

Development of the Compact InfraRed Camera (CIRC) for earth observation

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The compact infrared camera (CIRC) is one of technology demonstration payloads of Small Demonstration-Satellite type-2 (SDS-2). The Small Demonstration Satellite (SDS) program is a series of 100kg-class small satellites to demonstrate a range of new space technologies, from elemental to system-wide. The SDS is a piggyback satellite carried by the H-IIA launch vehicle. The first satellite of the SDS series (SDS-1) has just launched on January, 2009 as a piggy back payload with IBUKI (GOSAT, Greenhouse Gases Observing Satellite).

The CIRC is an infrared camera equipped with an uncooled infrared array detector (microbolometer). Microbolometers have an advantage of not requiring cooling systems such as a mechanical cooler. Although microbolometers are less sensitive than HgCdTe-based photonic infrared detectors, the advantage of not requiring a cooling system is suitable for small satellites or resource-limited sensor systems. The main mission of the CIRC is the technology demonstration of the wildfire detection using the microbolometer. Wildfires are major and chronic disasters affecting many countries in the Asia-Pacific region, and the situation may get worse with global warming and climate change. The second purpose of the CIRC project is the low-cost and early development of the thermal infrared imager.

The CIRC's baseline specifications are as follows. The size is below 100mm x 150mm x 200mm, the mass is below 3kg, the field of view is 12degree x 9degree, the sensitive wavelength is from 8 to 12 um, the dynamic range is from 180K to 400K, and the NEdT is 0.2K at 300K. We set the baseline specifications to meet the requirements for wildfire detection. The detector has a large format (640 x 480) to obtain a wide field of view. The 640 x 480 microbolometer array is the largest format ever used in Earth observations from space.

In order to reduce the sensor size and power consumption, we employ an athermal optics which can compensate for the focal shifts caused by operating over a wide temperature range. This will be an advantage of CIRC for small satellites because we do not need active thermal control for the optics. The CIRC's detector is a SOI diode uncooled infrared focal plane array with 25um square pixels developed by Mitsubishi Electric Corporation.

The spatial resolution is an important factor for wildfire detection. The spatial resolution of CIRC is 200m from an altitude of 600km (SDS orbit). We made simulated images with spatial resolutions of 180m and 270m from the original ASTER/TIR image (Advanced Spaceborne Thermal Emission and Reflection Radiometer/Thermal Infrared) in order to investigate the dependence of wildfire detectability on the spatial resolution. We find that 200m spatial resolution is adequate for wildfire detection. We consider the other CIRC missions to demonstrate the possibility of microbolometeres as a thermal infrared imager for other observation targets. For example, volcanoes and heat island phenomina in a city.

In this presentation, we show the details of the development status and observation feasibility of the CIRC.