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Design and Implementation of a Climbing Robot Limb for Clinging to Rough Walls

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Abstract
In recent years, the urgent need for robotics applications in various sensitive work areas and high buildings has led to a significant development in the design of robots intended for climbing rough surfaces. Where, attention became focused on the ideal clinging mechanism. In this paper, a gripper of the climbing robot has been designed to achieve clinging on rough walls. The objective of this design is to be lightweight with high performance of clinging, therefore, a robot gripper has been designed based on a model of a limb inspired by the hand and claws of a cat, in which the robot claws were implemented by fishing hooks. These hooks are arranged in an arc so that each hook can move independently on the wall's surface to increase the force of clinging to the rough wall. SolidWorks platform has been used to design the clinging limb and implemented using a 3D printer. In addition, the proposed design has been validated by performing several simulations using the SolidWorks platform. Experimental work has conducted to test the proposed design, and the results proved the success of the design.

Keywords
Climbing Robot, Clinging Mechanism, Gripper Device, SolidWorks, Rough Wall.

I. Introduction

In recent decades, interest and great growth in robotics has taken a large part. Research on climbing robots is considered attractive research, as they can be an alternative to humans in many fields, in which these robots are placed in dangerous or high places where humans cannot reach them, such as cleaning and inspecting high places, monitoring, maintaining, and diagnosing oil and gas storage tanks, nuclear and petrochemical power plants, and many facilities whose maintenance and monitoring cost huge sums of money [1–5].
There are several types of climbing robots used in vertical structures such as column climbing robots, pipe climbing robots, tree climbing robots, cable climbing robots, and wall climbing robots [3]. Wall climbing robots have a special operation mechanism in extreme environments. Climbing robots attach themselves to wall surfaces using four mechanisms: vacuum suction, magnetic attraction, adhesives, claws, or hooks as shown in Fig. 1. For smooth and glass-like surfaces, the adhesive or suction adhesive mechanism is effective, but it becomes unstable due to the influence of vibrating wall surfaces [1, 2, 6, 7].

The magnetic attraction technique is very powerful, but its application is limited, because it is only used for ferromagnetic surfaces, and fails for wall surfaces under long-term vibrations, such as diagonal cable bridge towers and bridge piers. In other climbing robots, adhesives techniques are used that uses special glue for sticking to the surface. These glues are added in the climbing limbs, which makes them adhere to the surfaces, but the adhering capacity of the limbs decreases gradually, making lost sticking with the wall. Therefore, these techniques are limited too. For rough surfaces such as rocks, bricks, and rough concrete, the grasping technique is the most