IVDC PS

PS: Exploration and Implementation of Motion Planning Algorithms

As per the given problem statement, I went on search for algorithms on the internet. After a considerable amount of research, I have encountered upon a few algorithms which claimed themselves to most used by the autonomous vehicle developers. They are the RRT, RRT\*, PRM, A\*, Informed RRT\* and a few others.

Due to my constrained knowledge on this topic, I could only explore and understand a few of the algorithms. I have documented my understandings on 3 algorithms:

***Motion Planning Algorithms***: An algorithm is a sequence of steps that are coded into a system to perform a set of tasks. Here we are going to be discussing the motion planning algorithm, which are the algorithms that helps determine the shortest path from the start point to end point. This set of steps helps analyze the map based on inputs from camera, lidar etc., and develop a path which traverse the shortest distance avoiding all the obstacles in the way.

***RRT Algorithm***: RRT stands for Rapidly-exploring Random Tree. This is an exponentially growing path finding algorithm that can be used in complex environments in robotics and motion planning of autonomous vehicles.

**Working principle**: This algorithm samples the space around the start points and initializes few random points around the initial point. This neighboring point is called a random sample. This random node is at a certain distance from its parent node. This random sample is again taken in as a input as a node and this algorithm again ran. This process is repeated until the desired point i.e., the end point is reached. In this process the random node is chosen in such a way that it lies inside the sample space and the path joining the previous node to the newly sampled node doesn’t cross or overlap with any of the boundaries or obstacles. Once the end point is reached, the node are retraced back to the start point and this retraced path is called as the final path. This process can be repeated multiple times to get a shorter path.

**Advantages:**

* Simplicity of implementation and understanding
* Can be applied in various types of Environments
* Good for large exploration

**Disadvantages:**

* It is not very effective as it has to randomize a lot of points
* The paths may not bet the shortest or the fastest path possible

***RRT\*Algorithm:*** RRT\* stands of Rapidly-exploring Random Tree Star. This algorithm is modified version of the RRT algorithm which helps reduce the distance travelled through a path by rewiring the path after every round

**Working principle:** This algorithm has the same initializing step as the RRT algorithm. After this step involves a unique step which differentiates it from the RRT algorithm is the rewiring step. In this step the parent node checks for any other Branch node around a certain range around it that cause lower cost of mapping in the final path. If there is no node in the given range then a new node made at a fixed point in random direction at fixed distance from the parent node. This step helps verify for the shortest path possible in the motion planning process. The final result is made when a node meets the end point and this path is traced backward and highlighted. The complete path network pattern is more organized than the RRT path network.

**Advantages:**

* This algorithm helps find more optimal and cheaper paths than its parent RRT.
* The path is continuously improved after every single process

**Disadvantages:**

* This algorithm is complex hence reducing the computational efficiency of the algorithm
* It is complicated to apply in large complex environment.

***Informed RRT\*:*** This is a much more improved version of the RRT algorithm and RRT\* Algorithm. This finds the shortest path much faster and more efficiently by only going through a smaller and more probable region on the sample space

**Working principle:** First the RRT\* algorithm is run to find an optimal region of sampling for the shortest path. Once the region (the region including the start and end points along with the initial path usually an ellipse) is selected, The RRT\* algorithm is ran again in the selected region and the above mention steps are repeated until the shortest path is found. This process enables the algorithm only the sample out a small area hence reducing the amount of time taken to find the path.

**Advantages:**

* This improves the efficiency of the process of finding the shortest path
* The performance is improved by avoiding unnecessary exploration

**Disadvantages:**

* The region needs to be properly and precisely be defined else can affect the performance
* This algorithm can cause computational overload on the system

***Note:*** The PS expects me to implement one of the above-mentioned algorithms. I couldn’t implement due to the following reasons:

1. Lack of time to explore and implement code
2. Limited amount of knowledge in coding
3. Limited knowledge on above algorithms

If I am inducted into the IVDC club, I will be happy to explore, learn and implement more types of algorithms

***Reference:***

YouTube: MATLAB Channel- LINK: <https://www.youtube.com/watch?v=-fePRPyeKnc&t=390s>

Udemy Course: <https://www.udemy.com/course/an-introduction-to-sampling-based-motion-planning-algorithms/>

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