Robotic Exploration of Martian Caves in the Search for Life

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The existence of caves on Mars and the possibility of life within them are of great interest to astrobiology, and the search for life on Mars is a major goal of NASA's Mars exploration program. However, the exploration of caves on Mars is a challenging task due to the remote and hazardous environment.

Cave exploration is a complex task that requires a multidisciplinary approach. The key challenges in cave exploration include navigation, mapping, and scientific analysis. Navigation in caves is difficult due to the narrow and irregular passages, and mapping is challenging due to the limited visibility and the complexity of the cave geometry.

To address these challenges, researchers are developing new technologies and approaches. One such approach is the use of autonomous robots that can explore and map caves autonomously. These robots can be equipped with advanced sensors and algorithms that enable them to navigate through complex environments and collect scientific data.

In this paper, we present a framework for cave exploration that combines advanced robotics and machine learning techniques. The framework includes a set of autonomous robots equipped with advanced sensors and algorithms that enable them to explore, map, and analyze caves autonomously. The robots are designed to work in a coordinated manner, communicating with each other and with a central control system to plan and execute missions.

The framework is designed to be adaptable to different cave environments, and it can be customized to the specific needs of each mission. The robots are equipped with a range of sensors, including 3D LIDAR, camera, and magnetometer, which enable them to build detailed maps of the cave environment and to detect and analyze potential scientific targets.

The framework also includes a decision-making system that allows the robots to make autonomous decisions based on the data they collect. This system uses machine learning techniques to analyze the data and to make decisions about the best course of action.

In conclusion, the framework presented in this paper provides a new approach to cave exploration that combines advanced robotics and machine learning techniques. This approach has the potential to revolutionize our ability to explore and understand the complex environments of caves on Mars and other extraterrestrial locations.