SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Near-Earth and Interplanetary Communications (3)

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DEVELOPMENT OF COOPERATIVE COMMUNICATION TECHNIQUES FOR A NETWORK OF SMALL SATELLITES AND CUBESATS IN DEEP SPACE

Abstract

In the last decades, great progress was made in the development of small satellites and CubeSats. Several small spacecraft were designed, fabricated, launched, and successfully operated in low Earth orbit. While more companies and space agencies are becoming interested in CubeSats and small satellites, also the mission goals for these spacecraft are gradually changing: these small spacecraft are starting to be considered for deep-space, interplanetary exploration. Given the limited size, mass and power capabilities of these small platforms, one of the most interesting problems to address is how to develop a communication system to allow small satellites to communicate from very far distance in the solar system.
This paper aims to address this problem by proposing a cooperative communication approach in which multiple CubeSats use CDMA to improve the link performance with respect to the case of a single satellite transmitting. The proposed uncoded CDMA yields receivers for CubeSats that have low complexity implementation. Each component of CubeSats could easily extract its own received data with almost no interference from other users in case of orthogonal spreading codes. For the downlink, depending on the available bandwidth, and the data rates, a large processing gain could be obtained if the number of CubeSat is not excessively large to cause multiuser interference.
The approach is applied to the specific case of a constellation of CubeSats located at the Lunar Lagrangian point L1 which aims to perform radio astronomy at very low frequencies (30 KHz -3 MHz).
The paper describes the development of the approach, the simulation and a graphical user interface developed in Matlab which allows to perform trade-offs across multiple constellation's configurations.

Part of this work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.