Flight path planning for infrastructure inspection based on artificial potential fields

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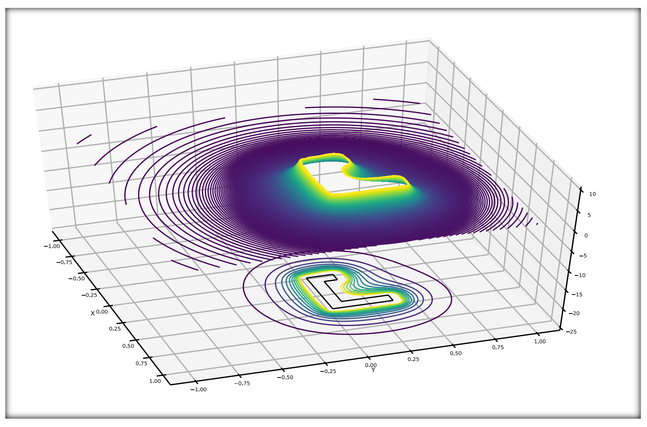
1. Introduction

Frequent inspections and surveys of infrastructure objects are essential for ensuring their safety and functionality. Autonomous robots offer a safe and reliable means of collecting this data, eliminating the need for human presence in hazardous environments.



Isolines of an artificial potential field

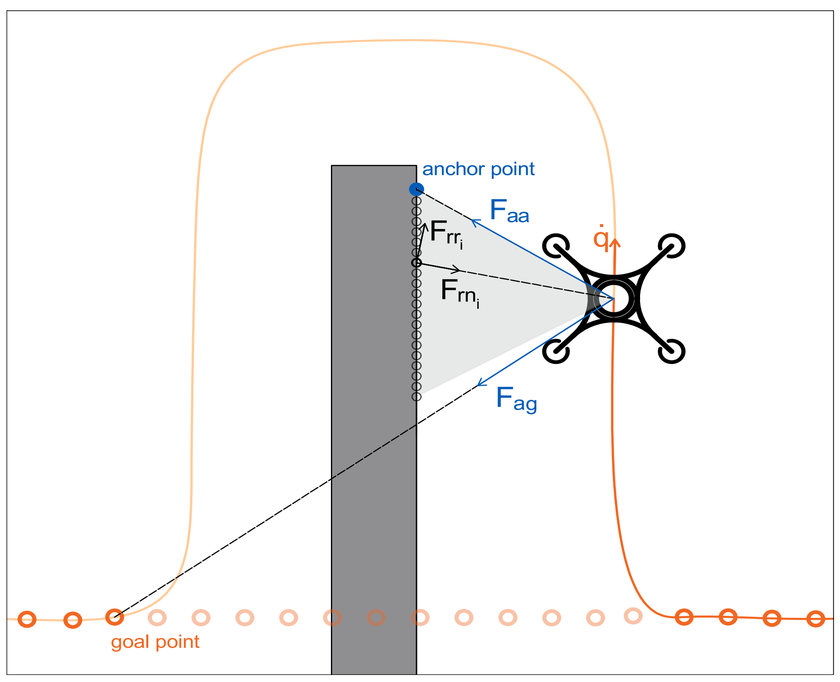
The recent advancements in unmanned aerial vehicles (UAVs) have substantially improved their autonomous capabilities, making them highly efficient at performing complex tasks.

2. Problem Description

The main goal of this research is to develop a path planning method for the UAV used for structural inspection. During the survey mission, it is not only important to reach the final target, but also to follow the planned path and visit all the viewpoints around the object to ensure high quality of the acquired data and avoid missing any area of interest. To navigate the UAV safely along the planned path in the unknown environment it is crucial to ensure collision avoidance with obstacles.

3. Methodology

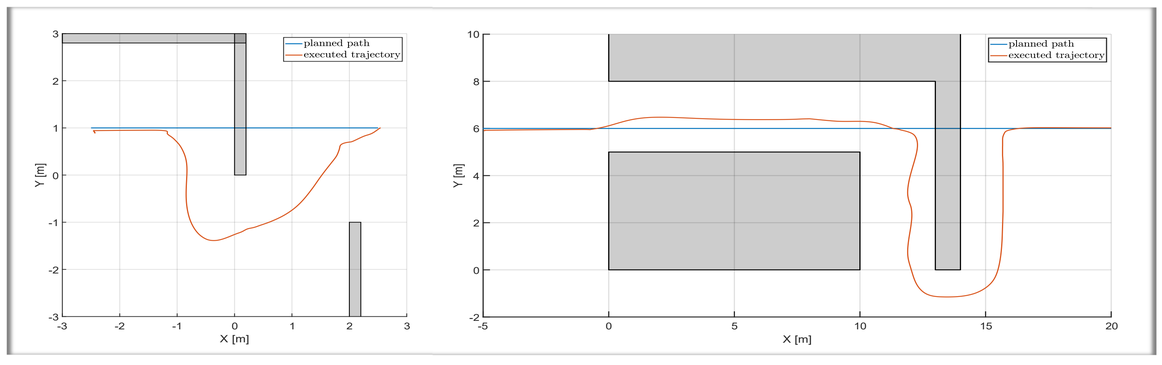
We propose utilizing the closed isolines of an artificial potential field, created by the structure, to develop a flight plan for infrastructure inspection in unknown environment. Following the closed isoline around the target, the UAV will maintain a constant distance while orbiting the structure. To ensure a collision-free path, our algorithm uses normal and rotational repulsive potential forces produced by detected obstacles, along with two attractive potential forces generated by the obstacle vertex and current goal point. The sum of these potential forces guides the UAV around obstacles, returning it to the first point on the originally planned path that is determined feasible.



