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The Modern Day Space Elevator as a Permanent Transportation Infrastructure (3)

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SPACE ELEVATOR APPLICATION ON HABITAT CONSTRUCTION AT LAGRANGE POINTS

Abstract

Nowadays, due to environemental issues and population expansion, migration to space seems to be another selection for human survival. Most of the space migration goals proposed so far have been celestial bodies such as the Moon or Mars. However, the Earth-Moon Lagrange points, which offer a stable gravitational environment for hosting massive space structures, serve as an ideal target for space habitat construction. This study investigates the feasibility of deploying a space elevator-based slingshot mechanism to propel large-scale payloads to Lagrange points, addressing scalability challenges and optimizing delivery precision. By integrating advanced trajectory design and stability analysis, we explore whether such a system can efficiently transport massive structures, laying the foundation for future space infrastructure. Our research enhances the slingshot approach by simulating launches from a space elevator at altitudes exceeding 60,000 km, leveraging Earth's rotational velocity (465 m/s) to minimize propulsion requirements. We assess the scalability of carbon nanotube tethers under dynamic loads, testing their capacity to withstand the stresses of accelerating massive payloads to the necessary ΔV for Lagrange point insertion. Advanced three-body simulations (Earth-Moon-Sun) incorporate lunar gravity assists and solar gravitational perturbations—analyzed in collaboration with a colleague—to design trajectories that ensure stable orbits despite high payload inertia. To capture these structures at Lagrange points, we consider a tether-based system linked to the Moon-L5 space elevator to manage kinetic energy effectively, alongside discovering the methods for trajectory adjustments. Moreover, the stability at L5 is further evaluated by integrating solar effects into the gravitational model, confirming its suitability for long-term habitation platforms. Visualizations, including stability contours and mass-versus-ΔV plots, illustrate how solar perturbations influence orbit design and station-keeping needs. Additionally, we explore electromagnetic launch adaptations along the tether to enhance propulsion efficiency, reducing reliance on chemical fuel for massive payloads. Therefore, we establish the theoretical feasibility of slingshotting massive structures to L5, offering a cost-effective alternative to conventional methods.