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SATELLITE FORMATION CONTROL BASED ON EVENT-TRIGGERED OPTIMAL REGULATION OF TWO-LAYER PERFORMANCE OUTPUTS

Abstract

Satellite formation flying is known as a promising strategy to improve the reliability and performance of systems of satellites and reduce the risk. Hence, many studies on formation flying have been conducted. Design of control laws to achieve a formation is one of core research topics in this field. The previous studies on the control law design mainly focus on the achievability of a prescribed formation. However, requirements on the transient behavior are generally different depending on missions. For example, in one mission, rapid regulation of the relative distance between satellites might be important. On the other hand, entering a desirable relative orbit might be more important in another mission. In this research, we propose a method for designing formation control laws that enables us to adjust the transient behavior. The idea is that we divide the achievement of formation into two types of objectives: one is achieved by each satellite individually and the other must be achieved cooperatively. By changing the priority of these two kinds of objectives, we can adjust the transient behavior. To execute this idea, we focus on a formation of one leader satellite and two follower satellites. The leader is assumed to be in a circular orbit. The Hill-Clohessy-Wiltshire equations are employed to describe the relative motion of each follower. The target formation is a line. The individual objective is that each follower enters into a circular orbit in the Hill frame, and the cooperative objective is that two followers keep the phase difference being π. We quantify these objectives as a two-layer performance output. Then, we use the hierarchical linear quadratic optimal control, which has been developed by our group. The resulting optimal control law can be divided into two parts. One is a local control law that puts each satellite on a circular orbit. The other one involves information exchange between two followers and regulates the phase difference to π. The obtained control law surely guarantees the achievement of formation. However, it generates continuous signals and each follower always must send its information to the other follower or the leader. To solve this problem, we exploit the idea of event-triggered control. Unlike the conventional event-trigger control, we assign a two-layer trigger condition. Then, the resulting control law generates piece-wise constant signals only. In addition, the communication frequency between two followers can be reduced.