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A DESIGN OF FEMTO-SATELLITE FOR SPACE DISTRIBUTED COLLABORATIVE MEASUREMENT

Abstract

Space distributed collaborative measurements are required in a wide range of scientific exploration tasks, such as ionospheric plasma detection and radiation measurement, in which hundreds or thousands of platforms, being able to work collaboratively through wireless network are needed. However, traditional large satellites weighing at least several hundred kilograms cannot be implemented in these tasks due to the enormous cost. Thus, small satellites are naturally demanded. Femto-Satellites, as a kind of small satellites, have very low cost, light weight, and are able to be deployed massively, which makes them have unique advantages on scenarios of space multi-point, distributed collaborative measurement.

In this paper, a femto-satellite, i.e. Star-dust, is introduced including the design of the satellite and the on-orbit experiments. Star-dust is designed on a single PCB(Printed Circuit Board) with a radio SoC(System on Chip) serving as both on-board computer and communication system, and a micro-antenna is printed on the PCB. A light weighted self-orgnized network protocal is designed for multi-point communication. The payload is a MEMS (Micro-Electromechanical Systems) sensor which can be used to measure three-axis magnetic field, three-axis acceleration, three-axis rotation speed and temperature of the PCB. Solar arrays providing sufficient power to sun light area, are mounted on both sides of the PCB. Therefore, the Star-dust has the ability to operate independently and communicate with each other through self-orgnized network. Star-dust was launched with a cluster satellite, i.e. Tiantuo 3rd in Sep. 2015, which consists of one micro-satellite of 20 kilograms, one phone-sat of 1 kilograms and four Star-dust femto-satellite of 35 grams each.

A series of experiments had been carried out including on-orbit multi-point self-orgnized network test, indirect telemetry and telecontrol of cluster satellites. The experiment results show that Star-dust worked well in space and the self-organized network worked very steadily, and the indirect telemetry and telecontrol of the femto-satellite operated normally. The Star-dust can be a good reference for the design of femto-satellite and femto-satellite based space distributed measurement systems.