

## **AER 1516 Project Proposal-Team 7**

Jingwei Zhang, 1003326616; Rongze Ma, 1007546425; Xinlin Li, 1003151705

### **1.0 Brief Introduction of the Selected Paper**

As a sampling-based planning algorithm, Fast Marching Tree (FMT\*) is good at dealing with complicated motion planning especially in high-dimensional spaces and is also proven to be faster than the state-of-the-art for example RRT\*. In this project, we will explore different variants of the FMT\* algorithm introduced by authors and seek to further improve its performance in terms of convergence rate. To be specific, we will mainly work on one of the following two aspects which are bi-directional strategy and non-uniform sampling by using a GAN-based heuristic strategy after the research. It will be appreciated if you could provide some advice on which is potentially better to work on (or neither).

### **2.0 Proposed Extension/Improvement**

#### **2.1 Bidirectional FMT\***

The first proposal the team would like to make is related to the extension of the Fast Marching Tree algorithm, named Bi-directional Fast Marching Tree (BFMT\*). Bi-directional search is a widely used method to improve the success and convergence rates of sampling-based motion planning algorithms. And it has been proved by numerical experiments that BFMT\* tends to an optimal solution AT LEAST as fast as its counterparts. Since our paper presentation is about the Fast Marching Tree, the team wants to implement not only the FMT\* algorithm, but also BFMT\* algorithm into different R, SE(2), and SE(3), and compare the performance. In other words, the team would like to know how computational expensive FMT\* is compared to BFMT\* in the same configuration space and which one has a higher performance result.

#### **2.2 GAN-based Heuristic FMT\***

As suggested by the authors, non-uniform sampling strategies that incorporate prior knowledge of the map and the problem could potentially help to improve the convergence rate in finding the optimal path. We would therefore propose the second possible improvement by adding a generative adversarial network (GAN) [2] that generates a region-of-interest (ROI) where a feasible path probably exists to reduce search space and achieve non-uniform sampling for the FMT\* algorithm.

We will use the maps with or without the generated ROI from [2] directly and compare the algorithm performance between FMT\*[1] and GAN-based heuristic FMT\* based on initial/optimal path cost, initial/optimal time cost, and initial/optimal number of nodes.

### **Reference**

- [1] Janson L, Schmerling E, Clark A, Pavone M. Fast marching tree: A fast marching sampling-based method for optimal motion planning in many dimensions. *The International Journal of Robotics Research*. 2015;34(7):883-921.
- [2] T. Zhang, J. Wang and M. Q.-H. Meng, "Generative Adversarial Network Based Heuristics for Sampling-Based Path Planning," in *IEEE/CAA Journal of Automatica Sinica*, vol. 9, no. 1, pp. 64-74, January 2022, doi: 10.1109/JAS.2021.1004275.