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A Hybrid System Model and Overlapping Decomposition for Vehicle Flight Formation Control

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Abstract. The overlapping control design approach has recently been extended by İftar and Özgüner to cover hybrid systems. In this paper we demonstrate the utility of the approach with a new example from flight formation control. A group of Unmanned Aerial Vehicles (UAVs) are required to fly in some desired formations in some situations. However, coordination and management within a close formation flight group is still a critical issue. Because of the interconnection and interactions of subsystems in formation flight group, it is difficult to design the controllers for close formation flight. In this paper, we first introduce a hybrid system model and consider a triangle as a basic element of flight formation, so that the formation flight system is decomposed into several triangular subsystems. By applying the inclusion and extension principles from overlapping control theory, the interconnected formation flight system is expanded into several triangular subsystems that do not interconnect with each other. Upon contraction, examples show that the controllers work effectively.
Keywords. Overlapping decomposition, inclusion principle, formation control, hybrid model, UAV.

1 Introduction

Unmanned Aerial Vehicles (UAVs) are autonomous flying vehicles equipped with sensing devices and/or weapons. They can be used to carry out tasks in dangerous situations, for example, reconnaissance over hostile territories, or to attack and assess battle damage of enemy's targets. UAV is becoming a valuable resource in future military. Recently, more and more effort has been put into this area from different points of view [5-9]. One of the hot topics of interest is the coordinating control of UAVs in formation flight that a group of UAVs fly in a desired graph formation [8]. It is clear that if a group of UAVs fly in some desired formation, for example, resembling a flock of birds, they will have benefits in many cases such as drag reduction.

However, coordination and management within a close formation flight group is still under investigation. Pollini et al. described the formation flight management with graph theory approach based and focused on the situation with communication failure [7]. Koo et al. addressed the trajectory method for formation flight management [8]. Recently, Stipanović et al. presented their approach with decentralized overlapping control using static