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Design and Numerical Modeling of a Breadboard Leveling Platform for the LGWA Mission

The main goal of the LGWA mission is to observe and monitor gravitational-wave (GW) signals. One of the key technologies employed for this purpose is the inverted pendulum suspension, whose low resonance frequency provides the mechanical sensitivity needed to detect the extremely faint surface displacements induced by GWs. However, because this suspension is extremely soft, the sensor becomes highly susceptible to tilt-to-horizontal coupling small deviations in ground orientation are readily misread as horizontal displacement. For this reason, a leveling mechanism is required to establish and maintain the correct orientation of the seismic station relative to local gravity, keeping the ground-mounted instrument level despite lunar terrain and settling effects. Each LGWA station platform must be leveled to an accuracy of a few tens of microradians to ensure optimal functionality of the Lunar Inertial Gravitational-wave Sensors (LIGS). Previous research on this subsystem has primarily addressed basic design concepts, constraints, and feasibility considerations. Building on this foundation, the objective of this work is to develop, through numerical simulation and CAD-based modeling, a breadboard-level leveling mechanism, and subsequently validate it experimentally. The expected outcome of this work is a numerically validated breadboard-level leveling mechanism model demonstrating stable operation under low-temperature conditions, as well as a suitable frequency response avoiding the mode region relevant to LGWA's measurement band, providing a basis for future scaling toward flight-relevant dimensions.

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