NEW APPLICATION OF THE UNCOOLED MICROBOLOMETER ARRAY TO REMOTE SENSING FOR ASTEROIDS AND MOON

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Asteroid would provide us information about the origin and evolution of solar system. Thermo-physical properties of the uppermost surface are characterized by grain size, porosity, or packing of the surface materials. However, direct evidences of them are limited in spite of recent explorations.

Thermal infrared imager (TIR) developed for Hayabusa2 investigates thermo-physical properties of C-type near-earth asteroid called 162173 Ryugu (1999JU3) by remote sensing [1]. TIR is a thermal infrared camera with the wavelength ranging from 8 to 12 μm and the field of view corresponding to 16° x 12° [2]. The detector is based on a two-dimensional Uncooled Micro Bolometer Array (UMBA) with 328 x 248 pixels. Since the UMBA does not need to be cooled, namely it has light weight without heavy cryogenic system, it is suitable for deep space missions. When the emission from a target strikes the UMBA whose temperature is strictly controlled by the Peltier element device, electrical resistance is slightly changed; the detector measures it for image creating [3]. Image data can be converted to brightness temperature by reference tables acquired beforehand. It has been well calibrated in the laboratory from -40 to 150 °C, which covers the expected temperature of the sunlit surface of the asteroid. Generally, the the noise equivalent temperature difference (NETD) of ~2 K is required in planetary observation when target temperature is -40 °C.

The specification of TIR is exactly same as that of LIR which is the thermal infrared camera mounted to Japanese Venus climate orbiter called Akatsuki launched in 2010. It was the first attempt of the UMBA applying to space mission in Japan [4]. The meaningful outcome of LIR accounted for adopting the UMBA to Hayabusa2 mission, however, the UMBA for Akatsuki and Hayabusa2 was too old for adoping future mission and should be renewed.

In 2014, a commercial product of the UMBA named "UL04171" provided by ULIS Inc. in France has been used to new thermal infrared camera and launched with an earth observing satellite for detecting wildfire [5]. It is made of amorphous silicon for detecting wavelength of 8-14 μm with pixel size of 640 x 480 and the NETD is ~0.12 K at 300 K with F/1.0. The specification of the UMBA has kept the highest at the time of launch. In this study, a prototype of the further newest thermal infrared camera with the UMBA of ULIS has been developed for future planetary mission. Pixel arrays are increased to 1024 x 768 and spatial resolution becomes finer while maintaining FOV. Pixel size of the new detector is smaller than that of old one, while sensitivity has higher; The NETD is kept to less than ~0.1 K at 300 K with F/1.0. We have carried out fundamental function test and evaluation of specification of the configured camera in the vacuum environment. The result shows the camera satisfies our requirement for applying to the planetary mission especially for observation of asteroid and moon.

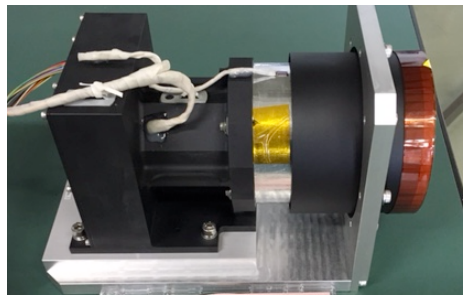

Fig.1. The uncooled microbolometr camera evaluated in this study

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