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Author: Dr. CHARLES LEE
California State University Fullerton, United States, CharlesHLee@fullerton.edu

Mr. Kevin Gomez
California State University Fullerton, United States, kgomez81@csu.fullerton.edu
Dr. Alessandra Babuscia
Jet Propulsion Laboratory - California Institute of Technology, United States,
alessandra.babuscia@gmail.com
Dr. Kar-Ming Cheung
National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory, United States,
kar-Ming.Cheung@jpl.nasa.gov

DYNAMIC FORMATIONS OF SPACE-BASED APERTURE ARRAYS USING CUBESATS AT LUNAR L1 LIBRATION POINT

Abstract

The concept of involving CubeSat satellites in Deep-Space missions is getting increasingly popular and will be realized in the coming decade. Solar Observing Low-frequency Array for Radio Astronomy/Separated Antennas Reconfigurable Array (SOLARA/SARA), developed at MIT, is one among several proposed missions, where a Multiple-Input-Multiple-Output communication network of CubeSats would be deployed around the L1 libration point of the Earth-Moon system. Its primary objectives are to establish a space-based radio interferometry array of CubeSats to observe the evolution of solar weather and its interaction with Earth's magnetosphere and to synthesize a large space-based aperture by beamforming the signals from the individual CubeSats in phase. Collectively SOLARA/SARA would consist of 20 six-unit CubeSats, flying in halo orbits while maintaining node-to-node distances in the range of 10-100 km. This paper addresses its geometric and flying formations and optimizes its configuration so that it could meet its mission objectives and requirements. In particular, a dynamical system model, which incorporates the relevant gravitational forces, is developed and implemented numerically to compute the trajectories of the SOLARA/SARA CubeSats. Different designs and formations of a single or multiple halo orbits will be presented along with stability, orbit sizes, long-term evolution of the constellations, and station-keeping cost.