Report on Assignment -1: Enhanced Dynamic Robot Movement System

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Section: 03

Course Code: CSE 366

Spring 24

Computer Science & Engineering

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Enhanced Dynamic Robot Movement System

Introduction:

The goal of this work is to describe the development and implementation of an advanced simulation environment for a robot exploring a dynamically generated grid. There are mainly two classes, environment class and agent class. Where environment class mainly representing the grid layout, possible actions and results. Grid layout consist of value 0 and 1, where 1 represents an obstacle and 0 is free space for robot to move. And the agent class basically the representation of the robot. I have used two pathfinding algorithms which are uniform cost search and A* for determining the optimal path for robot to reach the goal from the staring point. Also, this work includes the management of energy consumption, evaluation of these two algorithms by the number of times the robot needs to charge its battery while traversing the path to the goal. It is found that the A* algorithm is performing better then UCS for this environment.

Environment and Agent:

Environment class was created to build a 10x10 grid dynamically. This grid included obstacles placed at random, as well as a starting and ending position. The obstacles were strategically place with the probability of 20%. Agent class was created to simulate the robot. Robot can take 4 actions -up, down, left and right. A* and UCS algorithms are implemented for optional path finding. Which implementing these two algorithms, I have modified these algorithms and counted each step of the robot. The robot starts with a battery level of 100%. For each move from one block to another, the battery level decreases by 10%. after the battery level reaches 0%, the robot needs to be recharged 100% before continuing. I have counted each state where robot needed to be recharge while traversing to the goal for both algorithms, which helped me to find the best algorithm for this environment.

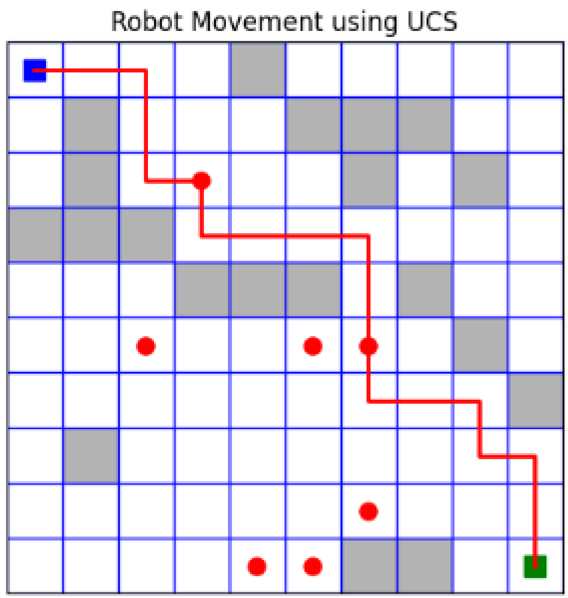
Simulation and Optimization:

The simulation accurately portrayed the robot's travel across the grid, including energy consumption and energy level management. Measurement of battery levels and recharging instances provided valuable insights into the robot's performance. Also, for optimization, I have incorporated both algorithms for finding the best one to minimize travel time and energy consumption. A* is more optimized then UCS and it is more optimal and energy efficient.

Visualization:

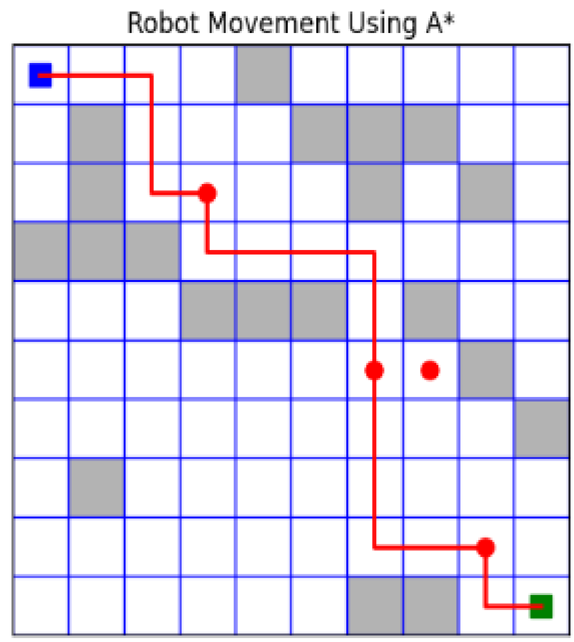
Visualization was achieved using libraries like matplotlib to depict the grid, obstacles, paths, and the robot's energy levels over time. The Visual representation is given below:

```
Robot Movement using (UCS):
```




```
Total Count of recharges (UCS): 7
Total Moves (UCS): 74
Final Battery Percentage (UCS): 80
Points where battery level became 0 (UCS):
(2, 3)
(5, 6)
(5, 5)
(8, 6)
(5, 2)
(9, 5)
(9, 4)
```

```
Robot Movement using (A*):
```




```
Total Count of recharges (A*): 4
Total Moves (A*): 44
Final Battery Percentage (A*): 70
Points where battery level became 0 (A *):
(2, 3)
(5, 6)
(5, 7)
(8, 8)
```

Here, blue square is denoting the starting position, green is denoting the goal, red circles are denoting the points where battery level became 0 and needed to be recharged again, grey color is denoting the obstacles and red line is the optimal path.

Conclusion:

From the visualization section, it is clearly identified that for robot movement A* overpowered UCS in all aspects. Therefore, in conclusion, we can say that the enhanced robot movement can be successfully achieved by both pathfinding algorithms but in term of efficiency, better energy management and time minimality, A* algorithm better compared to uniform cost search.