# PhD Dissertation Defense Announcement
# Mechanical & Aerospace Engineering Department
# University of Texas at Arlington

## AUTONOMOUS AERIAL VEHICLES DISTRIBUTED CONTROL & INTERACTIVE GAMES


**By**

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**Abstract**

As the number of quadrotors and other Unmanned Aerial Vehicles (UAVs) increases in industrial and urban areas, the development of reliable engineering methods to control their behavior as they interact with each other becomes of central interest in control research. With the increase in demand for UAVs to work together, several real-life challenges need to be addressed that include the implementation, test, and validation of the control algorithms in flight test experiments. On the one hand, the interests of UAVs may be in harmony to perform certain tasks such as transportation, surveillance and reconnaissance. On the other hand, the interests of UAVs may be directly opposite such as pursuing an evader UAV, and vice versa. This scenario is analyzed under category of the pursuit-evasion games in literature but constraints on the players' actions are not well considered. One of the primary requirements of autonomy is to be robust against the external disturbances, which can be achieved by designing a controller that guarantees L2 gain boundedness by a prescribed attenuation level. Unfortunately, the standard approaches to such control problems result in the sub-optimal gain solutions for guaranteed stability. In addition, when multi agent leader-follower control is considered, the mutual interests among the followers can be addressed within a well-established game theoretic framework. In particular, this can be achieved via solving an output containment problem by introducing selfish followers where each follower only considers its own utility. However, standard approaches result in coupled Riccati equations that are hard to solve. Motivated by the desire to solve these problems, this dissertation has been written.

This dissertation first proposes a backstepping-based, distributed formation control method that is stable independent of time delays in communication among multiple UAVs. The proposed non-standard backstepping technique enables designer to develop an outer position & velocity control loop that interfaces seamlessly with the inner attitude controller of the cascaded control system for UAVs. Next, by using the nonstandard backstepping structure, we present a rigorous formulation for the pursuit-evasion (PE) game when velocity constraints are imposed on agents of the game or players. The game is formulated as an infinite-horizon problem using a non-quadratic functional, then sufficient conditions are derived to prove capture in a finite-time. Then, a new formulation for the H-infinity static output-feedback (OPFB) control problem that guarantees both stability and L2 gain boundedness of a Linear Time Invariant (LTI) system is given. This formulation allows us to extend multi-agent distributed formation control to multi-agent leader-follower (MLF) output containment game where the agents of game are UAVs. Lastly, the MLF output containment game is analyzed by introducing a novel cost functional whose solution provides both Nash and distributed robust control strategies in the sense that each follower uses the state information of its own and neighbors.