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ONBOARD AUTONOMOUS MANAGEMENT SYSTEM OF SPARK EARTH OBSERVATION MICROSATELLITES

Abstract

Space remote sensing has played a key role in numerous fields, such as resource exploration, and disaster prevention. Many countries have been attracted to research the Earth observation microsatellite because of its short development period and low cost. With the increasing number of satellites in-orbit, however, traditional ground management way has caused a heavy workload, and is easy to make mistakes. That makes increasingly urgent demand for the onboard autonomous management ability of satellites. As the onboard resources of microsatellites are very limited, the implementation of onboard autonomous management is especially difficult. This paper addresses an onboard autonomous management system for Earth observation microsatellites. A concurrent CAN bus architecture is designed to avoid affecting original onboard systems. As a node on the CAN bus, the autonomous management system (AMS) runs independently on a single FPGA with extra SRAMs. By transmitting, receiving, and listening, the AMS can communicate with original housekeeping system and other subsystems. For Earth observation microsatellites, the AMS focuses on the autonomous generation of command sequences of payload and data transmission missions, three-axis guidance attitude corresponding to each data transmission mission, and entry and exit ephemerides of microsatellites. The satisfaction of multiple complex constraints and low computational cost are key difficulties of onboard autonomous planning. In the AMS, a new dynamic value based heuristic planning method is proposed for the multi-area-target observation of microsatellites. After putting the candidate interval with maximum value into the optimal solution, the value of remaining candidate intervals will be changed based on heuristic rules. Additionally, a novel constraint violation checking based recursive planning method is proposed for the attitude reorientation under bounded and pointing constraints. The AMS has been successfully applied in two SPARK microsatellites launched on 22 December, 2016, which were developed by Shanghai Engineering Center for Microsatellites. Microsatellite experiment results demonstrate that under very limited onboard computing resources (32MHz processor, 2MB RAM), the AMS can autonomously achieve seven-day mission planning for Earth observation microsatellites within 30 minutes. Cooperating with the housekeeping system, the AMS can realize complete onboard autonomy of planning and continuous executing.