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LUNAR FLASHLIGHT CUBESAT GNC SYSTEM DEVELOPMENT FOR LUNAR EXPLORATION

Abstract

The Lunar Flashlight (LF) CubeSat team is organized by NASA JPL and MSFC along with several industrial partners. LF is planned to be launched on the EM-1 flight and will map the lunar south pole for volatiles. The goal is to find potential water ice hidden in permanently-shadowed regions, which can be used for human exploration. This mission also demonstrates several technological first: the first CubeSat to reach Moon, the first planetary CubeSat mission to use green propulsion, and the first mission to use lasers to search for water ice.

JPL is responsible for integrating this 6-U CubeSat including the design of the GNC system. Its main functions are to transport the spacecraft from Earth to Moon then once in lunar orbit point the payload toward the center of Moon. The key requirements and drivers for this 8-18 month mission are:

- Up to 10 deg/sec slew rate.
- Detumble from post-separation slew rate 10 deg/sec within 10 minutes.
- Milliradian level of Moon pointing accuracy.
- Arcsecond level of pointing knowledge.
- Communicate properly with other subsystems and command thrusters in propulsion system.
- Good level of autonomy.
- A sun-pointing mode to ensure the safety of the spacecraft.

The original GNC architecture was developed together with another JPL CubeSat project, NEAScout. In this original design, solar sail propulsion was used taking advantage of its navigation agility. But unlike approaching an asteroid, it was found later that the solar sail was unable to provide a stable orbit around the Moon due to the perturbations caused by Earth. Therefore, a major redesign was conducted following the heritage of INSPIRE and MarCO. This new design also resulted in several new technology developments:

- New reaction wheel assembly: the standard 15 mNms CubeSat RWA by Blue Canyon Technology was found insufficient to meet the requirement of post-separation detumble from 10 deg/sec. Therefore, a new 50 mNms RWA is developed by BCT to meet LF requirement.

• The cold gas thrusters provided by Vacco for MarCO was found insufficient to meet delta-V requirement. As such, a new 100-mN chemical thruster using proven green monopropellant LMP-103S is developed for LF.

Also, it was determined that using the integrated attitude control system, XACT-50, developed by BCT can meet all desired requirements and is more cost effective than assembling individual components in-house. The XACT-50 unit includes 3 RWAs, 1 SRU, 1 IMU, and 4 sun sensors.