SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 1 (2A)

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AN INVESTIGATION ON THE POSSIBILITY OF LUNAR GROUND POSITIONING SYSTEM USING NETWORK OF CUBESATS

Abstract

The possibility of Lunar Ground Positioning System that uses network of CubeSats is investigated that will enhance the exploration abilities in moon. CubeSats are standardized nano-satellites ranging from 1000 cm3 to 6000 cm3 (1.33 8 kg), which we can benefit from cost and time budget. In the proposed network, 12 6U (6000 cm3) CubeSats orbit the moon with at least a 2200 km altitude average. Each CubeSats have five systems; a determination system, an orbit maintenance system, an inter-network system and a positioning system. The determination system consists of a sun sensor, which is further compensated using the inter-network system. The inter-network system solves the network distribution of the CubeSats to obtain the relative position between the CubeSats and then solves the absolute position based on the compensated sun sensor data. The orbit maintenance system uses micro thrusters developed for CubeSats such as pulsed plasma thrusters (PPT), cold-gas thruster or field emission electric propulsion (FEEP) systems to maintain the CubeSat constellation. A Chip Scale Atomic Clock (CSAC) or other miniature atomic clocks (rubidium atomic clock) are suggested to provide the accurate time with aging rates as low as 1E-10/month. Further synchronization will be performed through the inter-network system to compensate the time clock. Some major unresolved issues with such network of CubeSats are Trans Lunar Injection methods, space debris problems and the risks of using commercial off the shelf (COTS) components outer space. A mother ship will be put into the lunar orbit with the CubeSats as its daughter ship onboard. The CubeSats will be deployed after the mother ship is injected to the lunar orbit. The mother ship will stay in orbit with the CubeSats, for communication relay between the CubeSats and Earth. Regarding the space debris concerns, after the mission lifetime, which is aimed to be up to 24 months, thrusters will be used to send the CubeSats outer space or deorbit the CubeSats towards the moon for impact. COTS components have been used in LEO CubeSats, being space proven from flight experiences. However, components have not been tested for usage in missions as far as moon yet. Therefore, COTS components can be only used either after it qualifies the space environment tests or by sufficiently shielding the CubeSat. The investigation results show that Lunar Ground Positioning System using network of CubeSats is possible, but with few improvements in space radiation concerns that come with using COTS components.