

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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CHANDRAYAAN-3 POWER DESCENT 6DOF SIMULATION SOFTWARE

Abstract

On 23rd August, 2023 Chandrayaan-3 Vikram Lander spacecraft soft landed on moon south pole at a pre-determined location using an autonomous on-board NGC (navigation, guidance and control). To validate the NGC design, simulate the trajectory, generate the required pre-flight parameters and to carry out simulations for various perturbed conditions an indigenous software (Six DOF Software for Chandrayaan-3) is developed in C++ software language at ISRO, URSC. Software played a crucial role in success of Chandrayaan-3 by providing statistical analysis and details of various critical parameters such as landing error ellipse, touchdown stability parameters, propellant margins, navigation guidance and control margins, system behaviour under various failure scenarios and many more. This paper details the 6dof software architecture for simulating end to end power descent trajectory, MC (Monte Carlo) test cases, extreme perturbation of trajectory and spacecraft parameters test cases, contingency test cases, single point and multi point failure test cases. The 6dof software contains mathematical modules of NGC algorithm, sensors, engines, thrusters, DEM (digital elevation module) of Moon surface, dynamics for propagation of 6dof state vector using high fidelity moon gravity module. These modules are validated using ground test data. The pre-flight simulated reference trajectory is used for tracking the lander from ground tracking stations and as reference trajectory in telemetry displays during real time descent. Post flight trajectory data matched with the simulation results of the software there by validating the individual modules and the whole software architecture. This validation is critical to use the software for the future missions.

Keywords: NGC, 6Dof, MC simulations