

# Safe? Platooning of Unmanned Aerial Vehicles via Reachability

*Abstract—*

## I. INTRODUCTION

Motivation:

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

Related work:

- Platooning references: lack of (?) safety guarantees
  - Mention PATH papers & Lygeros thesis
- 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 (V2V comms, 2s disappearance time) allow close proximity
- Functions: define in terms of vehicle modes: join/merge into platoon, follow platoon, leave platoon<sup>1</sup>.

Vehicle modes:

- Free: Vehicle that's not in a platoon; can enter, travel, and exit highway
- Leader: Leader of platoon (could be by itself); can travel highway and leave platoon
- Follower: Vehicle in a platoon following; can follow platoon or leave 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.

## 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 thanks to linear chain and platoon assumptions. (Main proposition?)
- Safety with respect to intruder vehicles: under what exact conditions? What can we prove?

## V. SCENARIOS CASE STUDY

A. Normal Operation

B. Malfunctioning Vehicle in Platoon

C. Intruder Vehicle

D. Malfunction During Merging

## VI. CONCLUSIONS AND FUTURE WORK

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<sup>1</sup>For clarity, try not to "overload terminology", e.g. join/follow/leave for platoon, can use enter/travel/exit for highway.