SPACE SYSTEMS SYMPOSIUM (D1)
System Engineering - Methods, Processes and Tools (2) (6)

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THE RESEARCH OF PARTIAL RECONFIGURATION IN SATELLITE RUN-TIME COMPUTER

Abstract

As one of the commonly used spacecraft, satellite plays an increasingly important role in communication, resource exploration and other fields. To meet the need of international competition and domestic demand, the function requirements is growing rapidly, while the satellite design is becoming more complicated. To solve this problem, partial reconfiguration, which is a new reconfigurable computing technology, emerges to satisfy the development of satellite. This paper mainly researched the application of partial reconfiguration in satellite run-time computing. Through the multiplexing of system resource, the capacity, power consumption, and cost of satellite was reduced. What's more, the resource utilization and design flexibility of satellite was improved.

First of all, the paper studied the design and method of partial reconfiguration technology, which provided the theory support for its application on satellite. Then, according to the analysis of satellite run-time computing task, the mathematical model was built, including satellite dynamic model and satellite attitude model. These two models could be realized by PD (Proportional plus Derivative) control algorithm and large angle control algorithm. Through the use of partial reconfiguration, one algorithm could be replaced by another algorithm dynamically to adapt different conditions on orbit. Thus, a complete satellite run-time computing mathematical model was built and mathematical simulation was done by MATLAB to confirm the feasibility.

Secondly, the paper constrcuted the physical system by building hardware platform and doing corresponding software development, such as: timer, ICAP (Internal Configuration Access Port), serial sending and receiving module, and the partial reconfiguration method was based on EAPR (Early Access Partial Reconfiguration). Combined with the partial reconfiguration technology, embedded system, which was the core of the physical system, was established. PD control algorithm and large angle control algorithm was designed as reconfiguration module and realized by FPGA. Then, function simulation and co-hardware simulation was done to compared with mathematical simulation.

Finally, the paper tested reconfiguration duration, satellite computing performance and resource utilization, The results indicated that satellite run-time computing system with partial reconfiguration could not only finish reconfiguration in 32ms, but also effectively control the attitude during the control period 448ms, what's more, compared to the system not using partial reconfiguration, satellite run-time computing system saved almost 50% of hardware resource.