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DESIGN AND DEVELOPMENT OF SPACECRAFT SIMULATOR TESTBED: PLATFORM FOR VALIDATING MANEUVERING CONTROL STRATEGIES IN FRICTIONLESS ENVIRONMENT

Abstract

With the growing use of space technology in commercial, military and scientific domains, there is a requirement for high autonomous spacecrafts with excellent pointing accuracy. For this purpose, several attitude control techniques have been developed, which address the complex attitude tracking, stabilization and disturbance rejection requirements of future space missions. However, many of these methods lack experimental validation. Directly deploying a new control algorithm to a real spacecraft could result in loss of control and communication, ultimately leading to loss of the vehicle. Thus, it is very important to validate any novel control strategy on Earth first, before it is deployed in space. Doing this, however, is quite difficult because spacecrafts operate in a gravity-free, friction-free and torque-free environment which is not available on Earth. Simulating such a frictionless environment on Earth is not an easy endeavour. Only a few such experimental facilities are available in the world, and even fewer for academic research. This work describes the indigenous design and development of a spacecraft simulator test bed facility. The test-bed consists of a platform mounted on a spherical air-bearing that provides unrestricted yaw motion and restricted pitch and roll motion. For sensing, the platform has a 9-axis IMU and for actuation, it has 4 Variable Speed Control Moment Gyros (VSCMGs) mounted in a pyramid configuration. To achieve a torque free environment, the centre of the gravity (CG) of the platform must coincide with the centre of rotation of the air bearing. To achieve this, an algorithm was developed to identify the relative location of the CG compared to the centre of rotation. Then it was shifted to the correct position by manually adjusting 3 counterweights attached to the platform. We envision that this platform can be used to train students about the fundamentals of spacecraft attitude control and to develop novel attitude control techniques.