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Modern Day Space Elevator Transformational Strengths and their Applications (3)

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PERFORMANCE VERIFICATION OF SPACE ELEVATOR CLIMBER WITH HYBRID TYPE DRIVING ROLLER AND MECHANISM ANALYSIS BY SIMULATION

Abstract

The space elevator concept will be a structure that travels almost vertically, connecting the earth and space by a tether. Climbers applying this structure would need a special mechanism and would have to climb the tether under their own power. Therefore, it is quite difficult to apply the common elevator mechanism (pulling up with a rope) used on the ground to space. The main method considered is to use rollers to move on a vertical tether, which requires sufficient frictional force. Confronted and crossed roller drive mechanisms have been researched, but their operational effectiveness has not been fully investigated. The authors focused on the mechanism and durability of the climber when it travels long distances of tens of thousands of kilometers in space, and conducted experiments and analysis of a small climber to study its operational efficiency and safety. The proposed climber is a hybrid mechanism that combines confronted and crossed drive systems, and switching the advantages of each drive system is expected to improve the climber's drive efficiency. In this study, with the purpose of developing a hybrid roller-driven climber, the following verifications were conducted. (1) Mechanism analysis of each roller system (friction drive by tethers and rollers) was conducted, and the effectiveness of the hybrid type roller drive was confirmed through experiments. As a result, it was considered that the confronted type is less affected by the surrounding mechanical relationship, and the crossed type has a larger contact surface and greater frictional force, as well as less load on the tether because it does not pinch the tether. The situation in which each method is used differently was examined, and the efficient operation method of that climber was clarified. (2) Based on the results of (1), the operation of the climber with the hybrid type roller drive was simulated using mechanism analysis software. The hybrid type drive was simulated under several conditions (overall weight, speed, gravity, etc.) in each of the optimal operation patterns, and the optimal method was obtained in each case. The results are presented in detail in this manuscript and will be presented at IAC-2024.