# Path Planning

**INTRODUCTION** The topic of path planning has gained immense popularity due to the increasing use of mobile robots in various industries, such as industrial, service, and medical fields. Path planning is a critical research area in mobile robotics that aims to create a safe and obstacle-free route from a starting point to a destination.

# 1 Types of Algorithms

Selecting the right path planning algorithm is crucial to guaranteeing secure and efficient point-to-point movement.

## 1.1 Dijkstra's Algorithm

*Dijkstra's algorithm* is a popular and widely used graph search algorithm that finds the shortest path between a starting node and all other nodes in a graph. It guarantees finding the shortest path as long as all edge weights are non-negative.

1. Initialize: Start by setting the distance of the starting node to 0 and all other nodes to infinity (unvisited).

2. Select the node with the minimum distance: From the set of unvisited nodes, choose the node with the smallest distance as the current node.

3. Update distances: For each neighbor of the current node,if this new distance is smaller than the previously recorded distance, update the distance value.

4. Mark the current node as visited: After updating the distances, mark the current node as visited to indicate that its shortest path has been found.

5. Repeat steps 2-4: Repeat steps 2 to 4 until all nodes are visited or the destination node is reached.

6. Backtrack from the destination node to the starting node using the recorded distances to determine the shortest path.

## 1.2 A* Algorithm

The *A* algorithm* is a popular and widely used heuristic search algorithm that finds the shortest path between a starting node and a goal node in a graph. The key improvement of the *A* algorithm* over Dijkstra's algorithm is the use of heuristics, there are three parameters that are used in calculating the cost of each cell

- G cost:*Distance from starting node (top left)*
- H (heuristic)cost:*Distance from end node (top right)*
- S cost:*Total distance of G and H cost to describe the total weight of the cell grid.*

### 1.2.1 Brief steps of A* method

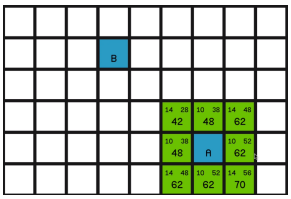


Figure 1: step1

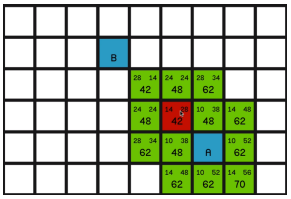


Figure 2: step2

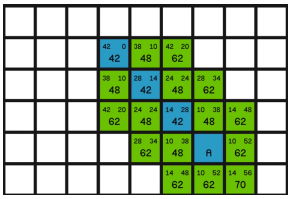


Figure 3: step3

# 2 Local and Global Planners

## 2.1 Local Planners

- local planners focus on finding a trajectory or path for the robot to follow in the immediate vicinity or for a short distance. They are responsible for handling obstacles, collisions, and other local constraints. Local planners typically use algorithms such as Rapidly-exploring Random Trees (RRT) or Potential Fields to find feasible paths.
- Local planner works only with the information it currently gets from the sensors and plans a path that is around a meter long.When the next set of information comes in it plans a new piece of the path.

## 2.2 Global Planners

- Global planners have a broader scope and consider the entire workspace or a longer distance. They take into account high-level goals, such as reaching a specific destination or performing a complex task. Global planners use algorithms like A* (A-star), and Dijkstra's algorithm to search for an optimal path or plan.
- The global planner, on the other hand, builds a map of the environment.

# 3 Practical Applications

- Autonomous Vehicles
- UAVs and UGVs

# 4 Challenges of Path Planning

**Dynamic and uncertain environments** Robot path planning becomes challenging when it comes to dynamic environments, where obstacles can change position, and new obstacles might appear.

**Sensor availability and limitations** Path planning algorithms heavily rely on sensor information to perceive the environment, However each sensor can have its limitations in terms of accuracy, range , and noise which can impact the path.

**Algorithm's Pros and Cons** One has to take into consideration the efficiency and time balance when choosing the right algorithm with robust perception for detecting the most optimal path.

# 5 Conclusion

In conclusion, path planning is a critical research area in mobile robotics that aims to create safe and obstacle-free routes for mobile robots. The selection of the appropriate path-planning algorithm is crucial for secure and efficient movement. Dijkstra's algorithm is widely used for finding the shortest path in a graph, while the A* algorithm improves upon it by incorporating heuristics. Local planners focus on short-distance trajectory planning, handling obstacles and collisions, while global planners consider the entire workspace and high-level goals. Path planning also faces challenges in dynamic and uncertain environments, as well as limitations in sensor availability and accuracy. It is important to carefully consider the pros and cons of different algorithms to achieve optimal path planning.

**A* Algorithm** https://www.youtube.com/watch?v=-L-WgKMFuhE

**Global and Local planners** https://discuss.px4.io/t/what-is-the-difference-between-local-and-global-planners/10299

**dijkstra algorithm** https://www.youtube.com/watch?v=bZkzH5x0SKU