CSE366: Artificial Intelligence

Section - 03

Assignment - 01

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Submitted To:

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Objective

The objective of this project is to design and implement an advanced simulation environment for a robot navigating through a dynamically created grid. The project aims to deepen understanding of basic programming concepts, object-oriented programming (OOP), algorithms for navigation and pathfinding, task optimization, safety, and energy management strategies.

Overview

The simulation environment simulates a robot moving through a grid-based environment with obstacles, a start position, and an end position. The robot's movement is controlled by algorithms for navigation and pathfinding, with considerations for energy management, task optimization, and safety.

Detailed Requirements

1. Environment Setup

Implemented an Environment class generating a 10x10 grid.

Dynamically placed obstacles, a start position, and an end position within the grid.

2. Robot

Implemented an Agent class with movement capabilities and tracking of its current position.

Included methods to manage the robot's energy levels and battery status.

Incorporated task optimization and safety for efficient and safe navigation.

Battery Management: The robot starts with a battery level of 100%. For each move, the battery level decreases by 10%. Recharge to 100% is required if the battery level reaches 0%.

3. Simulation

Simulated the robot's movement through the grid with randomly placed obstacles.

Accounted for energy consumption and managed energy levels to complete tasks.

4. Pathfinding Algorithms

Implemented Uniform Cost Search (UCS) and A* (A Star) pathfinding algorithms.

Evaluated these algorithms based on the number of times the robot needed to recharge its battery while traversing the path to the goal.

Determined the best algorithm for this environment based on the evaluation.

5. Visualization

Utilized libraries like matplotlib to visualize the grid, obstacles, paths, and the robot's energy levels over time.

6. Task Optimization and Safety

Implemented strategies to minimize travel time, energy consumption, and ensure robots can detect and avoid potential collisions, maintaining safety.

Implementation Details

Environment Setup: The Environment class generates a grid with obstacles, start position, and end position. Obstacles are randomly placed within the grid.

Robot: The Agent class manages the robot's movement, energy levels, and battery status. Task optimization and safety strategies are incorporated into the movement algorithms.

Simulation: The simulation environment simulates the robot's movement through the grid, considering energy consumption and managing energy levels.

Pathfinding Algorithms: UCS and A* algorithms are implemented to find optimal paths from start to end positions. The algorithms are evaluated based on battery recharge requirements.

Visualization: Matplotlib is used to visualize the grid, obstacles, paths, and the robot's energy levels over time.

Task Optimization and Safety: Strategies for minimizing travel time, energy consumption, and ensuring safety are implemented to optimize the robot's navigation.

Conclusion

The implemented simulation environment provides a comprehensive platform for studying robot navigation, pathfinding algorithms, task optimization, safety, and energy management strategies. By incorporating dynamic grid generation, obstacle placement, and evaluation of pathfinding algorithms, the simulation offers insights into efficient and safe robot navigation in complex environments.