ABSTRACT

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Spatial and Temporal Deconfliction of Trajectories in the Presence of Uncertainties

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Demonstration of conflict-free movement for multi-agent teams in challenging scenarios is crucial in developing trust and trustworthiness in an autonomous transport system. Tolerance verification queries are explored as a mechanism to enforce spatial and temporal deconfliction for a cooperating team of Unmanned Aerial Systems (UAS) with prescribed heterogeneous path-following performance. Obstacles in the environment are modelled as set of polyhedra, whereas each vehicle's trajectory is represented as a sequence of polynomial curves with C2 continuity, expressed in a Bernstein basis. Each vehicle is modelled as a point mass and a safety distance, informed by the geometry of the UAS and the worst-case path-following error. This defines a tube around the trajectories where each UAS is most likely to fly through. In addition, obstacles in the environment have an associated safety buffer around them to account for the uncertainty in their location and geometric description. The tolerance verification queries explored in this paper combine the safety distance information from each UAS and environmental hazard to compute trajectories that are contained within the safe configuration space. Tolerance verification is also compared with other proximity queries to determine the suitability of each method along the different steps of the trajectory generation algorithm. This paper analyzes the fitness and performance of three proximity queries – collision, tolerance verification, and distance computations – between polyhedral and polynomial curves to ensure deconfliction between obstacles and vehicles, but also between polynomial curves to guarantee safe separation among cooperating UAS.

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