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Numerical Analyses of Dynamics of Deployment of PW-Sat2 Deorbit Sail Compared with Results of Experiment under Micro-Gravity and Low Pressure Conditions

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Abstract : Big amount of space debris constitutes nowadays a real thread for operating space crafts; therefore the main purpose of PW-Sat2' team was to create a system that could help cleanse the Earth's orbit after each small satellites' mission. After 4 years of development, the motorless, low energy consumption and low weight system has been created. During series of tests, the system has shown high reliable efficiency. The PW-Sat2's deorbit system is a square-shaped sail which covers an area of 4m^2. The sail surface is made of 6 μm aluminized Mylar film which is stretched across 4 diagonally placed arms, each consisting of two C-shaped flat springs and enveloped in Mylar sleeves. The sail is coiled using a special, custom designed folding stand that provides automation and repeatability of the sail unwinding tests and placed in a container with inner diameter of 85 mm. In the final configuration the deorbit system weights ca. 600 g and occupies 0.6U (in accordance with CubeSat standard). The sail's releasing system requires minimal amount of power based on thermal knife that burns out the Dyneema wire, which holds the system before deployment. The Sail is being pushed out of the container within a safe distance (20 cm away) from the satellite. The energy for the deployment is completely assured by coiled C-shaped flat springs, which during the release, unfold the sail surface. To avoid dynamic effects on the satellite's structure, there is the rotational link between the sail and satellite's main body. To obtain complete knowledge about complex dynamics of the deployment, a number of experiments have been performed in varied environments. The numerical model of the dynamics of the Sail's deployment has been built and is still under continuous development. Currently, the integration of the flight model and Deorbit Sail is performed. The launch is scheduled for February 2018. At the same time, in cooperation with United Nations Office for Outer Space Affairs, sail models and requested facilities are being prepared for the sail deployment experiment under micro-gravity and low pressure conditions at Bremen Drop Tower, Germany. Results of those tests will provide an ultimate and wide knowledge about deployment in space environment to which system will be exposed during its mission. Outcomes of the numerical model and tests will be compared afterwards and will help the team in building a reliable and correct model of a very complex phenomenon of deployment of 4 c-shaped flat springs with surface attached. The verified model could be used inter alia to investigate if the PW-Sat2's sail is scalable and how far is it possible to go with enlarging when creating systems for bigger satellites.

Keywords : cubesat, deorbitation, sail, space, debris
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