BioGrip: A Bio-Inspired Gripper With Integrated Rock Hardness Sensing for Extreme Terrain Navigation

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In construction or any fields that involve blasting, workers often measure rock hardness and assess slope stability on steep, high-altitude surfaces, requiring high-risk suspended tasks. These operations, especially in open-pit mines and quarries, involve measuring rock hardness with tools like the Schmidt hammer, which is critical for drilling and blasting design. However, such tasks expose workers to danger and are physically demanding, reducing efficiency and safety. This project introduces a biomimetic gripper inspired by beetles, designed to improve safety and efficiency in mining. The gripper integrates micro-hook grasping, bio-inspired adhesion, and a rebound hammer for precise rock hardness measurement. The gripper mimics beetle claws, utilizing their hook-like structure. Its six-claw linkage mechanism adapts to rugged rock surfaces, ensuring secure attachment. One claw is replaced with a rebound hammer, enabling real-time hardness measurement. The gripper follows a stepwise process that biomimicries the beetles: surface alignment, adaptive grip, pressure adjustment, and repositioning, ensuring stable climbing. By reducing the need for high-risk suspended operations, the gripper allows long-duration, high-precision measurements, enhancing geotechnical monitoring and mining efficiency. This robot provides a safe, scalable solution for operations in dangerous terrains, improving productivity and safety in industrial applications.

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