Paper ID: 23015
student

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

Author: Mr. Ryosuke Sugano
Tokyo University of Science, Japan

Dr. Tomohiro Narumi
Japan
Dr. Naohiro Uyama
Japan
Prof. Shinichi Kimura
Tokyo University of Science, Japan
Prof. Koji Wada
Japan
Dr. Kenji Nagaoka
Tohoku University, Japan
Prof.Dr. Kazuya Yoshida
Tohoku University, Japan

DEVELOPMENT OF A VERY SMALL HIGH-PERFORMANCE IMAGE ACQUISITION SYSTEM FOR ASTEROID EXPLORATION ROVER MINERVA-II2

Abstract

Hayabusa 2 is a new C-type asteroid exploration mission that is scheduled for launch with the aim of arriving at asteroid 1999-JU3. The asteroid could provide valuable information regarding the origin and evolution of the solar system as well as the development of life on Earth and elsewhere. In addition to the mission to sample and return the asteroid's surface material, Hayabusa-2 will install MINERVA-II2, a tiny hopping rover. MINERVA-II2 has the potential for wide-range exploration to acquire various data on the asteroid surface. In particular, for a detailed surface exploration on the asteroid, in-situ image acquisition is essential for a survey of the surface conditions because the shape, size, and components of the surface materials are not clear. However, the touchdown positions of Hayabusa-2 are limited. We are therefore planning an image acquisition mission to visually survey the asteroid's surface conditions. We expect to get data on the color and shape of the rock, sand, or floating dust on the asteroid surface. We have developed a very small high-performance image acquisition system for MINERVA-II2 using commercial off-the-shelf technologies. The camera only weighs 40g and is expected to be the smallest space camera. In addition, the camera is able to capture images at megapixel resolutions. However, it is difficult to predict imaging conditions precisely because the asteroid surface conditions are still ambiguous. Moreover, it is difficult to remotely operate image acquisition systems in real-time because the communication bandwidth is limited. In order to solve these problems, we need to implement robust autonomous control software for the image acquisition system to adapt to ambiguous conditions. To implement this software, we first need to determine the possible asteroid surface conditions. We designed experiments to determine the image acquisition conditions by simulating the asteroid surface environment. Based on these experiments we successfully implemented robust, autonomous control software to reliably acquire images of the asteroid surface. This paper presents the miniature image acquisition system for the asteroid exploration mission. The results of the image acquisition experiments for a simulated asteroid surface environment and the control software are also introduced.