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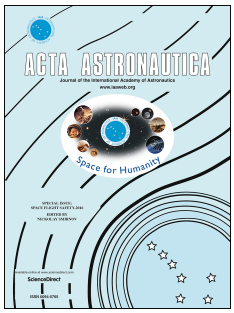

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Design and Implementation of a Cube Satellite Mission for Antarctic Glacier and Sea Ice Observation

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Abstract

The research for global climate changes calls for high quality satellite data and imageries regarding the Polar Regions. In recent years, the immerging Earth-Observation micro/nano satellite technology provides new data source for polar region observations. The STU-2A, also named TW-1A, is such a nano satellite designed for polar region observation activities. It is a 3U CubeSat of 2.9kg with a size of 30x10x10 cm carrying an Earth observation camera, launched into a Sun Synchronous Orbit (SSO) at 481km with an inclination of 97.3 degree, on September 25, 2015. During the Antarctic summer of 2015/16, it has acquired visible-light true color images with a resolution of 94m, covering different sea and coastal regions including Amundsen Sea, Ross Sea and Vincennes Bay. These images were used to analyze the change of glacier and sea ice, compared and calibrated with reference to the publically available MODIS images with a resolution of 250m.. As the camera was specially designed for the Polar regions which have an environment of low solar elevation angle and high surface reflectance, it eliminates the oversaturation problem of the MODIS sensors and can provide high quality images. Based on data analysis and assessment, it is confirmed that this satellite data can meet the demand of glacier and sea ice observation. This paper presents the Cubesat system design and configuration, the payload camera design, and its application in Antarctic glacier and sea ice observation.

Keywords: Nano Satellite, CubeSat, Antarctic Observation, Glacier Observation

1. Introduction

Antarctic glaciers and sea ice status have important impacts in the global climate change. Detailed and comprehensive observation to the glaciers and sea ice is one of the most important prerequisite of the Antarctic and global change research. Nowadays, lots of observation methods are used in Antarctica, where most of them could be divided into two kinds: in situ observation and remote sensing observation. In situ observation is a traditional way to measure the glaciers and sea ice with higher accuracy. However the harsh and remote climate of the polar regions limits the scope of in-situ observation in a smaller region around the very few observation stations. Thus the satellite remote sensing methods are widely used for the global change research, which provide more comprehensive observation with a coverage over large scaled elements.

From the year 1972, lots of polar orbit earth observation satellites were launched and most of them could give high quality images covering Antarctic regions. The resolutions of the satellites are in variety from several kilometer to less than 1 meter and the revisit period are from 1 days to tens of days. Among them, the most widely used data are from the terra and aqua MODIS[1], the Landsat series, SPOT series and the worldview series.

With satellite remote observation over Antarctic region, there are still some aspects calling for improvements or better solutions. Most of the satellites cost thousands of million dollars and their payloads are not specially designed for the polar region tasks so that there would be some errors and imperfect in observing Antarctic region. Their resolution and the revisit period could not reach a perfect combination to meet the needs. Some satellites could observe one certain region 1 time per day, like MODIS, but they could only give images in a medium resolution. Some satellites could give high resolution images, but they can't observe the concerned area every day. Antarctic region has a very strong reflection in day time, which causes very often saturation in the optical camera of many remote sensing satellites, thus limiting their application for Antarctic observation. A dedicated design for Antarctic