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Automatic Path Finder and Controller of Robotic Arm using Multi-Neuron Heuristic Search Algorithm

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Abstract — Robotics is a highly multi-disciplinary field which attracts the attention of many researchers from diverse fields. Robotic Path Planning is one of the major problems. Robot needs to find its path for navigation purpose without collision. Multi-Neuron Heuristic Search (MNHS) which is an advanced form of A* algorithm, used in this paper. MNHS is used for Robot path planning. The motivation is to make the problem robust against the uncertainties that might arise like the sudden discovery path being followed. The MNHS has better capabilities to solve maze-like maps where the uncertainty is extremely high. Another such area is when the robot enters into a highly chaotic area. Here, it might be better to go with a path that is less chaotic or has lesser number of obstacles. We tested the algorithm for numerous test cases. In all the cases, the MNHS was able to solve the problem of path planning in well manner.

Keywords— *Robotic Path Finding; Robotics; Multi-Neuron Heuristic Search; Robotic Navigation.*

1. Introduction

Robotic Path Planning is one of the problems in the field of robotics that tries to find and optimize the path from the initial position to the final position [1]. Besides optimization, it needs to be ensured that the robot moves without any collision in the entire path, it follows from the source to the destination. The algorithm avoids all obstacles and reaches the destination starting from the source in least possible time. This is also referred to as the navigation plan of the robot. The problem is usually studied in two separate heads [2].

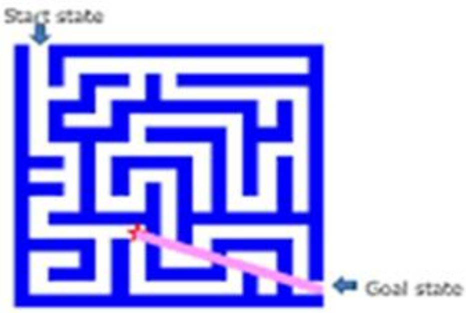

Fig. 1: Scenario of path finding

These are path planning under static environment and path planning under dynamic environment. In static environment, the condition of the robotic map is constant and does not change with respect to time due to absence of the moving obstacles. In dynamic environment, the map keeps changing with the passage of time.

2. Existing System

A* Algorithm is used in most researches for path finding and traversal. It finds efficient path between multiple nodes. It uses for finding the small 8grid path with fast tracking techniques in different environment [3].

2.1 Disadvantages of Street Light System

- Only works in simple graph, get trapped in complex graph while finding longer paths. Often longer than the standard 8-connectivity algorithms, its speed becomes slow.

2.2 Genetic Algorithm

- Genetic algorithm is normally used for the purpose of searching the optimal path in natural environment [4][5].

2.4 Disadvantage

- Genetic Algorithm is tested on environments with increasing complexity [6].
- The computational cost is also expensive.

2.5 ACO Algorithm

Ant Colony optimization (ACO) is a problem solving algorithm for the robots to find the path with the help of setting flag to check whether any error appears in the destination path, and if anything, it clears the obstacle by coding techniques [7].

2.6 Disadvantage

- The major drawback in ACO algorithm is it takes too much of time to track the destination.

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- The process of restarting is available in ACO algorithm so it takes time for reaching the goal.

3. Proposed System

In heuristic search algorithm the basic thing is that the robot can easily detect the path by calculating the total distance of multiple paths, and finding the shortest distance. The MNHS came over many algorithms to solve the difficulty of finding shortest path to reach the goal. This is the advancement of "a "star algorithm, genetic algorithm and ant colony optimization. It can also introduce many neurons for the purpose of reaching the goal successfully. The advancement techniques of A star algorithm are heuristic. The only difference is that in each iteration, we take and process "α" nodes from the open list one after the other.

3.1 Advantages of Proposed Street Light

- The robot checks the available ways from the source to destination, then it calculates each way's total distance and reach the goal.
- By this methodology the robot can easily reach the destination.

4. Methodology

We use the heuristic algorithm to make the robot to find the shortest path's distance to reach the destination.

4.1 Heuristic Algorithm

$$F(n) = h(n) + g(n)$$

Where,

F (n) is overall distance of h (n) +g (n).
h (n) is the start point of robot.
g (n) is the next shortest point of robot.

This algorithm can be taken as a betterment over the A* algorithm where the heuristic function exists, but is bound to change suddenly. The heuristic and A* approach use the heuristic function in order to get, the search closer and closer to the goal, but when it changes suddenly, the strategy is destroyed. Hence, these algorithms suffer. A solution may be not be use in heuristics at all. But if the heuristic function is available, it is always better to use it rather than not to use it.

