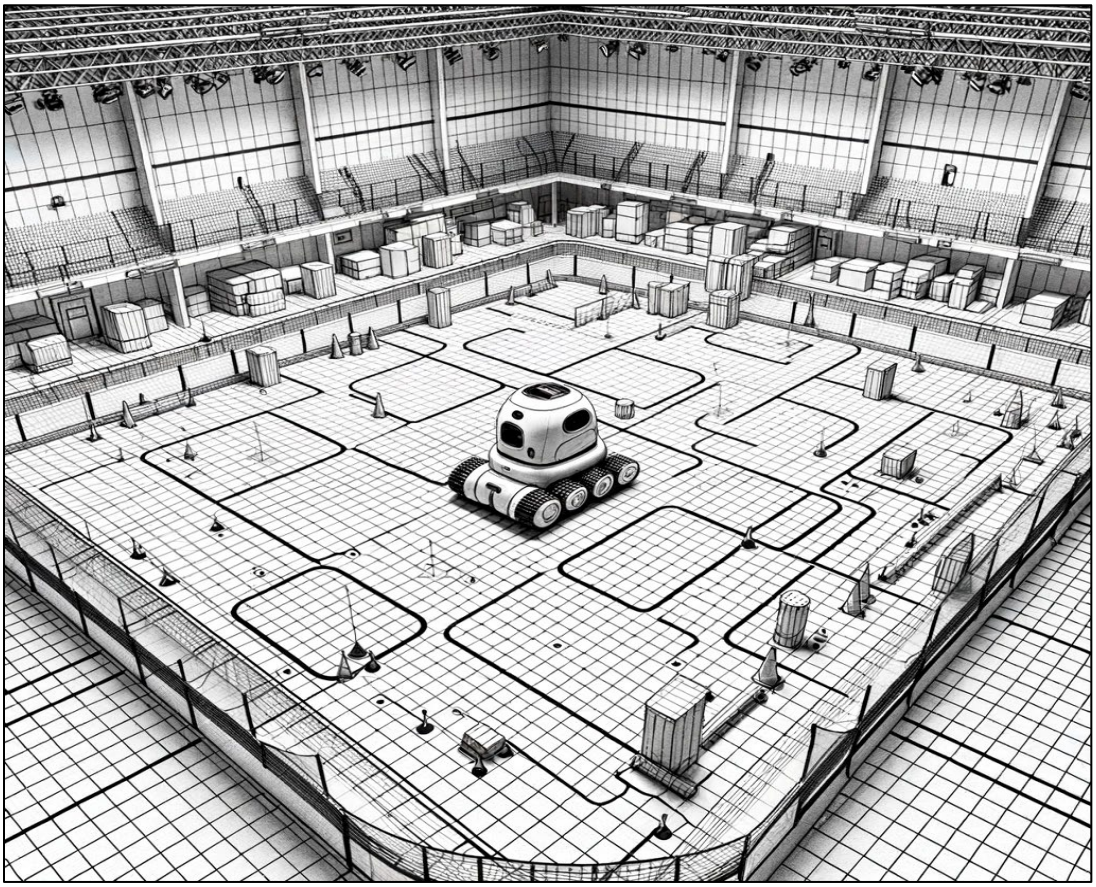
Autonomous Indoor Navigation Challenge - Obstacle Avoidance



Challenge Description: The Autonomous Indoor Navigation Challenge with a focus on Obstacle Avoidance is designed to test your skills in developing an autonomous navigation system for a mobile robot. In this challenge, your objective is to program a mobile robot to navigate through a predefined indoor environment, avoiding obstacles, and reaching a specified target location while optimizing the path taken. This task simulates real-world applications in robotics, autonomous vehicles, and smart manufacturing where robots must safely navigate complex environments.

Challenge Objectives:

1. Develop proficiency in autonomous navigation techniques, including path planning, obstacle detection, and avoidance.
2. Demonstrate the ability to handle dynamic and static obstacles effectively.
3. Implement an efficient and optimized path-finding algorithm.
4. Gain practical experience in simulating and testing autonomous navigation systems.

