Time-Critical Coordination of Multiple UAVs with Absolute Temporal Constraints*

Javier Puig-Navarro†

University of Illinois at Urbana-Champaign, Urbana, IL 61801

This presentation will give an overview of a time-critical coordination control law to support multi-vehicle missions that impose both absolute and relative temporal specifications on the trajectories of the vehicles. The proposed cooperative strategy yields robust behavior against external disturbances by allowing the vehicles to negotiate their speeds along the paths in response to information exchanged over an inter-vehicle communication network. Simulation results of a sequential auto-landing scenario will be presented to demonstrate the efficacy of the control law for group coordination.

The use of teams of autonomous, cooperating unmanned aerial vehicles (UAVs) is expected to bring unprecedented levels of flexibility, efficiency, and reliability to the execution of a variety of mission. Reconnaissance, surveillance, search and rescue and 3D terrain modeling are just a few examples of the missions that can benefit from such technology. In addition, advances in UAV capabilities are expected to impact other domains; such as air traffic management, where sense and avoid technologies have the potential to reduce the workload at control centers and provide safer management of the airspace.

Some of the mentioned missions require the UAVs to maintain a desired inter-vehicle schedule without a fixed arrival time. This type of requirements falls under the category of relative temporal constraints. However, some other missions impose absolute temporal constraints. In this case, the UAVs must not only coordinate with each other, but also arrive at their final destination at a pre-specified time or within a desired window of arrival.

The cooperative missions considered in [1] require that the fleet maintain a desired *relative timing schedule* that ensures that all vehicles execute collision-free maneuvers. Some missions, however, also impose *absolute temporal constraints* on the trajectories of the vehicles, in addition to relative temporal assignments. Representative examples are the calibration and validation of satellite instruments for remote sensing, and sequential auto-landing within desired temporal slots. The first refers to the situation in which a formation of aircraft must cooperatively fly a set of predefined trajectories at different levels within the atmosphere, while coordinating their maneuvers with an Earth-observing satellite. In the case of sequential auto-landing, a fleet of aerial vehicles must break up and arrive at the assigned glide path within a desired temporal window and separated by pre-specified safe-guarding time-intervals.

In this presentation, we will introduce an extension of the coordination algorithm in [1] (and its multi-leader version adopted in [2]) to the case of absolute temporal specifications.

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†Graduate Student, Department of Aerospace Engineering; puignav2@illinois.edu.

References

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[2] E. Xargay, "Time-critical cooperative path-following control of multiple unmanned aerial vehicles," Ph.D. dissertation, University of Illinois at Urbana-Champaign, Urbana, IL, United States, May 2013.

Biography

Javier Puig-Navarro is a PhD student in the Department of Aerospace Engineering at the University of Illinois at Urbana-Champaign (UIUC). He earned an MS in aerospace engineering from the Polytechnical University of Valencia, Spain, in 2015. During the last year of the MS program, he was an exchange student at UIUC, where he completed his MS thesis. His research interests are cooperative strategies for unmanned aerial vehicles, robust and nonlinear control and its applications to flight controls system and very flexible aircraft.