SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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STUDY OF THE LOCOMOTION PRINCIPLE OF A NEW DIELECTRIC ELASTOMER ROLLING ROVER

Abstract

Dielectric elastomer actuators (DEA) can be favourably used for the construction of smart structures and in innovative robotic applications. In particular, DEA can be used for the construction of rolling rovers for space exploration, which are moved by exploiting the deformation of their DEA surface. The advantages of DEA based rolling rovers with respect to classical rovers are several: small mass requirements, small volume requirements, since they can be folded during launch and then deployed during the mission, and increased locomotion performance. Recently, some of the authors developed and experimentally tested two rover prototypes whose surface is made of DEA. The first prototype has a spherical shape and an internal frame in order to make the DEA sectors independent, whereas the second one has a cylindrical shape, and doesn't have any internal frame. The experimental tests validated the lumped parameters dynamic models used, thanks to the matching of simulated and experimental data, which evidenced limited modelling errors. Nevertheless, the locomotion principle, which is strictly related to the dynamics of the first time instants of motion, was not completely understood. In this paper, the rolling principle and the dynamics in the first time instants of motion are analyzed in detail and, in particular, the influence of the center of mass position and of the ground contact point are assessed and demonstrated by means of dynamic models. Both the aforementioned effects are due to the global deformation of the rover during the activation of the DEA sectors for the motion generation; alternative rover configurations are then proposed, both with and without an internal frame, in which only a local effect of shape deformation is foreseen due to the activation of the DEA sectors. Finally, the validation of the developed dynamic models, and the evaluation of the real prototypes locomotion performance, are carried out by means of experimental tests.