Platooning of Unmanned Aerial Vehicles via Reachability

Abstract—

I. INTRODUCTION

Motivation:

- Applications of UAVs, potential numbeurs
- Importance of safety guarantees
- Computation complexity

Related work:

- Platooning references: lack of (?) safety guarantees
- HJI, safety guarantees, limited by dimensionality

Summary of results

- Hybrid systems model of vehicles
- Reachability guarantees wrapped around existing methods
- Reachability offers flexibility in terms of design
- Illustrative platoon functions

II. PROBLEM FORMULATION

N quadrotors in a platoon in single file

- Platoon definition: strict requirements (2s disappearance time) allow close proximity
- Functions (Define in terms of vehicle modes: Merge into platoon, follow platoon, leaving platoon.

Vehicle modes:

- Free: Vehicle that's not in a platoon; can join and follow highway
- Leader: Leader of platoon (could be by itself); can follow highway and exit platoon
- Follower: Vehicle in a platoon following; can follow platoon or exit platoon
- Faulty: Vehicle in a platoon that has gone fault: reverts to default behavior and descends after 2 seconds

How do vehicles form platoons?

How to ensure safety of the vehicles?

- during normal operation
- during faults with platoon

How can the platoon respond to intruder UAVs?

We present one way of looking at these questions.

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III. SOLUTION

A. Hamilton-Jacobi-Isaacs Reachability

B. Merging Into Platoons via Reachability

- liveness application

C. Wrapping Reachability Around Existing Controllers

- safety application

IV. ANALYSIS

Safety:

- There always exists a safety control to keep the system safe for a prescribed time horizon despite the worst case disturbances
- Pairwise safety is translated into safety among all vehicles in the platoon

V. SCENARIOS CASE STUDY

A. Normal Operation

B. Malfunctioning Vehicle in Platoon

C. Intruder Vehicle

D. Malfunction During Merging

VI. CONCLUSIONS AND FUTURE WORK