22nd IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Spacecraft for Deep-Space Exploration (8)

Author: Mr. Zhou Hao
The University of Manchester, United Kingdom, zhou.hao@postgrad.manchester.ac.uk

Mr. Qin Xu
University of Manchester, United Kingdom, qin.xu-3@postgrad.manchester.ac.uk
Dr. Stephen Hobbs
Cranfield University, United Kingdom, s.e.hobbs@cranfield.ac.uk
Dr. Peter Roberts
University of Manchester, United Kingdom, peter.c.e.roberts@manchester.ac.uk
Dr. Jenny Kingston
Cranfield University, United Kingdom, j.kingston@cranfield.ac.uk

SYSTEM DESIGN FOR DEEP-SPACE CUBESATS – A CASE STUDY FOR ESA ASTEROID IMPACT COPINS CUBESATS

Abstract

CubeSats became very popular in the past decade for space missions. This is because CubeSats can realise similar or part of the functionalities compared to regular size satellites, with much lower cost and easier accessibility for universities and research institutes. However, all present CubeSat missions have been limited to operate on Low Earth Orbit. Recently, the space industry has drawn attention to using CubeSats for higher orbits or deep-space missions. A widely discussed approach is to use the CubeSat as a secondary or piggyback payload with the primary higher-orbit or deep-space spacecraft.

The most challenging phase of deep-space CubeSat missions is orbit insertion. An applicable concept is to launch the CubeSat as a secondary payload or piggyback satellite with the primary spacecraft in the same launch vehicle.

ESA recently launched an open bid offer on its asteroid probe – Asteroid Impact Mission (AIM) in 2020. AIM will carry a set of two three-unit CubeSats (COPINS) that will be deployed and operated as a communications and sensors network. ESA aims to use COPINS to test intercommunication systems and carry sensors to boost and complement AIM's own scientific return.

This paper identifies the problems and challenges for designing COPINS, including sensors selection and science design, guidance navigation and control system design, on-board autonomy design, radiation protection for commercial-off-the-shelf electronics, propulsion and power system design, station keeping and end-of-life phase design. The research focuses on the currently available or near future technology of each subsystem and how to apply these technologies to resolve deep-space CubeSat operation problems.

Furthermore, from the research and current industry recognition about deep-space CubeSat missions, this paper also presents a comprehensive system design paradigm for any similar deep-space CubeSat mission. It also briefly discussed CubeSat installation and separation from the AIM spacecraft from a system and mechanical prospective.

The research uses ESA AIM CubeSat as a study case but the conclusions can provide reference and design paradigms for future higher orbit or deep-space CubeSat missions.