Smart Warehouse Design Prompt

1. Objective

Design a smart warehouse for multiple logistic robots without human operators present. The goal is to maximize the number of tasks completed within a time range per robot and to avoid collisions between robots as many as possible. Specifically, given the 2D grid layout of the warehouse, place the starting positions of robots, the goal positions of robots, the shelves, and design traffic patterns of each lane for robots within the warehouse (similar to one-way streets found in large cities). A good analogy will be designing a 2D layout of streets (empty space) and houses (shelves) so that people can drive from their houses (start position) to work (goal position) in the shortest time possible.

2. Expert Knowledge

1. The smart warehouse consists of five components: the starting positions of robots, the goal positions of robots, the robots, the shelves, and empty floor spaces.
2. The layout of the warehouse is a 2D grid map, where each grid can be the starting position of robots, the goal position of robots, a shelf, or part of the lane for robots to move.
3. The grids containing shelving cannot be occupied by a robot.
4. Any grid not containing a shelf can be occupied by at most one robot at a time.
5. Time is discretized and each robot can move exactly one cell distance per time-step.
6. Robots can only move left, right, up, or down at each time-step.
7. Diagonal movements are not allowed for robots.
8. Each robot is assigned one task to perform.
9. The starting positions of robots refer to the locations where robots start the task.
10. The goal positions of robots refer to the locations where robots end the task.
11. A task is defined as: a robot pick-up a package at a starting position, drop-off that package at a shelf, and go to the goal position; or a robot start at a start position without a package, pick-up a package at a shelf, and drop-off the package at a goal position.
12. The shelf can occupy one grid, or the shelves can form a cluster by using multiple grids.
13. The path between shelves can only have the width of one grid.
14. A shelf is “accessible” if there exists an empty space either to the left, or to the right of the shelf.
15. Empty floor space is “reachable” if there exists a sequence of bordering empty floor spaces from the floor space to the start position.
16. Empty floor space is “serviceable” if there exists a sequence of bordering empty floor spaces from the floor space to the goal position.

17. When accessing the shelves, robots do not go inside the shelves, instead they will access the shelves from an adjacent empty floor.

3. Design Specifications

1. The warehouse is a 2D grid with a size of 16x16.

2. There will be two starting positions and two goal positions. Starting positions and goal positions can only be placed in any position on the top edge, bottom edge, left edge, and right edge of the grid.

3. The shelves can be placed in any position within the grid.

4. There are 80 shelves to be placed.

5. A csv file will be given. Please label the starting position by using “S”; label the goal position by using “G”; and label the shelf by using “X”. For the empty floor spaces, please label upward traffic pattern by using “U”; label the downward traffic pattern by using “D”; label the rightward traffic pattern by using “R”; label the leftward traffic pattern by using “L”; and a grid can be empty without any label, which means a robot is allowed to go any direction.

6. Every single shelf should be “accessible”.

7. Every empty floor space should be both “reachable” and “serviceable”.

8. There must be a path from every starting position to every shelf, and from every shelf to every goal position.