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

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DEVELOPMENT OF HYBRID SPACE ELEVATOR CLIMBER WITH CONTINUOUSLY ADJUSTABLE ROLLER DRIVE ARRANGEMENT

Abstract

The space elevator concept is a structure that moves vertically on a tether installed between the Earth and space. It is quite difficult to apply the general elevator mechanism used on the ground (a mechanism that pulls up with a rope) to this structure. Therefore, it is thought that the climber will have a driving force (contact that requires friction between the vertical tether and rollers) and climb by itself. Pinch and capstan types of roller drive mechanisms have been researched, but their operational effectiveness has not been fully examined. The climber proposed by the authors is a hybrid mechanism that combines each roller method, and by using the advantages of each method, it is expected that the drive efficiency of the climber will be improved. In this study, the following verifications were carried out with the purpose of developing a hybrid space elevator climber in which the roller drive arrangement can be continuously changed. (1) Mechanism analysis of friction drive by tether and rollers and experiments using a climber capable of each roller arrangement were conducted to confirm the effectiveness. As a result, it was confirmed that the operating efficiency of each method was within the acceptable range. In terms of advantages and disadvantages, the pinch type requires almost no tether tension, and the mechanism is simple and compact, but the contact between the tether and the roller requires a large force, which causes localized loads. The capstan type requires an appropriate amount of tether tension and has a somewhat complicated mechanism, but since the force required for contact between the tether and roller is small, it is possible to lift larger loads with a configuration that is less affected by the load on the tether and roller. By using a hybrid mechanism that continuously changes each configuration, a method for efficient operation was clarified. (2) The hybrid mechanism in (1) can be used in the high vacuum space environment, and a model of a hybrid climber using this mechanism was produced. This climber was operated under conditions simulating the space environment (atmospheric pressure, high vacuum, etc.) to find the necessary conditions for each drive unit (heat, materials, mechanism, etc.). Details of the results will be presented in this manuscript and will be presented at IAC-2025.