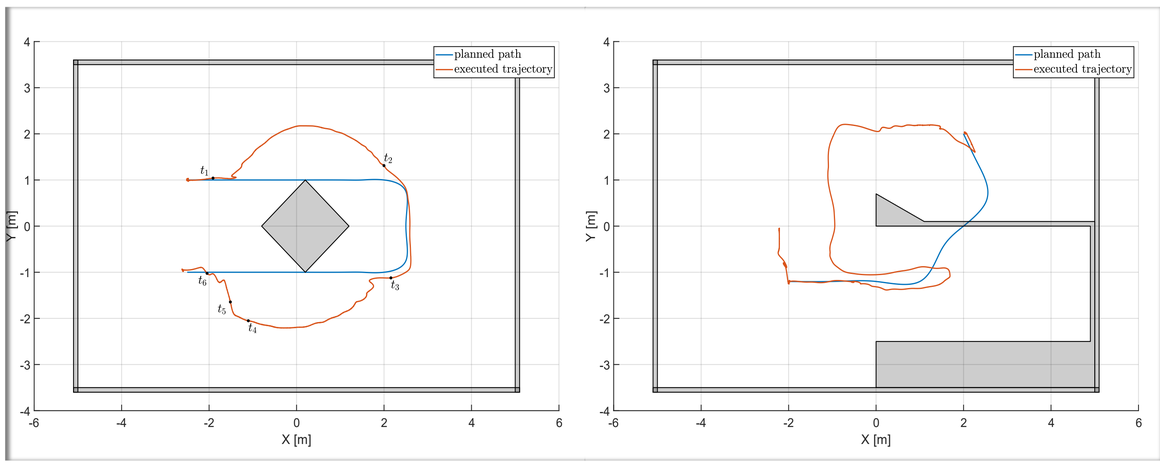
Normal and rotational repulsive (black), and goal and anchor attractive (blue) potential filed forces

4. Results

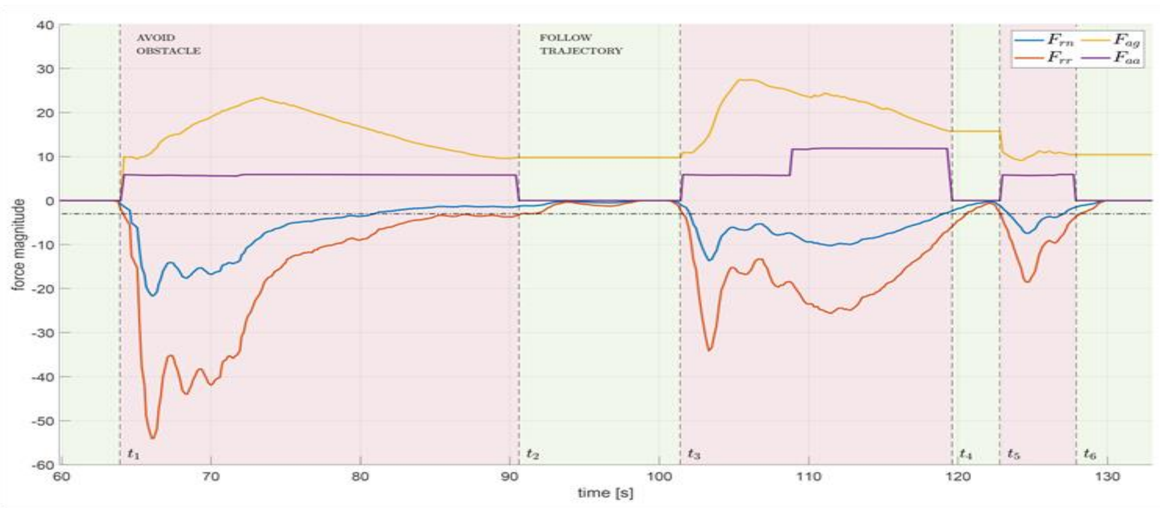
Flight path tracking method equipped with collision avoidance algorithm based on augmented artificial potential fields was evaluated through a series of simulations and experiments in different environments containing varied obstacle configurations, including walls, cylinders, narrow corridors, and concave structures.



Planned and executed trajectory in X-Y plane for the simulation with 2 walls (left) and narrow corridor (right)



Planned and executed trajectory in X-Y plane for the experiment with central (left) and concave obstacle (right)



Magnitudes of potential field forces during the experiment with central obstacle

5. Conclusion

Using an artificial potential field-based collision avoidance algorithm ensures the safe and autonomous flight of UAV, while examining the feasibility of the planned path enhances the efficiency of path tracking. In future research, we aim to incorporate isolines of the potential field for real-time path planning of inspection trajectories in an unknown environment.

Acknowledgments

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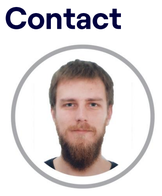
HEKTOR

Contact



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