TransitBot: Transitional Shape-Adaptive Wall-and-Pole Climbing Robot With Rotary Microspine Mechanism

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Climbing robot mechanisms offer substantial advantages for navigating challenging terrains. The rotary microspine excels in climbing rough surfaces due to its capability for rapid speeds and smooth transitions from horizontal to vertical planes. Despite the critical need for high environmental adaptability to diverse conditions, studies on robots designed for distinct surface geometries remain limited. To address this gap, I developed TransitBot, a transitional shape-adaptive climbing robot leveraging multiple adjustable links that incorporate the rotary microspine mechanism. This design is underpinned by extensive kinematic and dynamic analyses, which optimize the robot's engagement with curved surfaces, facilitating efficient climbing on rough vertical structures, including walls and poles. The development process involved numerous iterations of design and testing, progressively integrating different settings of microspine wheel links, revolute joints, and tails. A significant improvement was realized with the second prototype after the employment of longer tails instead of back supports, enabling successful initial climbs. Subsequent prototypes introduced active tails, additional grippers, and a symmetrical layout, culminating in the sixth prototype which exhibited improvements in stability and control. These findings confirm the robot's ability to climb both wall and pole structures with rough surfaces and effectively transition from horizontal ground to these surfaces. The robot's versatility supports potential applications in the maintenance of tall structures, reconnaissance, exploration, and safety enhancement in various environments.

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