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APPLICATION OF SCHEDULING METHOD IN TIME-TRIGGERED SPACECRAFT CONTROL NETWORK WITH BANDWIDTH CONSTRAINTS

Abstract

With the rapid development of electronic technology in aerospace field, as well as the increasing complexity of the spacecraft, traditional bus can no longer meet the design requirements proposed by the novel spacecraft control system. Therefore, in this paper, a new kind of communication bus using time-triggered protocol was introduced, which brings higher reliability and less time delay. Specifically, the basic features of the time-triggered network, such as frame structure, fault-tolerant character and time synchronization, were investigated, and the feasibility of applying it in the spacecraft control system was discussed.

However, considering the channel capacity of the network is always limited, it means that only part of the system components can exchange information with the communication network, which may significantly affect the system performance. Consequently, developing an effective access mechanism that can guarantee the stability and robustness of the spacecraft control system becomes a challenging problem in network and control system integration on the spacecraft. In order to solve this, the design strategy of a control optimal communication schedule in time-triggered networked control system for spacecraft was studied here. The mathematic model of a periodic schedule was first given, and the system augmented model was then derived with the network dynamics integrated. To deal with the nonlinearity existing in the spacecraft model, the Lie-algebra was used for the approximation purpose. The next step is now to evaluate the optimality of the schedule. The cost function of the system was formulated with the discrete lifting technology, which could help get rid of the periodicity of the schedule, as different schedules will result in different cost functions. Once a cost function of the networked spacecraft control system for a given fixed communication schedule is defined, it is then possible to compare and choose the schedule that minimizes this cost with the sum-of-squares framework.

Finally, some illustrative examples were given on the preliminary design of the network topology, information transmission mode and nodes realization method with the optimal communication schedule, which provides important technical reference to the integration application of time-triggered bus technology in the aerospace field.