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ICIEA22-000441 A Passive Upper Limb Assistive Exoskeleton for Overhead Assembly Tasks

X. Li, H. Ma, Y. Han, D. Shi, W. Zhang and X. Ding
School of Mechanical Engineering and Automation,
Beihang University, Beijing, China

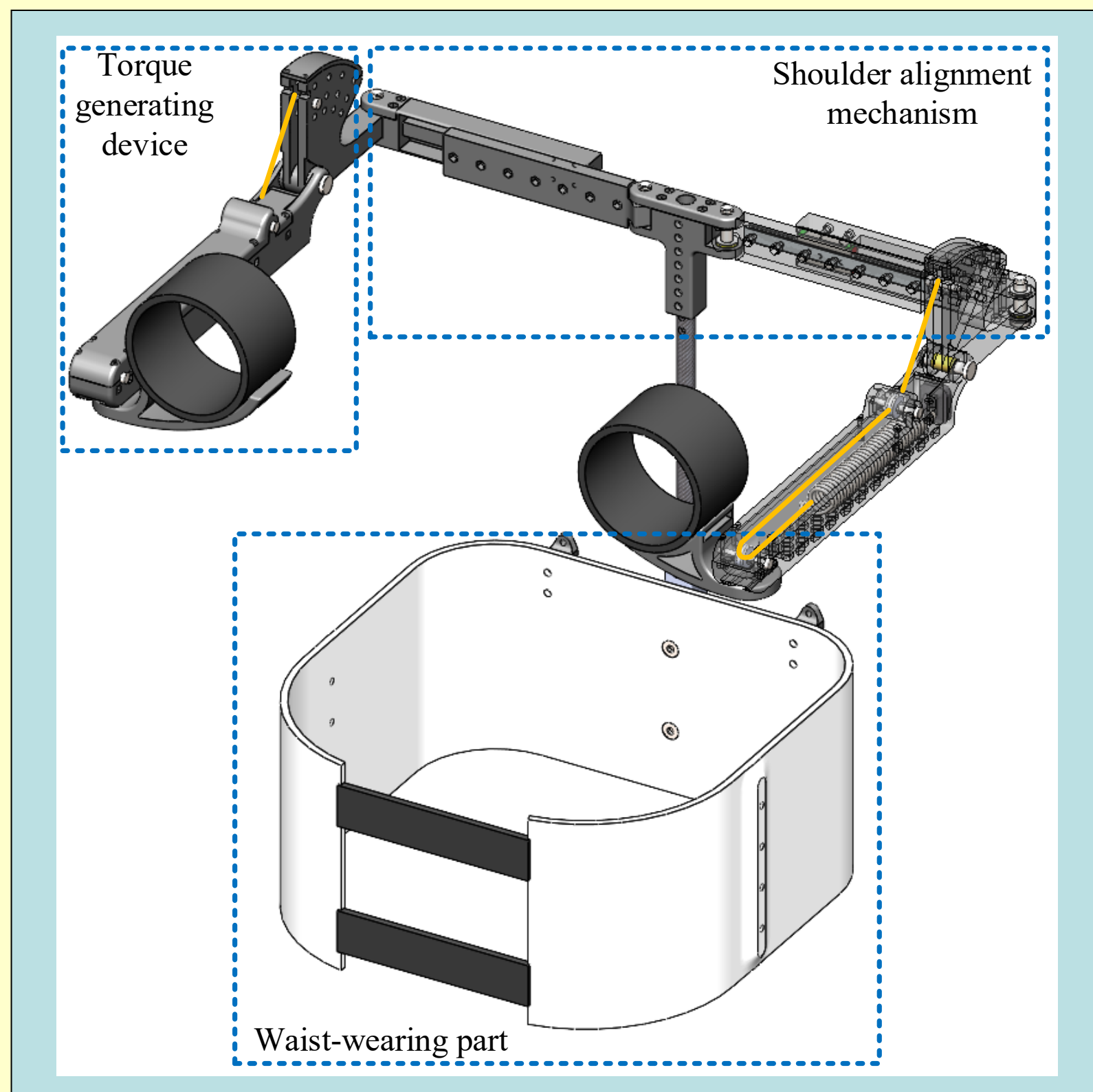


Fig. 1. Model of the passive upper limb assistive exoskeleton.



