SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration - Part 1 (3A)

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PRELIMINARY DESIGN OF MARS EXPLORATION MISSION BY MULTIPLE LANDERS AND ORBITERS

Abstract

Growing interest on Mars has generated a number of great missions for past 40 years. Most of them have been single-probe missions. The next generation of Mars mission should include a cooperative and compound exploration by multiple spacecraft. The authors propose a preliminary mission plan for Mars exploration by multiple landers and orbiters.

An unique feature of this mission is combined exploration by orbiters and landers. One orbiter is for observation of atmospheric escape, to understand how Mars atmosphere has evolved. The other small orbiter investigates Martian climate, to understand what is going on now on Mars. The landers aim elucidation of interior structure and surface environment of Mars, to understand how the solid body affects the atmosphere. The landers also demonstrate advanced technologies for entry, descent, landing and mobility.

These landers and orbiters are inserted into the Mars transfer trajectory from the Earth by a single launch. After the cruising phase, they are inserted into the initial orbit around Mars simultaneously without separation.

As for the orbiters, an orthogonal constellation around Mars must be realized for compound observation. The mars atmospheric orbiter requires a low orbit close to the Martian atmosphere for in-situ direct measurements of escaping atmosphere. On the other hand, the meteorology orbiter should have a highly elliptical orbit to obtain global images of Martian meteorology at once from a distant point from Mars. It is essential that the orbit planes of the two orbiters should be orthogonal, to capture images of the whole orbit planes of the atmospheric escape orbiter. Moreover, this constellation must be kept at least during the mission under several kinds of perturbation. We will describe how to establish such orthogonal constellation after simultaneous insertion into the initial orbit, and how to maintain it by utilizing natural perturbations such as J2 terms or the atmospheric drag.

The landers are inserted into the initial orbit with orbiters, and then deorbit successively for descent to the Mars. This allows us more accurate landing, freedom of timing, and wider distribution of the landers over the Mars, compared with direct entry from the interplanetary trajectory. The sequence of the entry, descent, and landing of the landers will be described. Autonomous guidance, navigation and control by using images and other sensors during the descent may realize more accurate landing and avoidance of obstacles.

We will show a preliminary mission plan and some simulation results.