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SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Design and Technology for Nano-Sats and Cube-Sats (6B)

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MISSION DESIGN FOR PICO-SATELLITE "SPACE TETHERED AUTONOMOUS ROBOTIC SATELLITE II"

Abstract

Kagawa University develops a pico-satellite for the purpose of technical verification and evaluation of Tethered Space Robot (TSR). Also, tether extension technology for a small satellite has to be developed in order to perform a mission for TSR. TSR is a new type of space system proposed in 1995. We envision the tethered subsatellite to be a multi-body system. The major advantage of the multi-body nature of the subsatellite is that its attitude can be controlled under tether tension by its own link motion. TSR can become a small robot because of small energy consumption.

The first satellite in Kagawa University is "KUKAI" which was launched by the H-IIA rocket by the Japan Aerospace Exploration Agency (JAXA) on 23 January, 2009. Main characteristics of KUKAI are: (i) it is two satellites system, mother and daughter; (ii) it becomes a 5m tethered system on orbit at the maximum; (iii) the daughter satellite is TSR. The mother satellite is a tether deployment system, and it deploys the daughter satellite and retrieves it. The daughter satellite has one arm link attached to the end of the tether. As a result, KUKAI has deployed tether for only several centimeters. Then TSR attitude control could not be performed. However, many technical verifications have been achieved, for example, launch of mother and daughter pico-satellites, arm link motion control, and inter-satellite communication, etc.

The next satellite named "STARS-II" is under developing. KUKAI failed to deploy tether enough. Also KUKAI has only 5m tether, and only 20 seconds for deployment. Then, the primary objective of STARS-II is to keep tether tension for long time, and to deploy enough length tether, in order to perform experiment of TSR. In order to keep tether tension, two steps mission is planned. In the first step, mother and daughter satellites, which are connected by a few meters tether, rotate each other. In the second step, 1 km tether is deployed by gravity gradient force. During tether deployment in these steps, attitude control of TSR under variable tether tension will be performed. Numerical simulations confirm and evaluate the STARS-II mission. Also, satellite specifications (structure, function, control) designed for performing the above missions.