Exploring Stick-Climbing and Grabber-Wheel Hybridization: The Development of an Inchworm Robot with Integrated Skateboard Mechanism

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In the diverse landscape of robotic applications, there has been limited research on robots capable of navigating under stick structures, despite their critical importance in high-risk environments such as power grids and steel cable systems. This study aims to develop innovative bionic robots that emulate the locomotion patterns of caterpillars and inchworms, facilitating movement under stick structures and offering a viable alternative to hazardous manual labor. These bionic robots have undergone four distinct generations of development. The first and second generations primarily focus on wire pulling by servos and the implementation of friction control for the robot's legs. Following a series of experimental iterations, these generations can crawl at various angles and exhibit flexibility on straight sticks with diameters ranging from 6-10mm, achieving a speed of approximately 3.9mm/s. The third and fourth generations shift their emphasis toward a tandem servo structure that mimics inchworm locomotion. This enhancement introduces new functionalities, including the capacity to navigate bending sticks, perform obstacle avoidance, and traverse multiple pipes simultaneously. Furthermore, the fourth generation features the ability to transition between grabber and wheel states, significantly augmenting overall efficiency. With the incorporation of advanced grabber technology, these robots can now crawl under sticks with diameters of 15-30mm. Potential applications include grid maintenance, steel cable breakage detection, navigation through narrow, complex spaces, and numerous other scenarios yet to be explored. This research contributes to the advancement of robotic systems in high-risk environments and showcases the potential of biomimetic design principles.

Awards Won:

First Award of $5,000

Craig R. Barrett Award for Innovation