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PRECISE MODELLING OF SOLAR RADIATION ACCELERATIONS AND DISTURBANCE TORQUES ON MARS ORBITER MISSION (MOM)

Abstract

All satellites in space experience external forces and torques that influence their motion and orientation in space. Solar radiation pressure torque is a major environmental disturbance torque, caused by the absorption and reflection of photons striking the sunlit surfaces of the spacecraft, which significantly affects satellite motion and attitude at high altitudes. This paper presents an analytical approach for modeling the torques induced by the Solar radiation Pressure (SRP) on Mars Orbiter Mission spacecraft which enables to arrive at best orientation of panels with respect to body so that the torque induced by SRP is minimum and hence reducing the momentum dumping requirement of the wheels and thus saving the fuel and hence impact on orbit.

An asymmetric satellite has a problem with momentum accumulation due to solar radiation pressure when compared with a symmetric satellite. Thus, periodic momentum dumping is required to maintain a level of momentum in the reaction wheels of satellite. The accumulated momentum is proportional to the area of the solar array and the length of the moment arm. The momentum accumulation is reduced by applying the solar array offset angle. The exact planning of insertion trajectory and insertion time requires the prediction of disturbance torque, Angular momentum, desaturation pulses and acceleration due to Solar Radiation Pressure. The modeling of these parameters was done to an accuracy of about 95 percentage in cruise phase with different attitude geometries. The required predictions were provided to Flight Dynamics Team of ISRO and Navigation team of JPL for Mars Orbit Insertion planning. Such precise predictions helped to propagate the orbits accurately thereby the orbit propagation uncertainties got reduced considerably, which enabled an accurate capture on 24th Sep 2014.