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Report-1
Autonomous Robot Waiter Simulator

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Abstract

The Autonomous Robot Waiter Simulator aims to simulate the operation of a robot designed to efficiently deliver food items to designated locations within a predefined environment. This simulation provides a platform for testing and refining algorithms that enable robots to navigate dynamic spaces while avoiding obstacles and optimizing their path to ensure timely delivery.

1 Introduction

In recent years, the demand for autonomous food delivery systems has surged, driven by the growth of online food delivery services and the need for efficient and contactless delivery solutions, particularly in urban environments. However, the development and optimization of such systems pose significant challenges, including the need for realistic and scalable simulation environments to test and refine algorithms, strategies, and hardware designs. Therefore, the problem at hand is to design and develop an Autonomous Robot Waiter Simulator (ARWS) that accurately models the operation of autonomous robots delivering food items within dynamic and complex environments, such as restaurants or urban streets.
The aim is to code and simulate a robot that takes a food item and places it at a designated location by pushing it in any of the four directions, while ensuring optimal and shortest path, along with avoiding obstacles.

2 Features

2.1 Environment

The simulator presents a dynamic environment represented by a grid or map. This environment includes various elements such as walls, tables, chairs, and other obstacles commonly found in restaurant settings. This could also be extended to an outside-world map.

2.2 Robot Characterization

The robot is characterized by its ability to move in four directions (up, down, left, right) and to push objects (food items) in the same directions. It is equipped with sensors to detect obstacles in its path and to determine its current position on the grid.

2.3 Path finding Algorithms

The simulator employs well-known path finding algorithms such as A*, DFS, IDS and BFS to calculate the shortest path from the robot's current position to the designated table while avoiding obstacles.

These algorithms consider factors such as distance, terrain, and obstacles to determine the optimal route.

2.4 Obstacle Avoidance

The robot dynamically adjusts its path to avoid collisions with obstacles. It utilizes sensor data to detect nearby obstacles and re-routes its path accordingly to ensure safe navigation.

2.5 Optimal Delivery Strategy

The simulator evaluates different delivery strategies to optimize delivery time and efficiency. It considers factors such as distance to the table, time taken and available pathways to determine the most efficient route for each delivery.

2.6 Real-time Visualization

The simulation provides a real-time visualization of the robot's movement within the environment. Users can observe the robot's path, interactions with obstacles, and delivery progress in a graphical interface.

2.7 Customizable Parameters

Users have the flexibility to customize various parameters of the simulation, including the size and layout of the environment, the number and placement of obstacles, and the starting position of the robot.

3 Applications

This system also be utilized by urban planners and logistics professionals to optimize the design and layout of urban spaces. By simulating the behavior of food delivery robots in urban environments, planners can assess the impact of infrastructure changes, traffic patterns, and pedestrian flow on delivery efficiency and safety. The insights gained from ARWS can inform urban planning decisions and contribute to the development of more sustainable and efficient urban transportation systems.