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TETHER SYSTEMS FOR PHOBOS EXPLORATION

Abstract

The field of space tethers has received very much attention in recent decades. The main advantage of space missions using tethers in many applications is the relatively simple implementation and the relatively low cost of both fuel and the mission as a whole. The tethered systems can be used to solve a wide range of issues in space, including an exploration of the planets of the Solar System and their satellites.

The purpose of the work is to explore the potential of three different missions using tether systems for the exploration of Phobos. The first mission, originally proposed by NASA, utilizes an orbiting spacecraft that is positioned at the L1 or L2 collinear libration point of the Mars-Phobos system by using its engines, and a tether deployed toward Phobos. In the second mission, a tether is anchored on the surface of Phobos and a tethered spacecraft hovers over the L1 or L2 collinear libration points of the Mars-Phobos system. In the third mission a main spacecraft moves in a quasi-satellite orbit around Phobos, as in the Mars Moon eXploration (MMX) mission by the Japan Aerospace Exploration Agency (JAXA), and a tether system is deployed from this spacecraft. The end body of the tether system surveys the surface of Phobos from a low altitude and then the end body is delivered to the main spacecraft. In addition, such the system can be used to deliver a rover to the Phobos surface and return the rover to the main spacecraft.

In this study, the control laws for deployment and retrieval of tether systems for the implementation of these three missions are proposed. The tether tension forces are estimated analytically and numerically. The possibility of realization of these three missions is shown in the framework of the planar restricted three-body problem.