

Design of robotic wheelchair capable of overcoming stairs

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Abstract— Individuals with lower-limb disabilities often face significant challenges in overcoming everyday obstacles such as stairs, limiting their mobility and independence. This study introduces the design of a robotic wheelchair engineered to navigate such barriers effectively. The robotic wheelchair not only manages flat terrains but is also equipped with mechanisms that allow it to easily surmount obstacles typically insurmountable by conventional wheelchairs, such as stairs. This capability significantly enhances the mobility and freedom of individuals with lower-limb disabilities.

I. INTRODUCTION

In addressing the mobility challenges faced by individuals with lower-limb disabilities, overcoming obstacle such as steps or stairs remains a significant barrier that conventional wheelchairs fail to overcome. This limitation not only restricts access to multiple places but also impacts the autonomy and quality of life of those affected. Therefore, the requirement of the development of wheelchairs capable of overcoming obstacles and free to move has been asked from the people with lower-limb disabilities. There were few types of wheelchair systems capable of overcoming stairs with using caterpillar system [1], combination of multiple legs [2], wheel cluster system [3] and leg-wheel combined system [4]. However, in the case of the caterpillar system, there are instances where maintaining the wheelchair's posture becomes challenging due to slippage that occurs depending on the relative position of the stairs and the wheelchair. The wheel-cluster based wheelchair can effectively overcome the only pre-defined dimensional stair. They face limitations when the size of the stairs varies, making them less adaptable to different conditions. In case of wheel-leg based wheelchair and leg based wheelchair, their size and system becomes complex and the dependency on sensor system is increased. Because of these limitations, it was difficult to find appropriate wheelchair system for overcoming obstacles. In this paper, we propose the design of robotic wheelchair capable of overcoming steps and stairs which were difficult to overcome using general wheelchair. We proposed the specially designed the caterpillar system which has curved shape to support the ground effectively. In addition, the application of the adaptable wheel in the wheelchair system is also described to increase stability of overcoming obstacles.

II. DESIGN OF WHEELCHAIR MOBILITY MODULE

To increase stability of the wheelchair system while climbing stairs, the special track mechanism is proposed to ensure that the wheelchair maintain a stable grip the stair without slipping. This mechanism allows the continuous track to support the ground surface effectively as Fig. 1. This robotic

wheelchair system includes standing module capable of 5-different posture variation.



Figure 1. Robotic wheelchair system capable of stair climbing

In addition, there is also consideration for application of deformable wheels that can change its shape using a wedge-shaped serial structure for wheelchair as Fig. 2. Each of wedge-shaped structure can be largely split when it contacts to the edge of stair, then it can be easily deformed.

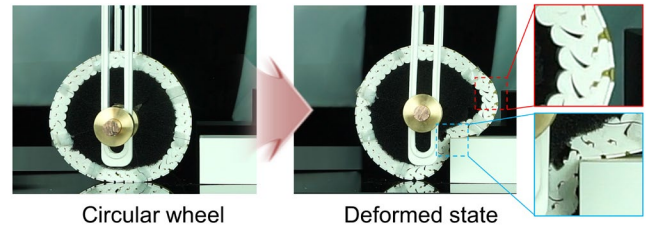


Figure 2. Deformable wheel design using wedge-shaped serial structure

III. CONCLUSION

The design of a robotic wheelchair for overcoming obstacles such as stair was proposed and the two different mobility systems with curved caterpillar and wedge-shaped deformable wheel were presented.

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