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A Self-Adaptive Intelligent Inspection System for Polar Palaeoenvironment Research

Hou Hei Lam, Chi Weng Fong, Maggie Xie

The Affiliated School of the University of Macau, Macao Special Administrative Region, China

The harsh climate with low temperatures, heavy snow and high UV intensity in polar region, severely reduces mobility and causes great physical exertion. Moreover, researchers were unable to explore the caves in detail because of the high uncertainty of the icy terrain, putting researchers at risk of injury or death. Working in the polar regions without the proper equipment is a major safety problem, researchers cannot access small caves and crevices.

In the study of the polar paleoenvironment, sufficient samples are needed for sample testing and analysis. However, low efficiency of drilling project, lack of samples, low flexibility of sampling equipment, inability of robots to enter narrow channels, and the need to enlarge the space range of research means are the existing problems. Moreover, the resources and time invested in ice core drilling projects are high. And if there are not enough samples collected, the resources cannot be fully utilized.

However, current polar robots are not suitable for exploring caves and crevasses in detail. According to the above problems, it is necessary to build a robot that can meet the polar conditions to replace human for sample collection and environmental detection. In our research, a polar exploration robot which is able to adapt different environments is proposed as a sampling tool for geological analysis of Antarctic samples.

The design of the self-adaptive inspection polar robot adopts a combination of 6 groups (one group contains two wheels), 12 separate drive wheels, and 6 groups of feedback control technology. And through the completion of the structural design, control system design and control strategy, it can be actively adaptive to different hole diameters, and samples of fossils and rocks can be collected in environments of different sizes. And the system stability tests under different conditions are conducted to confirm the feasibility of the system.

For rock samples, zircon U-Pb radiometric dating and geochemical ICP-MS analysis were conducted. In X-ray fluorescence analyses, the intrusive rocks are classified as calc-alkaline andesite. LA-ICP-MS analyses yielded zircon U-Pb ages of 51Ma±4Ma for the calc-alkaline andesite, indicating that it was emplaced in the early Cenozoic. The geochemical characteristics of diorites reveal that they originated from

the partial melting of the mantle wedge. Consequently, Cenozoic diorites in the Palmer Archipelago region of Antarctica are associated with the subduction of the Phoenix Plate.

Overall, the intelligent system can be used in different polar scenes for detection or sampling, providing a new means for polar scientific research.