Platooning II - This is a temporary title

***Abstract*—[ref to platooning paper] proposed a formulation for platooning UAVs to make reachability analysis on UAVs in traffic infrastructures tractable. In [ref to platooning paper], the theory and scenario studies, through virtual simulation, showcase the potential of the formulation for ensuring liveness and safety guarantees on vehicles in transit. To show the efficacy of platooning on real systems we implemented the formulation on real quadrotors. Due to the curse of dimensionality, HJ reachability-based control is rarely implemented for quadrotors. In this paper we present a novel hardware implementation architecture for platooning with both real UAV's and real information patterns. We demonstrate the efficacy of our implementation by showcasing the results of running the system through three scenario studies.**

I. Introduction

** Similar to the lab's usual UTM intro, but talk about hardware **

II. Problem Formulation

** Lots of referencing of Platooning I and specifying where this paper expands on Platooning I **

A. Platooning

1) Full Quadrotor Dynamics: ** Quick section on full 12 state model of quadrotor dynamics and near-hover linearization **

2) Lower-Dimensional Vehicle Dynamics: ** The vehicle dynamics from Platooning I that are used to compute reachable sets for this implementation **

3) Platoon Structure: ** Platoon formulation and structure **

4) Liveness: ** Mention of the meaning of liveness and what behaviours it entails**

5) Safety: ** Talk about what is done by the centralized traffic flow manager **

B. UTM Hybrid System

** Walk through hybrid system and talk about both dynamics and control of hybrid system **

III. Implementation

A. Hardware Implementation

1) Hardware Environment: ** Hardware that is being used and their real world analogs **

2) Communications Infrastructure: ** The ROS communications layer and why it is structured the way it is ** [ref to wolfgang's work and maybe benoit's]

B. Reachability on real systems

** Talk about the numerical challenges and solutions of implementing reachability on real dynamical systems **

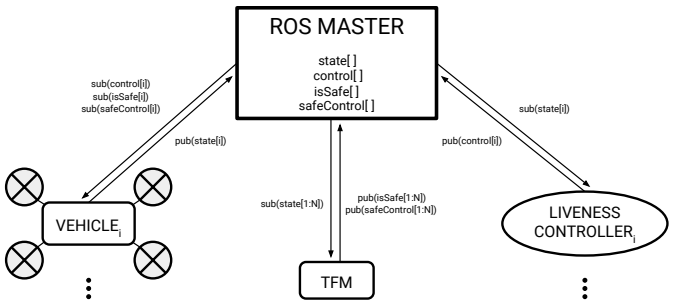


Fig. 2. ROS Network governing the platooning implementation.

C. Controller

1) LQR Framework: [ref to CDC system ID paper] ** Detail the LQR framework being used for this implementation and the time-invariant near hover K matrix being used **

2) Enforcing lower-dimensional reachability: ** How guarantees on a lower-dimensional system are being enforced in the full higher-dimensional state space of quadrotor dynamics **

IV. Case-Studies

A. Forming a platoon

** Forming three vehicle platoon **

B. Intruder on platoon

** Platoon reacting to a single intruder **

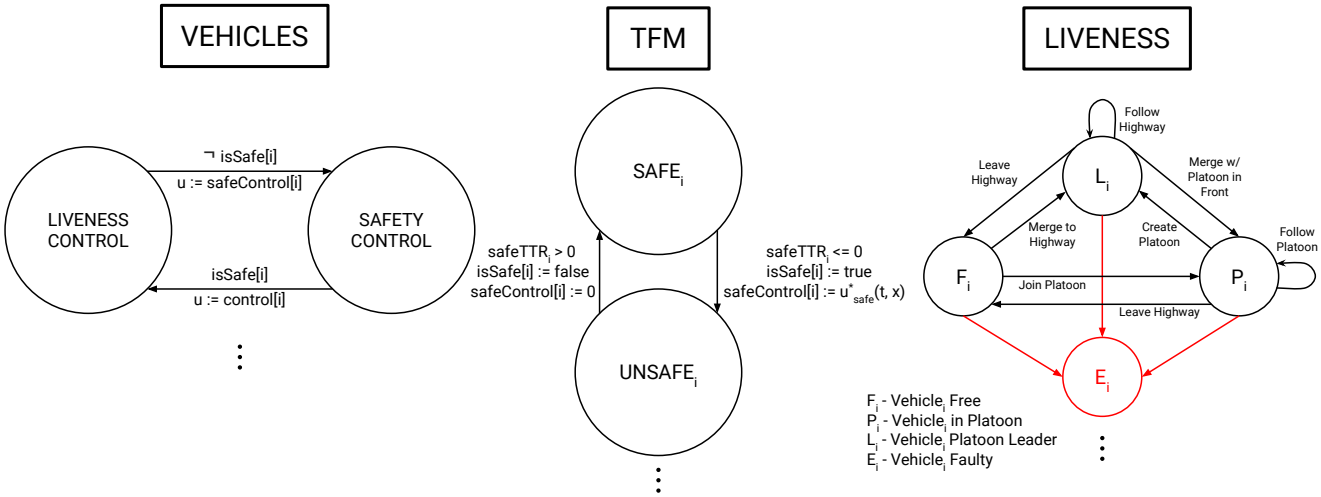
C. Changing platoons

** One vehicle leaving a three vehicle platoon to join a two-vehicle platoon to form new three vehicle platoon **

V. Conclusion

References

[1] ref to platooning I
[2] ref to cfnnet
[3] ref to wolfgang's repo



Left: Model of hybrid control of the UAVs; Center: Finite automatons managed by the third-party TFM; Right: Hybrid system that computes the liveness controls for the UAVs.

Fig. 1. Finite automaton model of the entire platooning hybrid system