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ON-BOARD ORBIT MODEL ACCURACY STUDY FOR CHANDRAYAAN-2 LANDER-CRAFT NAVIGATION

Abstract

Chandrayaan-2(CH2) is the second spacecraft in its series of Lunar-exploration by ISRO. It carries Orbitercraft and Landercraft, where Orbiter revolves around the Lunar Orbit of 100 kms altitude and Lander performs the soft landing on the Lunar Surface. It carries instruments to supplement and complement the measurements carried out by Chandrayaan-1 to study lunar exosphere, topography, mineralogy and to detect water molecules. After injection of CH2 into the orbit, seven apogee raising maneuvers are planned to gain the perigee velocity and then the trans-lunar injection maneuver is performed which will put the Ch-2 in the Lunar transfer trajectory. Lunar orbit insertion is carried out once the spacecraft enters the Moon's sphere of influence to insert it into a polar orbit of 160 perilun and 12150 apolun and subsequent maneuvers are carried out place the spacecraft into a 100km altitude orbit. After spending nearly two weeks 100km orbit, landercraft is separated from the orbitercraft and then the deorbit maneuver is performed which places the spacecraft into 100 by 18km altitude orbit. From 100km to 7km, navigation is carried out using accelerometer deltav change occurring due to attitude maintenance with an onboard propagation model to provide the position and velocity to guidance algorithm. From 7km onwards absolute sensors altimeter and landercraft position detection cameras are used for navigation. In this paper, a study on the onboard orbit propagation model used in the navigation is presented as it plays a key role in the navigation of CH2. The onboard propagation model is based on integrating the equation of motion modeled with central force and the perturbing force due asphericiy of Moon. Due to the limitation of onboard processor, a trade of study is required to find the order of gravity harmonics to be used for propagation without the accuracy. The achievable orbit accuracy with LP165 model and latest GRAIL gravity model for different harmonics is studied. Landercraft position difference of 285meters with harmonics of order 15x15 and 27meters with 30 X 30 zonal and tesseral harmonics of LP165 between Full force(which accounts all major perturbations like Moon's apshericity, gravity harmonics of order 150, solar radiation pressure effect, third body perturbations and lunar tides) model and on-board propagation model. Even though the GRAIL model is not considerable but the velocity accuracy with GRAIL is 5cm/sec which is better than LP165, it is preferable to use GRAIL model on-board.