Proposing and Simulating a Novel Solar Sail Deployment Mechanism for Nanosatellites

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The rise of public interest in space exploration has sparked the development of new satellite technologies such as CubeSats, making research opportunities more accessible for scientists around the world. Solar sails are a promising propulsion technology for long-range CubeSat missions, but their deployment methods must improve before they can be utilized reliably. In this project, a newly designed solar sail deployment mechanism called the “pusher”—inspired by an inverted umbrella—is modeled in a computer-aided design software (Fusion360) with variations in stowage position (stowed or deployed) and number of panels (four or six). Using simulation software (Ansys Mechanical), a random vibration analysis (RVA) is performed on the models in a simulated rocket launch environment under random vibroacoustic perturbations. Preliminary results show major deformations at the tips of the sails at an average expected deformation frequency of 24.8 Hz. The response power spectral density (RPSD) curves for the trials reveal that the stowed model has a significantly less vibration response or is otherwise more stable than the deployed model, as expected. There is no notable difference between the RPSD curves of the four-paneled and six-paneled models. Therefore, further experimentation is needed to observe an effect of the number of panels on the stability of the model. Overall, the RPSD curves for all trials fall under the threshold for the maximum predicted vibration response and are thus compliant with NASA’s Payload Vibroacoustic Test Criteria (NASA-STD-7001), suggesting that this design could be a viable deployment method for solar sails in future CubeSat missions.