ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics - Part 1 (3)

Author: Dr. Narayanasetti Venkata Vighnesam
Indian Space Research Organization (ISRO), India

Mrs. Anatta Sonney
ISRO Satellite Centre (ISAC), India
Mr. Pramod Kumar Soni
Indian Space Research Organization (ISRO), India
Mr. N.S. Gopinath
ISRO Satellite Centre (ISAC), India

INDIA'S FIRST MARS MISSION ORBIT DETERMINATION SYSTEM

Abstract

India's first Mars mission proposed to be launched in November 2013 is an elliptic capture orbiter (500 X 80000) km with about 30 deg inclination. The spacecraft is expected to be in Mars orbit by September 2014 with an expected mission life of about six to ten months. The mission is expected to provide opportunities to study the Mars atmosphere, solar interactions, loss processes etc.

The tracking of satellite during initial phase is expected to be from network of stations from India and also from external agency. It is proposed to provide S-band range, Doppler and angle measurements to derive the spacecraft position. The determined daily orbital estimates are used for spacecraft navigation, mission planning, and science processing. ISRO's operational Chnadrayaan-1 Orbit Determination (OD) system software was updated to meet the orbit determination requirement during different phases of the Mars mission. The trajectory (ephemeris) generation and orbit determinations were carried out during different phases of the mission using simulated tracking data from the possible tracking network considered for this mission.

The main computation process of the orbit determination system is trajectory generation and estimation. Trajectory generation is performed through numerical integration of differential equations of motion. The force model mainly includes earth's, Sun's/Mars's gravitation, aerodynamic drag, third body gravitation and solar radiation pressure. Cowell's method is used for trajectory generation. Weighted least squares technique and iterative differential correction process is used to obtain the refined state.

Orbit determination system methodology, software validation especially trajectory generation and achievable orbit determination accuracies during different phases of the mission are studied in detail.

Simulation studies have been carried out for Earth-centered, heliocentric as well as Mars-centered trajectories of MRO, MGS and Mars Express missions for system validation. The results are compared with corresponding trajectories from NASA's Web site generated by JPL Based on MRO trajectory generated in the earth-centered phase using indigenously developed system, the maximum difference observed is about 190 m and 0.0024 m/sec respectively in position and velocity at the end of two days. Orbit determinations were carried out with simulated tracking data from Canberra, Goldstone and Madrid DSN ground stations for the Mars mapping phase orbit and results show that the achievable orbit determination accuracy is within one kilometer in position.