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Design of a Satellite Solar Panel Deployment Mechanism Using the Brushed DC Motor as Rotational Speed Damper

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Abstract : This paper presents an innovative method to control the rotational speed of a satellite solar panel during its deployment phase. A brushed DC motor has been utilized in the passive spring driven deployment mechanism to reduce the deployment speed. In order to use the DC motor as a damper, its connector terminals have been connected with an external resistance in a closed circuit. It means that, in this approach, there is no external power supply in the circuit. The working principle of this method is based on the back electromotive force (or back EMF) of the DC motor when an external torque (here the torque produced by the torsional springs) is coupled to the DC motor’s shaft. In fact, the DC motor converts to an electric generator and the current flows into the circuit and then produces the back EMF. Based on Lenz’s law, the generated current produced a torque which acts opposite to the applied external torque, and as a result, the deployment speed of the solar panel decreases. The main advantage of this method is to set an intended damping coefficient to the system via changing the external resistance. To produce the sufficient current, a gearbox has been assembled to the DC motor which magnifies the number of turns experienced by the DC motor. The coupled electro-mechanical equations of the system have been derived and solved, then, the obtained results have been presented. A full-scale prototype of the deployment mechanism has been built and tested. The potential application of brushed DC motors as a rotational speed damper has been successfully demonstrated.

Keywords : back electromotive force, brushed DC motor, rotational speed damper, satellite solar panel deployment mechanism
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