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A NAVIGATION SYSTEM CONCEPT BASED ON RADIO BEACON MESH

Abstract

In recent years plans for the future solar system research has started shifting from standard rovers and landers into flying probes and even human exploration. Missions like Dragonfly and Mars Helicopter Scout chart a pathway for future surveys. In view of increasing mobility of surface exploration, the need for the positioning system suitable for use in an extraterrestrial environment arises. One of possible solutions to this problem is usage of the local radio beacon mesh with known distances between nodes. The local approach allows bypassing the need for usage of costly satellite based positioning systems. In this paper, we present two missions utilizing aforementioned technology.

Proposed system contains of four miniaturized radio beacons used as addition to main mission vehicle. They are designed to be ejected during descent and land autonomously using aerobrake. Beacons operates in two modes, as a transmitter for obtaining distances to other probes, and as re-transmitter for tracking object signal, allowing distance measurement and therefore triangulation of position relative to the given mesh point.

Two missions has been developed.

First mission is proposed as a theoretical survey of the middle size Martian crater with use of flying probe. Beacons placed on the crater slopes would provide signal range in whole cavity. Engineering challenges such as power management, landing survivability and probe stability on the sloped Martian soil while maintaining beacon low weight has been considered.

Second mission is proposed as a technology demonstration to be built for European Space Agency Rexus rocket flight. A descent module with integrated probes is lifted to 80 kilometers, where separation from rocket occurs, probes are deployed after module gains stability. Deployment height is based on desired mesh separation and is driven by a spring based mechanism with probes bay doors also working as main probe aerobrake. The probes flight path is designed for them to land before the main module allowing tracking its path in the last phase of descent. Probes land using aerobrake, main module utilizes parachute opened after entering probe mesh radio signal range. Main considerations involved simulating deployment events height and forces, descent and landing speeds as well as predicting beacons separation. Additionally, main probe and beacons mechanical and electronic systems have been proposed.