Challenge Details: In the Autonomous Indoor Navigation Challenge - Obstacle Avoidance, you will encounter the following components:

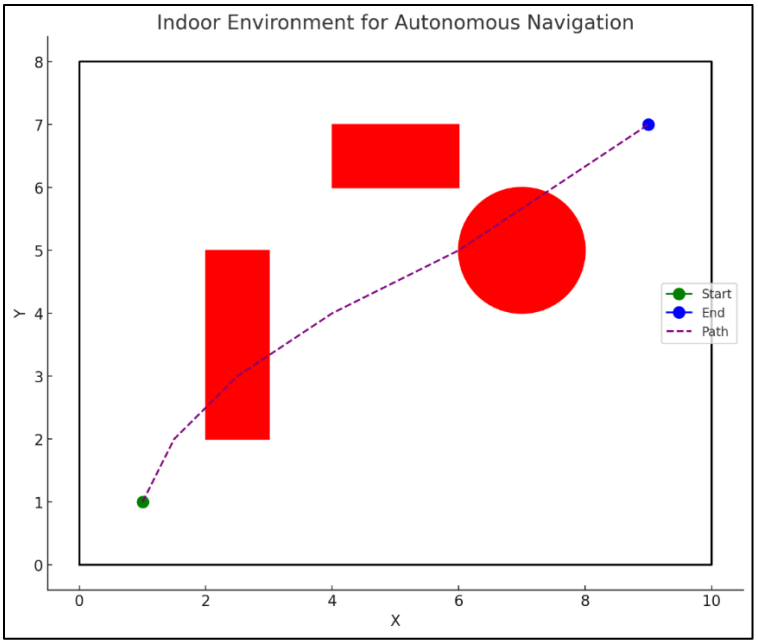
1. **Indoor Environment:** You will work within a simulated indoor environment that includes walls, obstacles (both static and dynamic), and a designated starting point and target destination.

2. **Mobile Robot:** You will program a mobile robot equipped with sensors such as ultrasonic, infrared, or lidar for obstacle detection and localization. The robot will have the capability to move in a 2D space.
3. **Control Interface:** You will have access to a control interface (under MATLAB or Python or other programming languages) or software environment (e.g., ROS or a simulation platform) to program and control the mobile robot's movements and navigation.

Challenge Tasks:

1. **Obstacle Detection (optional):** Your mobile robot should be able to detect obstacles in its path using the onboard sensors.
2. **Path Planning (required):** Develop a path planning algorithm to determine the path from the starting point to the target location while avoiding obstacles.
3. **Obstacle Avoidance (optional):** Program the robot to react to real-time sensor data to navigate around obstacles and prevent collisions.
4. **Optimal Path Execution (required):** Your robot should follow the planned path while adjusting its trajectory to avoid obstacles.
5. **Scoring:** Your performance will be evaluated based on the mobile robot's ability to complete the following tasks efficiently and accurately (**controlled by code**):
    a. **Reaching the target location:** The mobile robot must navigate to the designated target position successfully while maintaining precision. Use your own grid map.
    b. **Collision avoidance:** The robot should detect and avoid obstacles in its path, ensuring smooth and safe movement without unnecessary collisions.
    c. **Path optimization:** The robot's movement path should be optimized to minimize travel time while maintaining accuracy.

Workspace Layout: Here is a simplified illustration (just an example, use your own grid map) of the indoor environment layout for the Autonomous Indoor Navigation Challenge - Obstacle Avoidance:



1. **Starting Point:** The robot begins at the starting point (S).
2. **Obstacles:** Various static obstacles (2 or more) are placed throughout the environment.
3. **Target Location:** The target destination (T) represents the goal the robot must reach.
4. **Mobile Robot:** The mobile robot is equipped with sensors for obstacle detection and localization.

Project Deliverables: For this challenge, you will need to submit the following project deliverables:

1. **Project Code:** Provide the code that controls the robot's navigation, obstacle detection, and avoidance.
2. **Documentation (2-3 pages max):** Create a comprehensive report documenting the project's objectives, design, implementation, challenges faced, solutions developed, and results achieved.
3. **Presentation:** Prepare a presentation summarizing your project, including a demonstration of your robot's autonomous navigation and obstacle avoidance capabilities.

Grading Criteria: Your project will be evaluated based on the following criteria:

1. **Technical Depth:** The sophistication of the navigation and obstacle avoidance algorithms.
2. **Accuracy and Efficiency:** How effectively your robot navigates the environment and avoids obstacles.
3. **Optimal Path:** The efficiency of the path taken from the starting point to the target location.
4. **Innovation:** Creative solutions and approaches to obstacle avoidance.
5. **Presentation Skills:** Clarity and effectiveness of the project presentation.

6. **Project Documentation:** The quality and completeness of the project report.

The Autonomous Indoor Navigation Challenge - Obstacle Avoidance will test your ability to create a controlled navigation system that can safely and efficiently navigate its environment. It emphasizes problem-solving, creativity, and practical implementation skills essential for the field of mobile robotics and navigation systems. Good luck!