Fig. 2. The exoskeleton provides upper limbs with assistive torque.

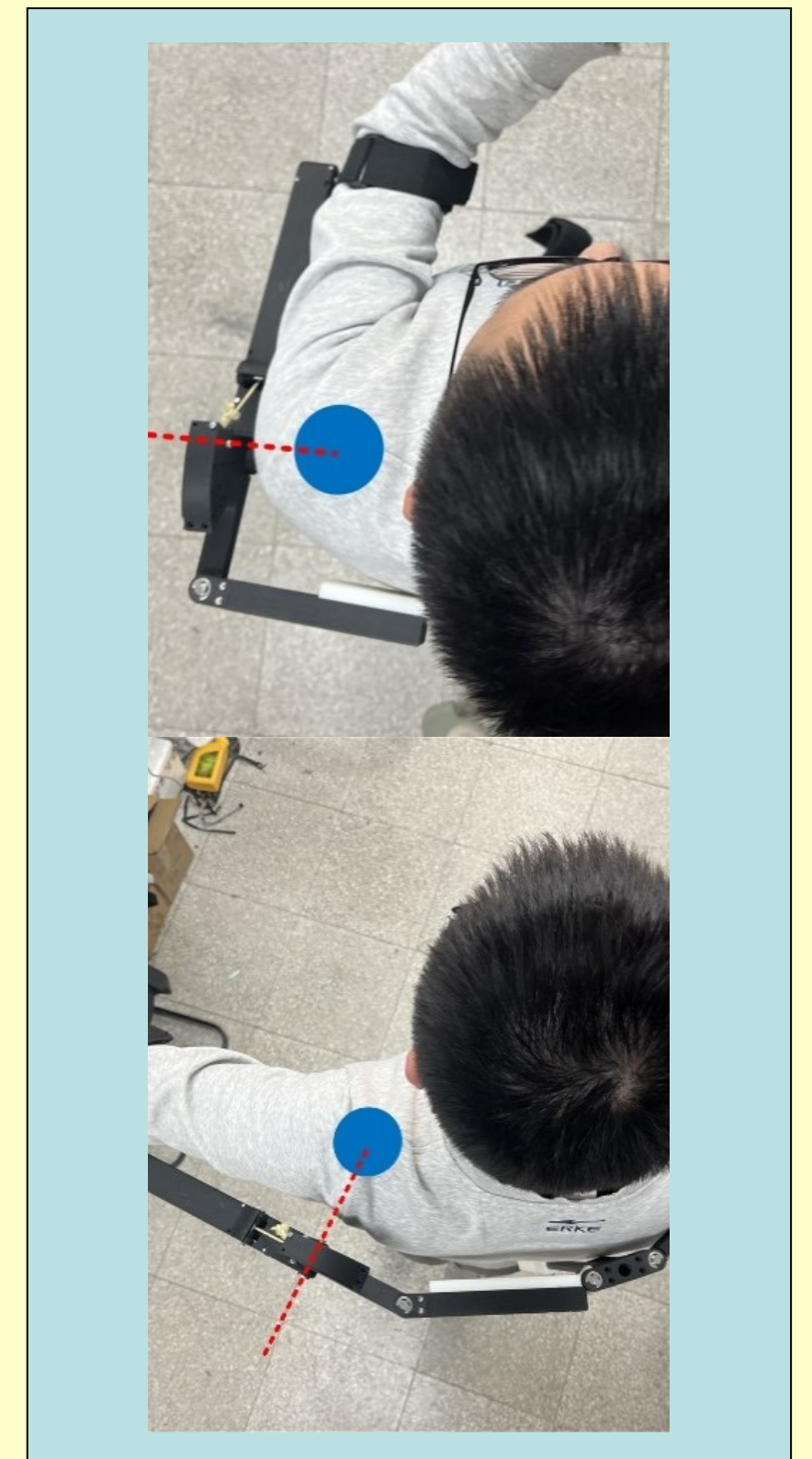


Fig. 3. The exoskeleton achieve self-alignment.

