Distributed Multi-satellite Collision Avoidance with Tunable Priority via Control Barrier Functions

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Abstract: Miniaturization and clustering exacerbate collision risk of future satellites. In this paper, we propose a distributed framework for inter-satellite collision avoidance with tunable priority. We first deduce the collision-free condition of multi-satellite systems based on High Order Control Barrier Function techniques. We then decouple such a condition for respective satellites, and further encode safety on the nominal controller in the form of distributed safety filter. By introducing priority parameter in the safety filter, the responsibility of evading collisions between satellite pairs becomes tunable, making it possible to modify the swarm behavior. Based on such a mechanism, we further showcase the safety filter's ability to cooperate with high level decisions: cooperating with optimization to approximate global optimal behavior and cooperating with Large Language Models to accommodate to tasks, respectively. Theoretical analysis have proved the safety guarantee of the safety filter and numerical Experiments validated the effectiveness of proposed method.

Keywords: Multi-satellite, Collision Avoidance, Control Barrier Function

1. INTRODUCTION

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2. PRELIMINARIES

3. PROBLEM FORMULATION

4. DISTRIBUTED SAFETY FILTER DESIGN

5. COOPERATING WITH HIGH-LEVEL DECISIONS

6. NUMERICAL EXPERIMENTS

7. CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

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REFERENCES

Able, B. (1956). Nucleic acid content of microscope. *Nature*, 135, 7–9.

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