SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Small Space Science Missions (2)

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DESIGN SYNTHESIS OF TETHERED NANO-SATELLITES TO OBSERVE THE SOLAR CORONA

Abstract

Few years ago the Group of Space Solar Physics at the Osservatorio Astronomico di Torino, OATo, and the AeroSpace Systems Engineering Team, ASSET, at Politecnico di Torino begun a cooperation for the research program "Studies of Solar System Exploration", funded in 2007 by ASI (Italian Space Agency). The request made by OATo was the development of the capability of taking pictures of the solar corona by means of simple and low cost cameras. ASSET developed the concept of a system constituted by two low cost tethered nano-satellites, the Occulting and the Observing. After an extensive trade-off analysis between alternative concepts, ASSET has proceeded with the system design synthesis. Main results are here briefly summarized: - the definition of the external and internal layout of the system, constituted by the two nano-satellites and the tether. Unlike the first concept, the Occulting and the Observing satellites have different shapes: the Occulting is a simple cube, whereas the Observing is a double cube. The alignment between the two nano-satellites and the Sun is met by means of the Attitude Determination and Control Subsystem (ADCS), constituted by magnetometer, solar sensors, Inertial Measurement Unit and magnetic torques, and by means of the Orbit Determination and Control Subsystem (ODCS), constituted by laser telemeter, webcam and reaction control cold gas jets. In particular, while the ADCS is used to control the attitude and is installed on-board both satellites, the ODCS is used to control the alignment of the satellites to the Sun and is present only on-board the Observing. Talking about the Payload Subsystem, the Observing carries on-board one photo camera to take pictures of the solar corona, while the Occulting carries on-board an optic device to obscure the solar sphere. As far as the tether system is concerned, the tether, which is folded on a winch during the initial mission phases, is then unwrapped. This challenging operation is controlled by an electric motor, which drives the winch in such a way to maintain the tether taut and to avoid end-course bouncings; - the complete system sizing, in terms of system mass and power budgets and subsystems components specifications; - the assessment of the various modes of operations through the extensive use of functional simulations. The paper addresses first the external and internal layout of the system, then the system sizing and eventually shows the main results of the functional simulation of the mission modes of operations.