EAST WEST UNIVERSITY

Assignment 1

Course Name: Artificial Intelligence
Course Code: CSE 366
Section - 3

Assignment Name: Enhanced Dynamic Robot Movement Simulation

Submitted By
Name: Tithi Paul
ID: 2021-2-60-057
Dept. of Computer Science & Engineering

Submitted To
Dr. Mohammad Rifat Ahmmad Rashid
Assistant Professor
Department of Computer Science and Engineering
East West University

Enhanced Dynamic Robot Movement Simulation

Introduction

To navigate a robot across a randomly generated grid environment, this assignment examines the application and comparison of two pathfinding algorithms: A* and Uniform Cost Search (UCS). A path needs to be found by the robot from a given start point to a destination point, and the grid consists of both accessible and blocked cells. The robot's ability to move is limited by its battery life, which runs out while it moves and needs to be recharged.

Implementation

- **Components:**
  - ➢ PriorityQueue: A helper class that makes it easier to store nodes in a priority queue so that the node with the highest priority (lowest cost) can be retrieved quickly.
  - ➢ Node: Indicates a state in the search space by providing details about its position, parent node, method of entry, and path cost.
  - ➢ Environment: Consists of the grid size, the grid itself, the starting and goal positions, and functions to generate a random grid and ascertain potential courses of action from a given state.
  - ➢ Agent: An agent is a representation of an entity that moves through space. It covers techniques for doing A* and UCS searches, reassembling the path from beginning to end, modeling movement along a path while taking battery limitations into account, and displaying the grid and path.
  - ➢ Heuristic Function: A simple Manhattan distance function used by the A* algorithm to estimate the cost from the current state to the goal.
- **Algorithms:**
  - ➢ A* Search: A heuristic that calculates the cost from the current node to the target is incorporated into the UCS to improve it. It prioritizes exploring paths that appear to lead closer to the goal.
  - ➢ Uniform Cost Search (UCS): A search method that makes sure the first complete path to the objective is the best one by expanding the least cost node first. It does not use a heuristic.

- **Simulation:**
  The agent is tasked with finding a path from the start to the goal in a 10x10 grid environment. The search algorithms consider the robot's battery capacity, which depletes with movement. Battery consumption, recharging, and the capacity to get to the location within the limitations are all taken into consideration by the simulation.

A* Search:

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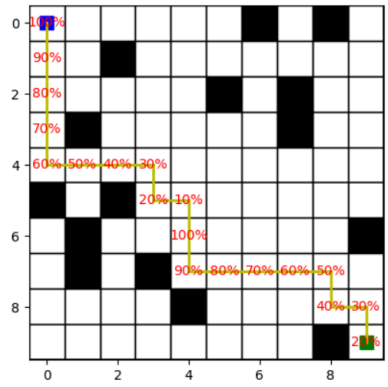
A* Path: [(0, 0), (1, 0), (2, 0), (3, 0), (4, 0), (4, 1), (4, 2), (4, 3), (5, 3), (5, 4), (6, 4), (7, 4), (7, 5), (7, 6), (7, 7), (7, 8), (8, 8), (8, 9), (9, 9)]
Cost: 18
Destination Battery Level: 20%
Recharge Times: 1
```



UCS Search:

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UCS Path: [(0, 0), (1, 0), (2, 0), (2, 1), (2, 2), (2, 3), (2, 4), (3, 4), (3, 5), (4, 5), (4, 6), (5, 6), (5, 7), (6, 7), (6, 8), (7, 8), (7, 9), (8, 9), (9, 9)]
Cost: 18
Destination Battery Level: 20%
Recharge Times: 1
```

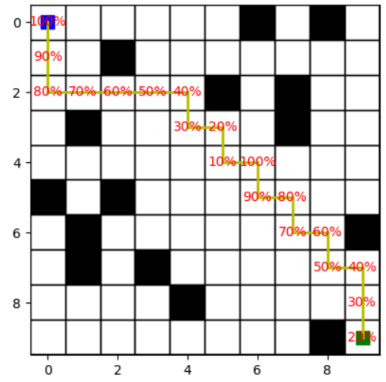

Features

- ➢ Random Grid Generation: A given size environment is created, with probabilities governing the distribution and each cell having the potential to be accessible (0) or inaccessible (1).
- ➢ Pathfinding with Battery Consideration: The robot has to find a way to reach the objective and manage its battery life, charging as needed.

- ➢ Visualization: The simulation gives an obvious visual representation of the robot's journey by including a visualization of the grid, the path taken, and particular places like the start, objective, and battery level.

Analysis

A* Search

- ➢ Heuristic-Driven: A* search utilizes a heuristic function to estimate the cost from the current node to the goal, guiding the search more directly.

- ➢ Efficiency: Generally, A* search finds a path more efficiently than UCS, as observed in shorter paths and potentially lower battery consumption, thanks to its heuristic.

UCS Search

- ➢ Uniform Cost: UCS expands nodes in order of their path cost from the start node, without considering the goal's location until it is reached.

- ➢ Applicability: While UCS is comprehensive and guarantees the shortest path in terms of steps taken, it may not be as efficient as A* in scenarios where a heuristic can provide directional guidance.

Conclusion

A* and UCS algorithms are implemented and compared in a grid-based pathfinding scenario with battery limitations. Finding routes to the objective is accomplished by both algorithms, however, A* shows efficiency advantages because of its heuristic guiding. The project demonstrates the difficulties of pathfinding in limited surroundings and the significance of choosing an algorithm according to the task's particular constraints.