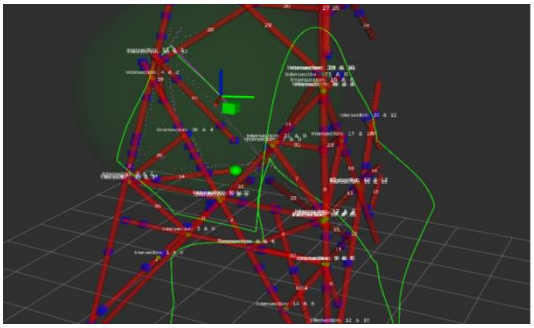
Geometry-Informed Path Planning for Steel Structure Inspection

Zhu Zhengming

Professor : Alcherio Martinoli
Assistant(s) : Lucas Wälti

In this project, I primarily implemented a frontier-based navigation algorithm based on geometric information provided by previous work. The core idea of the algorithm revolves around leveraging the processed geometric data to guide the drone in active exploration and ensure complete coverage of the steel structure.



The main concept behind this work is a frontier-based and NBV algorithm, which is divided into two key stages.

Figure 1 Pipeline of system

Here I define the endpoints of the segments constituting the structure as frontiers. The first stage involves evaluating and managing the frontiers that can be utilized by the drone, based on an information gain function that I designed. This function helps assess the potential usefulness of each frontier, and the output is a set of viewpoints with associated information gain values. These viewpoints are then passed on to the second stage-path planning.

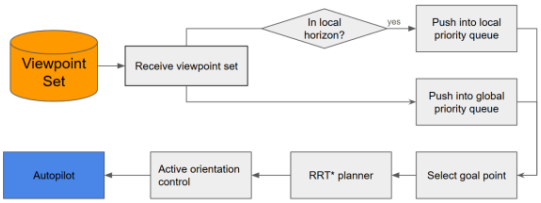


Figure 2 Pipeinle of Frontier Evaluation

In the path planning stage, I have employed a hierarchical strategy that utilized a priority queue to manage the viewpoints according to their information gain. The strategy prioritizes decision-making within the local horizon, where the drone first aims to visit all viewpoints within this local region before expanding to the global horizon. Once the local horizon is fully explored, the algorithm selects target viewpoints from the global horizon.

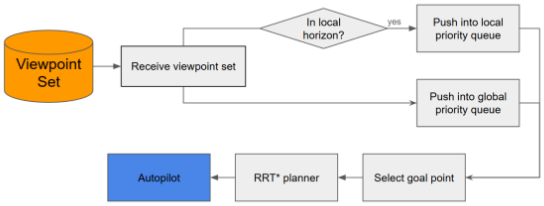


Figure 3 Pipeline of Path planning

To generate collision-free paths, I applied the RRT* planner, ensuring efficient path generation in complex environments. Additionally, to avoid losing perception of the covered steel structure, I optimized the generated trajectory by extending and interpolating additional orientation towards the weighted center axis of covered structure.

The method successfully guides the drone in its exploration task, offering a systematic approach to covering large, complex structures efficiently.