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MEASUREMENT AND ANALYSIS OF THE SOLAR ARRAY PANEL'S DYNAMIC DISPLACEMENT CAUSED BY THERMAL SNAP USING AN ON-BOARD MONITOR CAMERA

Abstract

Degradation of the attitude stability of low Earth orbiting satellites at the beginning and the end of the eclipse was known for years. Cause of the degradation is believed to be dynamic deformation of the solar array panels caused by the thermal shock. When the satellites go through the eclipse, their solar array panels are cooled down rapidly and after the eclipse rapid heating occurs. These rapid thermal changes produce temperature differences between both sides of the solar array panels and produce unequal thermal expansion and shrink of the solar array panels. These thermal expansion and shrink produce vibration or deformation of the solar array panels and result the degradation of the satellite attitude stability. These phenomena are called the "thermal snap". However these phenomena are rarely measured in orbit since the motions of the solar array panels caused by the thermal snap are very slow and are difficult to measure by sensors such as accelerometers. It is also difficult to observe the motion by a camera since lighting conditions for monitor camera are not good to take images of the solar array panels. JAXA is measuring thermal snap of the solar array panels using CMOS camera mounted on the Greenhouse gases Observing Satellite (GOSAT) that was launched in 2009. The camera is mounted on the satellite main body. The deformation will be measured using images taken by the on-board camera. The measurement is made by obtaining spatial orientation of the edge of the solar paddles. In order to make it easy to identify the edge of the solar paddle, visual markers are attached at the end of the solar paddles. Images taken by the camera are sent to the ground. When the satellite enters the eclipse, the measurement of thermal snap is conducted. Images are taken several times with changing the camera's exposure because the lighting environment varies during the measurement. 2 types of algorithms for obtaining the markers' position are used according to the lighting environment. Then, thermal-structural analysis of the solar array paddle is conducted using the measurement result. In the analysis, effects of thermal shock and solar radiation pressure on thermal snap are evaluated. Thermal shock is used as thermal input of the analysis and estimated from transit time of penumbra. Solar radiation pressure can be obtained from attitude of the satellite. Detailed results will be reported in the final paper and at the conference.