EAST WEST UNIVERSITY

Department of Computer Science and Engineering

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Assignment 01

Submitted to:

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Objective:

The objective of this project is to implement and compare two search algorithms, Uniform Cost Search (UCS) and A* Search, for a robot navigating through a grid with obstacles. The robot has a limited battery, and the goal is to find an optimal path from the starting position to the goal while efficiently managing the battery and avoiding obstacles.

Overview:

The project involves the following components:

1. **Grid Generation:**
   - A random grid is generated with obstacles, and start and goal positions are defined. The grid represents the environment in which the robot will navigate.
2. **Search Algorithms:**
   - Two search algorithms are implemented: UCS and A* Search. Both algorithms consider the limited battery of the robot and aim to find an optimal path to the goal while avoiding obstacles.
3. **Visualization:**
   - The `visualize_grid_and_path` function is used to visually represent the grid, the start and goal positions, and the path taken by the robot.
4. **Battery Management:**
   - The robot's battery level is reduced during movement, and the robot recharges when the battery level drops below a certain threshold. This simulates realistic scenarios where the robot needs to manage its energy efficiently.

Detailed Requirements:

The project involves the following detailed requirements:

1. **Grid Representation:**
   - A grid is represented as a 2D array, where 1 indicates an obstacle, and 0 indicates free space. Start and goal positions are defined, ensuring they are not obstacles.
2. **Search Algorithms:**
   - Uniform Cost Search (UCS) and A* Search are implemented as methods in the `Robot` class.
   - Both algorithms take into account the limited battery of the robot.
   - The algorithms explore the search space to find the optimal path from the start to the goal.
3. **Battery Management:**
   - The robot's battery is initialized and decreases during movement. Recharging is performed when the battery level is critically low.
4. **Visualization:**
   - The `visualize_grid_and_path` function is utilized to create a visual representation of the grid and the path taken by the robot.
5. **Output:**

- The results of each search algorithm, including the path, total count of recharges, total moves, and final battery percentage, are printed for analysis.

Implementation Detail:

1. **PriorityQueue Class:**
   - Implements a priority queue for managing nodes in the search algorithms.
   - Utilizes heapq for efficient heap-based operations.
2. **Node Class:**
   - Represents a state in the search tree.
   - Includes information about the current state, parent node, action taken, and path cost.
3. **Environment Class:**
   - Represents the environment in which the robot operates.
   - Provides methods for determining possible actions, calculating results of actions, and checking if the goal is reached.
4. **Robot Class:**
   - Manages the robot's actions, including searching algorithms and battery management.
   - Implements UCS and A* Search, as well as path reconstruction and visualization.

Conclusion:

The project successfully implements and compares two search algorithms for a robot navigating through a grid with obstacles and a limited battery. The visualization aids in understanding the robot's path and the impact of recharging on the overall journey. The project provides insights into efficient pathfinding strategies and battery management for autonomous robots in constrained environments. Further enhancements could include additional search algorithms, dynamic obstacle handling, and real-world applications.