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CHANDRAYAAN-2 DUAL GIMBAL ANTENNA SYSTEM

Abstract

Chandrayaan-2 Orbiter and Lander (named Vikram) as an integrated module was launched from Sriharikota, the space port of India, on the 22nd of July 2019. The Lunar orbit insertion took place on 20th of August 2019 as composite module. After initial orbit raising maneuvers around the Earth, the Moon and also the calibration of the sensors and actuators, the integrated module reached 119kmx127km lunar orbit on 1stSep 2019. The Chandrayaan-2-Lander's mission objective was to land on the south pole of the moon, while Orbiter makes scientific measurements of Moon from 100km with the help of 8 imaging and scientific payloads on-board. Dual Gimbal Antenna (DGA) system in Chandrayaan-2 was an innovative, state of art development for payload data downlink from lunar orbit to ground stations on earth. The moon subtends an angle of approximately 0.54 to an observer on earth. This calls for stringent pointing requirement in real time for onboard downlink antenna. DGA system is designed with 2 Brushless DC motors (one for Azimuth and other for elevation) in dual gimbaled configuration. Onboard algorithm generates reference trajectory on DGA frame for both motors based on satellite ephemeris, orbit time, attitude information and ground station coordinates. The motor positions are sensed by resolvers, thereby being controlled in close loop. It is capable of having a maximum rate of 15/s for the acquisition of initial reference. DGA electronics was realized on a single card comprising of analog drivers, Resolver-to-digital converter (RDC) for resolver processing, current sensing circuitry, over-current protection circuit, BJT based H-bridges. Proportional-Derivative controller was implemented along with estimators for cogging, dither and other non-linear elements compensation. DGA onboard software caters for different operational modes and safety features. The operational modes include normal mode and offset mode. In normal mode, DGA will follow reference trajectory generated onboard. The offset mode is basically a ground based commanding, where DGA is commanded to an absolute angle along with duration of rotation. Safety features include sensor data corrections, fault detection and correction etc. This paper brings out the details of the DGA design, initial phase operations summary, and observations during the operational phase, their mitigation plan and the performance of the DGA in the Earth bound, trans-lunar phase and the moon bound phases of the mission.