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UTILIZING MOMENTUM DUMPS FOR KPLO FINE TRAJECTORY CORRECTION IN BALLISTIC LUNAR TRANSFER

Abstract

The Korea Pathfinder Lunar Orbiter (KPLO) successfully entered lunar orbit on December 16, 2022 (UTC), via a weak stability boundary/ballistic lunar transfer (WSB/BLT) trajectory. During the WSB/BLT transfer, the spacecraft experienced a significant error during small burns. One of trajectory correction maneuvers (TCMs) exhibited a burn error exceeding 10%, causing a significant deviation from the reference trajectory, because small velocity changes can have a significant impact on highly sensitive trajectories like WSB/BLT. The TCM error was found to be caused by the attitude control after burns to stabilize the spacecraft, generating a small but significant Delta-V error.

The KPLO bus system was originally designed for 3.5 phasing loop transfer to the Moon, which do not require precise small maneuvers. While the bus system exhibits high accuracy for large maneuvers, small maneuvers introduce relatively large errors due to Delta-V required for post-maneuver attitude control.

To compensate for this maneuver error, either another small maneuver must be performed shortly after, or the error must be accumulated and then corrected with a large maneuver later. However, small maneuvers were unreliable, and large maneuvers were constrained by the fuel budget.

The KPLO operations team decided to utilize the small Delta-V generated during momentum dumping for trajectory correction. Due to mass budget constraints, KPLO is equipped with small reaction wheels, necessitating relatively frequent momentum dumping. Starting from November 18, 2022 (UTC), a total of five momentum dumps were performed, successfully reducing the Delta-V requirement of the last TCM before the lunar orbit insertion maneuver, from approximately 80 m/s to 0 m/s. This paper presents the momentum dumping-based fine trajectory correction maneuver strategy and the successful KPLO trajectory correction results achieved using this strategy.