ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (2) (6)

Author: Dr. David Bamber
Surrey Space Centre, University of Surrey, United Kingdom

Dr. Jason Forshaw
Surrey Space Centre, University of Surrey, United Kingdom
Dr. Thomas Frame
Surrey Space Centre, University of Surrey, United Kingdom
Prof.Dr. Guglielmo Aglietti
Surrey Space Centre, University of Surrey, United Kingdom
Mr. Ramin Geshnizjani
Institute of Flight Mechanics and Control, University of Stuttgart, Germany
Mr. Simon Goerries
Airbus Defence and Space (DS), Germany
Dr. Andrei Kornienko
Airbus Defence and Space (DS), Germany
Mr. Jens Levenhagen
Airbus Defence and Space (DS), Germany
Prof. Yang Gao
Surrey Space Centre, University of Surrey, United Kingdom
Mr. Abadi Chanik
Surrey Space Centre, University of Surrey, United Kingdom

ABSOLUTE ATTITUDE DETERMINATION SYSTEM FOR A SPHERICAL AIR BEARING TESTBED

Abstract

Three degree of freedom (3-DOF) ACS satellite testbed systems are essential hardware-in-loop testing facilities for the construction of a wide range of intelligent AOCS algorithms. Intrepid is a 3-DOF spherical air-bearing satellite testbed custom designed at the Surrey Space Centre, UK, and installed on-site at Airbus DS in Friedrichshafen, Germany for the AOCS GNC Group. The testbed consists of a table-top for the mounting of satellite hardware, 4 control moment gyroscopes (CMGs) mounted in a pyramid configuration and a sensor suite including an IMU. Under normal operation the CMGs can be used to command the table to required angles thus testing the AOCS alogrithms using only the IMU as an attitude sensor.

Satellites require long-term stable and short-term high resolution attitude measurements, which are fused on-board to estimate the attitude. The IMU provides high resolution attitude information, but has the drawback of not knowing the initial attitude and also drifting over time. This paper concerns the development of an absolute attitude determination system (AADS) that utilises an infra-red camera, a series of LEDs positioned across the table-top, and intelligent software to independently determine the absolute attitude of the table-top. The system thus provides long-term stable attitude measurements and overcomes the shortcomings of the IMU.

The newly installed AADS software contains vision processing and triangulation algorithms that provide real-time absolute attitude information to the host computer. The vanilla system can achieve attitude

determination accuracy within 1 degree in yaw and 2 degrees in pitch and roll. The software can calibrate itself compensating for intrinsic and extrinsic offsets including incorrectly placed LEDs and a misaligned camera system. A sub-pixel feature detection technique is utilised to enhance the accuracy of the system. It is shown that by modifying the position of the LEDs or modifying the placement of the camera, more optimal attitude accuracies along different axes can be obtained. This paper will detail the main operation of the system from both a hardware and software perspective and provide experimental results during operation.