SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Architectures (4)

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MULTI-AGENT BASED ONBOARD AUTONOMY OF DISTRIBUTED SPACE SYSTEMS USING SMARTPHONE TECHNOLOGY

Abstract

The smartphone is now the most widely used telecommunication product in the market. A typical smartphone has the mass of less than 200 grams, costs 200-400 Euros, and has the standby time around 400 hours. It runs on the ARM architecture processor with a mobile operating system such as Android or Windows Mobile, which makes the smartphone powerful and capable of complex tasks. For example, a high-end smartphone typically combines the functions of high-speed data access via Wi-Fi, mobile broadband, portable media players, compact digital cameras, and GPS navigation units. More important, the speed of technologies emerging allows the releases of more powerful smartphones in a monthly basis or even shorter.

On the other side, the utilization of innovative technologies in space community is relatively slow, and cannot share the ever-changing progress of terrestrial technologies. This is mainly due to the reliability considerations in space environment. In order to promote the spin-in of terrestrial technologies and reduce the complexity and costs of space systems, recently several projects have been kicked-off to test smartphones onboard cubesats.

This paper further extends the utilization of smartphone technology to distributed space systems, with a focus on the onboard autonomy of a cluster of small satellites or swarms. The paper is organized into three parts. In the first part, the requirements of distributed space systems on the computing and autonomy are analyzed, and the capability of the state-of-the-art smartphone processors and operating systems are examined against these requirements. Here, the focus is on the flight history of the ARM processors onboard cubesats or other small satellites and the suitability of developing onboard software on mobile operating systems. The second part investigates the onboard autonomy architecture of distributed space systems. Autonomy can be generally achieved by means of different technologies, and multi-agent system (MAS) technology is one particularly promising candidate. In this part, an onboard autonomous architecture with cooperative mission planning capability is grounded on MAS technology. The uniqueness of this architecture is that it is implemented on an ARM processor with the Android system. In order to realize MAS on Android, the open-source MAS development environment JADE (Java Agent Development Framework) is utilized. Finally, preliminary experimental results of implementing the onboard autonomy architecture are presented. The results from both the simulation and the hardware-in-loop test on the formation flying testbed indicate that the architecture is efficient and has great potentials.