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THE VINEBOT AS A LIGHTWEIGHT AND COMPACT ALTERNATIVE TO TRADITIONAL ROBOTIC MANIPULATORS IN SPACE

Abstract

Space technology faces the challenge of minimizing weight and volume to avoid exponential increases in costs during launch; this is not the exception for robotic manipulators that often have multiple heavy actuators. This study presents the Vinebot as a lighter and smaller alternative to traditional space robotic manipulators. It tests the behavior of several Vinebot prototypes operated in microgravity during a parabolic flight.

A Vinebot is a soft robot with a plant-inspired design that resembles a grounded root and a growing vine. The robot grows by supplying air pressure from the base, and a flexible plastic tube is pushed outwards, creating a growing plastic vine. Depending on its design, the direction of the growing tip can be either controlled remotely, pre-shaped, or influenced by its surroundings by colliding with objects in a plant-like manner.

Instruments like cameras or grippers are usually attached to the tip of the growing vine, but given its inflatable structure, the Vinebot is limited to carrying only low-weight objects. However, the weight limit is disregarded in a microgravity environment, where the Vinebot can achieve its full potential in addition to providing the lightweight and compact design highly sought for space applications.

This study evaluated the potential of Vinebots in microgravity by developing a series of prototypes specially designed to carry and move objects in low gravity. The Vinebots were tested on a parabolic flight that simulated lunar and zero gravity; all operations were recorded to be analyzed post-flight. Their performance proved that the Vinebot can manipulate objects efficiently and is hazard-free for human interaction due to its soft structure. This work contains the experiment's results analysis and discusses the Vinebot's advantages, challenges, and possible applications in space technology

Keywords— Vinebot, soft robot, parabolic flight, microgravity