IAF ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (1) (8)

Author: Mr. Thu Vu Trong
Khalifa University of Science and Technology (KUST), United Arab Emirates, vu.thu@ku.ac.ae

Dr. Firas Jarrar
Khalifa University of Science and Technology (KUST), United Arab Emirates, firas.jarrar@ku.ac.ae
Dr. Sean Shan Min Swei
Khalifa University of Science and Technology (KUST), United Arab Emirates, sean.swei@ku.ac.ae

INTEGRATED NAVIGATION DEVICE FOR CUBESAT ATTITUDE DETERMINATION

Abstract

Attitude Determination Subsystem is one of the most critical parts of a CubeSat as it helps the satellite to determine its attitude in space accurately, usually based on inputs from coarse/fine Sun sensor, Earth horizon sensor and star tracker. These sensors are usually individual components of a CubeSat's Attitude Determination Subsystem, requiring separate harnesses connecting each to the CubeSat, consuming more power and adding complexities in integration.

This study presents preliminary results obtained from ground testing of a small-sized, low-cost, low-power, and flexible integrated navigation device designed for attitude determination on a CubeSat. It aims to function as a replacement for the attitude sensors mentioned above, reducing the number of components needed, mass budget and power consumption for CubeSats.

The hardware consists of a microcontroller, attitude sensors, and a multi-function camera, all procured from Commercial Off-The-Shelf parts. The software used is based on open source software and includes the three standard steps in star tracking: centroiding, star identification, and attitude determination. The device is being developed at Yahsat Space Lab part of the Space Technology and Innovation Center at Khalifa University.

The device is capable of automatically determining the optimal exposure time based on the CubeSat's spin rate input from integrated gyro sensors. It has the flexibility in trading attitude determination accuracy with computing time and power consumption. Depending on the mission need, it can output coarse attitude information quickly with reduced accuracy or output highly accurate attitude information over a longer period.

A preliminary test was conducted on the prototype device with internal simulated star-fields and actual stars images from NASA's STEREO (Solar TErrestrial RElations Observatory) satellite, and the initial test results showed a promising path forward. A comprehensive study and testing are planned, including the tests to be conducted inside a dark room with externally simulated star-fields and the outdoor ground testing at night with reduced light pollution. Additional environmental tests in thermal-vacuum chamber and vibration tests will also be conducted. The complete results will be presented in the final manuscript.