

SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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A HIGH-PERFORMANCE IMAGE ACQUISITION AND PROCESSING SYSTEM FABRICATED
USING FPGA AND FREE SOFTWARE TECHNOLOGIES

Abstract

For space activities, it is becoming imperative to have visual capabilities. Owing to advances in space systems, spacecraft and their missions are becoming highly complex, so both telemetry and visual data are important for monitoring these systems. Visual capabilities can also be used for sensing, e.g., star sensors. Visual information is also highly educational and entertaining. Small satellites, including university satellites, are becoming more popular, and visual capabilities are important in such cases for education. Therefore, a small, low-cost space camera is needed for various applications. To enhance the possibility of using visual images in space missions, it is necessary to couple image capture technologies with image processing technologies. spacecraft housekeeping and maintenance is generally limited, image compression technologies are indispensable to transmit images for monitoring. Moreover, if we use autonomous shape recognition or motion detection using image processing technologies, a part of the monitoring process can be made autonomous and the downlink bandwidth can be used more efficiently. If we use on-orbit image processing capabilities, human monitoring of visual images can make effective sensors for spacecraft control of the image capturing device. Low-cost cameras based on COTS technologies are starting to emerge, but generally speaking, their image processing capabilities are still not up to the mark. For example, the only image compression offered by the cameras is simple, ready-made image compression that cannot be customized. Even though the cameras offer flexible image processing capabilities and the size of camera unit is very small, an additional image processing unit is required for image compression and processing. Recently, small satellites are gaining interest, and in such satellites, space is a precious resource. Small, low-cost cameras that offer image processing capabilities can dramatically increase the capabilities of these satellites. We have developed a very small, high-performance image processing unit that is based on COTS technologies. It has a 500 MIPS calculation capability in a single, 50 mm × 50 mm printed circuit board, and it incorporates various types of interfaces using a field-programmable gate array (FPGA) technology. With this image processing unit, we have developed a small, very low-cost camera for spacecraft that incorporates image processing capabilities. The camera is called the High-Performance Image Acquisition and Processing unit (HP-IMAP), and in 2010, it will be launched to monitor a deployable structure. In this article, we describe the HP-IMAP and discuss its qualification tests.