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DESIGN AND DEVELOPMENT OF A COMPACT LEGGED DRONE FOR UNDERGROUND PLANETARY EXPLORATION

Abstract

Lava tubes are natural tunnels formed by the flow of lava during non-explosive volcanic activity. These tubes can be found on various planetary bodies, including Earth, Moon, and Mars. Since they have been recognized by satellite observations and orbital imaging, lava tubes have never been explored from the inside by direct robotic missions.

The proposed design aims to develop a specialized drone capable of exploring and assessing the habitability of these lava tubes. This involves analyzing various environmental factors, such as radiation levels, temperature variations, and mapping the interior structure of the tubes. Understanding these factors is crucial for determining whether lava tubes could serve as potential sites for human settlements in the future.

The drone represents a fusion of terrestrial and aerial technologies, leveraging the advantages of both legs and aerial capabilities. Its compact design is aimed at maximizing manoeuvrability and efficiency, enabling navigation through challenging terrains such as Lunar and Martian lava tubes. Additionally, the drone is envisioned to play a crucial role in terrestrial operations, including search and rescue missions and the analysis of at-risk underground environments.

Key objectives of this research include the optimization of the drone's design to ensure versatility and adaptability across different environments. Innovative manufacturing methods, such as 3D printing, will be explored to facilitate the production of compact and lightweight components essential for space missions.

To navigate and explore the lava tubes effectively, the drone's design includes features optimized for both aerial and ground mobility. The aerial segment of the drone is designed for vertical descent into the tubes through openings known as skylights. Once inside, the drone will rely on its legged mobility system to traverse the uneven and unfamiliar terrain within the tubes. This legged system provides versatility, allowing the drone to navigate slopes, obstacles, and granular surfaces that are characteristic of lava tube environments.

Overall, the design of this specialized drone represents an innovative approach to space exploration, with the potential to uncover new insights into the habitability of lava tubes and their suitability for future human exploration and settlement.