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A LOW COST THRUST STAND FOR TESTING OF NANO-SATELLITE PROPULSION SYSTEMS

Abstract

The miniaturization of electronics components allows implementing the complete satellite functions in very compact systems. Not only companies but also universities, with their typical academic budget and time constraints, are often involved in the development of these nano-satellites as they set off as a cheap and accessible platform for applied space research and education, giving students the opportunity to gain hands on experience in space hardware. Miniaturized satellites lead to the development of micro-thrusters that provide levels of thrust sometimes lower than a few micronewtons. Very sensitive systems, capable of detecting such low forces, are required to test and characterize these small engines. This paper describes a simple, small and low-cost thrust stand designed, manufactured and tested at University of Rome La Sapienza for measuring the thrust produced by microthrusters in the micro-to-milli newton range. The mechanical design is based on a hanging pendulum configuration : a cross-beam rests on a pair of sharp-tip elements (two razor blades) that allow the pendulum to rotate with minimal friction. The cross beam is equipped with a laser, whose beam is projected on a flat graduated surface one meter distant in order to amplify the reading of the small oscillations caused by the thrust exerted by the micro engine fixed at the bottom of the pendulum arm. A camera records the displacement of the laser beam, which is quantified thanks to the graduated surface and from which the thrust trend is estimated. To avoid any dynamic disturbance arising from physical connection of the pendulum with static support, the pendulum is built with his own gas and electrical supply (tanks and batteries) which are activated by means of a wireless radio connection. The performed experimental activities proved the thrust stand to be able of measuring forces in the order of a few millinewton as well as in the order of 100 μN. The results show that even with limited budget (a hundred Euro) and low cost technology, satisfactory performances, suitable for typical university microsatellite applications, can be obtained. Besides being a cheap, portable, and easy-to-use thrust stand, the pendulum could be a useful tool, with an educational value, providing an interesting and exciting way for school and university students to better understand the dynamics of a damped driven oscillator.