5. Implementation

CASE 1: At first the grid was empty were the robot can reach the destination from the source easily by calculating the overall distance of the grid.

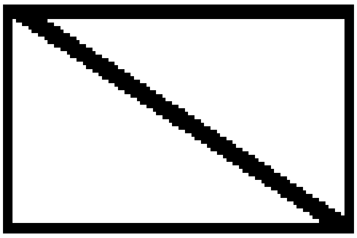

Fig. 2: No obstacle condition

CASE 2: The grid was placed with a single obstacle where the robot has to sense the wall and it calculates the destination distance with multiple values and the robot fixes with shortest path to avoid time delay.

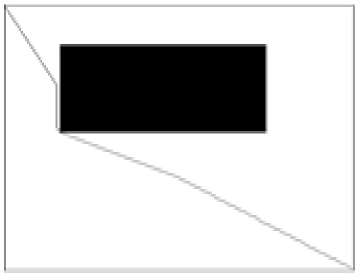

Fig. 3: Single obstacle

CASE 3: The grid was placed with a more than one obstacle where the robot has to sense the wall and it calculates the destination distance with multiple values and the robot fixes with shortest path to avoid time delay.

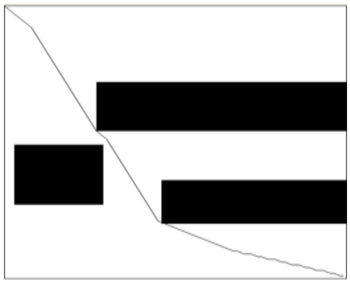

Fig. 4: Complex obstacles

FINAL STAGE: Complex obstacle with the value of alpha is 10. The grid size is 100 * 100.

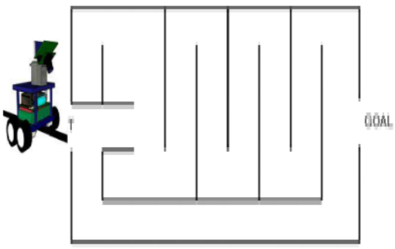

Fig. 5: Final stage with large number of obstacles

- The final stage designed with many obstacles where, the robot gets multiple optional ways to reach the goal.
- Once the robot got one way, it adds the distance value with the source value and do same procedure for other ways.
- Finally it selects the shortest paths value and March against it.

6. Result

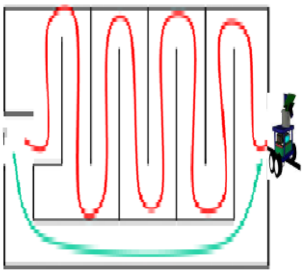

Fig. 6: Multiple destination paths

- The red line denotes first obstacle free path to reach destination.
- The green line denotes second obstacle free path to reach destination.

Finally the robot plans the path to reach the destination using heuristic algorithm, where at first the robot have got two values. From those two values the robot finds the shortest time consuming obstacle free path and travel through the direction of the destination.

6. Conclusion

In this paper, we proposed the use of MNHS to solve the problem of robotic path planning. We saw that we are able to solve the problem in almost all given scenarios well in time. The MNHS proved to be a great algorithm for the purpose. We formulate this path planning as a graph-search and Multi-Heuristic A* which is a variation of Multi-Heuristic A*. Heuristics often lead to the same concept or conjecture in several ways, along quite distinct paths. In one run, the same body of heuristics ended up defining multiplication in two different ways: as repeated addition and the Cartesian product of two sets. This paper has presented the leading algorithms for autonomous robot path planning. By using optimizations to speed up path recalculation, these algorithms have become viable for many robotic applications. In the field of robotics path planning will continue to play a major role in the behaviour and intelligence of robots and for now, optimal graph search algorithms will lead the peak.

7. Future Enhancement

The algorithm further needs to be used in practical life scenarios which are more complex than the cases presented here. Also the value of α was kept constant in the cases presented. The determination and setting of the most optimal value of α need to be studied in the future.This algorithm is suitable to use in cases where, it is necessary to quickly find a path. If the computational time is not significant and length of path is especially important then it is suitable to use Basic Theta* algorithm. The advanced heuristic algorithm can improve the time of path finding comparing to MNHS algorithm. In future, the multiple robots can perform path finding operation using MNHS algorithm without any collision with this approach. Later, the path planning can be done using coding techniques, which may consume less time compared to other algorithms.

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