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EVALUATION OF FOUR MOVEMENT MECHANISMS FOR A MICROSCOPY-BASED MONITORING SYSTEM OF AN ELYTRA SAMPLE IN MICROGRAVITY CONDITIONS

Abstract

This paper presents the assessment of four different mechanisms to implement microscopy in an experiment that will monitor the effects of microgravity conditions on the elytra of a Costa Rican indigenous beetle at the International Space Station (ISS). The mechanisms are: (1) ball screw – bull nut body, (2) four bars linkage with horizontal displacement, (3) piezoelectric actuator, and (4) pinion rack system. A stepper motor will be used in all the mechanisms, except on the third option. Some beetles of the genus Chrysina have elytra (wing case) with metallic appearance; this property, called structural color, has been investigated by the Materials Science and Engineering Investigation Center (CICIMA) of the University of Costa Rica (UCR) and could have applications in the space field as an external coating to protect the electronics of aircraft and satellites. The Central American Association of Aeronautics and Space (ACAE) provides the technical support needed to monitor the structural behavior and appearance during its programed stay in the ISS. The tests at the ISS will allow monitoring the material under conditions of microgravity and cosmic radiation. We have previously designed an experiment without microscopy component. This design was successfully tested on two sounding rocket launches (200 and 8,000 meters AGL, respectively). The microscopy system, with the help of the displacement mechanism, obtains periodic magnified images of the entire surface of the elytra; allowing tracking any changes during the experiment. Microscopy imagery will offer vast information to our scientific partners to understand the behavior of the material. To monitor the entire surface of the elytra, the sample needs to be moved with respect to the camera. Four mechanisms will be evaluated using a comparative analysis of the mechanical, electrical, and financial components of the system. Among the technical criteria, the mechanism has to meet volume, weight, and power consumption limitations, since the experiment must comply with our service provider requirements. In addition, these mechanisms will be assessed by testing the reliability in the presence of vibrations, such as those experienced during its launch to ISS. The movement of the sample must be accurate and should not present any jerk. This paper aims to determine an appropriate mechanism to be implemented inside our nanolab as part of our proposed microscopy system. Our results may be used in similar experiments where performing precise movements with space and energy consumption constraints is required.