This article presents the design of a passive upper limb assistive exoskeleton for overhead assembly tasks, which consists of three different subassemblies: a torque generation device, a shoulder alignment mechanism, and a waist-wearing part. Considering the exoskeleton should provide support and be worn with comfort, this approach can provide customized upper limb assistive torque, and achieve self-alignment of the pitch axis of the torque generating device with the shoulder joint of the human body.

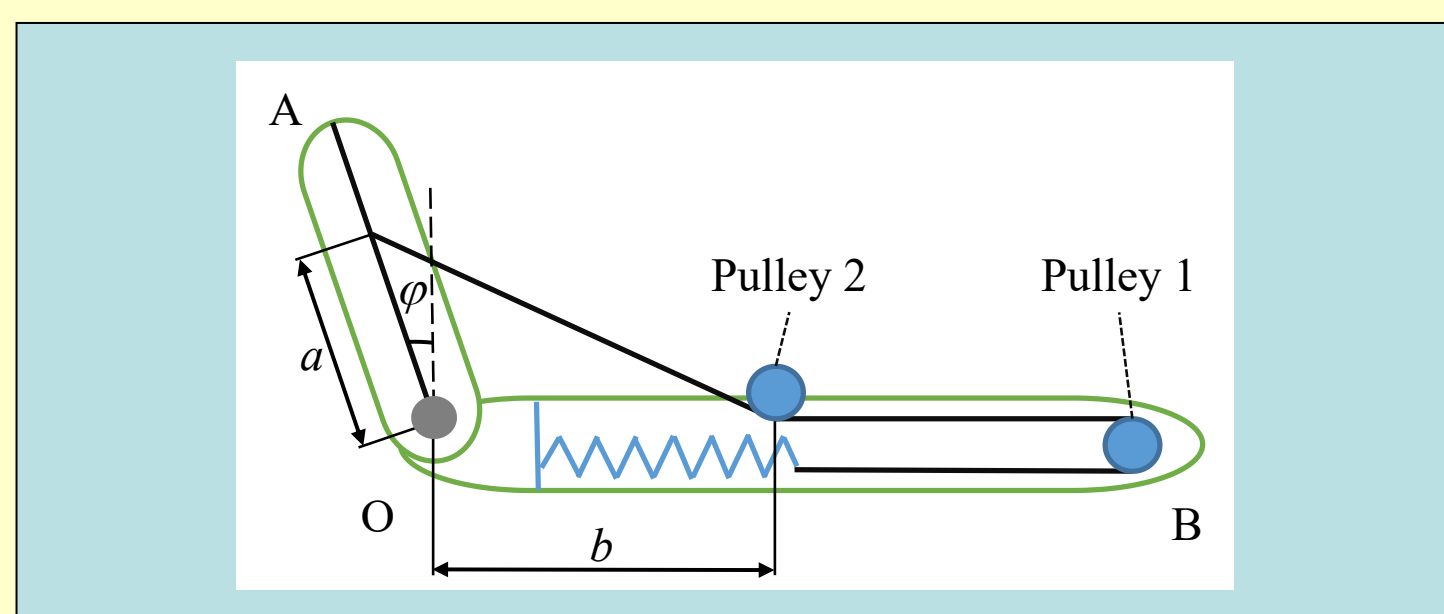


Fig. 4. Gravity balancing mechanism.

$$\tau(\theta) = \frac{k(\sqrt{a^2 + b^2 - 2ab\cos\theta} - |a - b|)ab\sin\theta}{\sqrt{a^2 + b^2 - 2ab\cos\theta}}$$

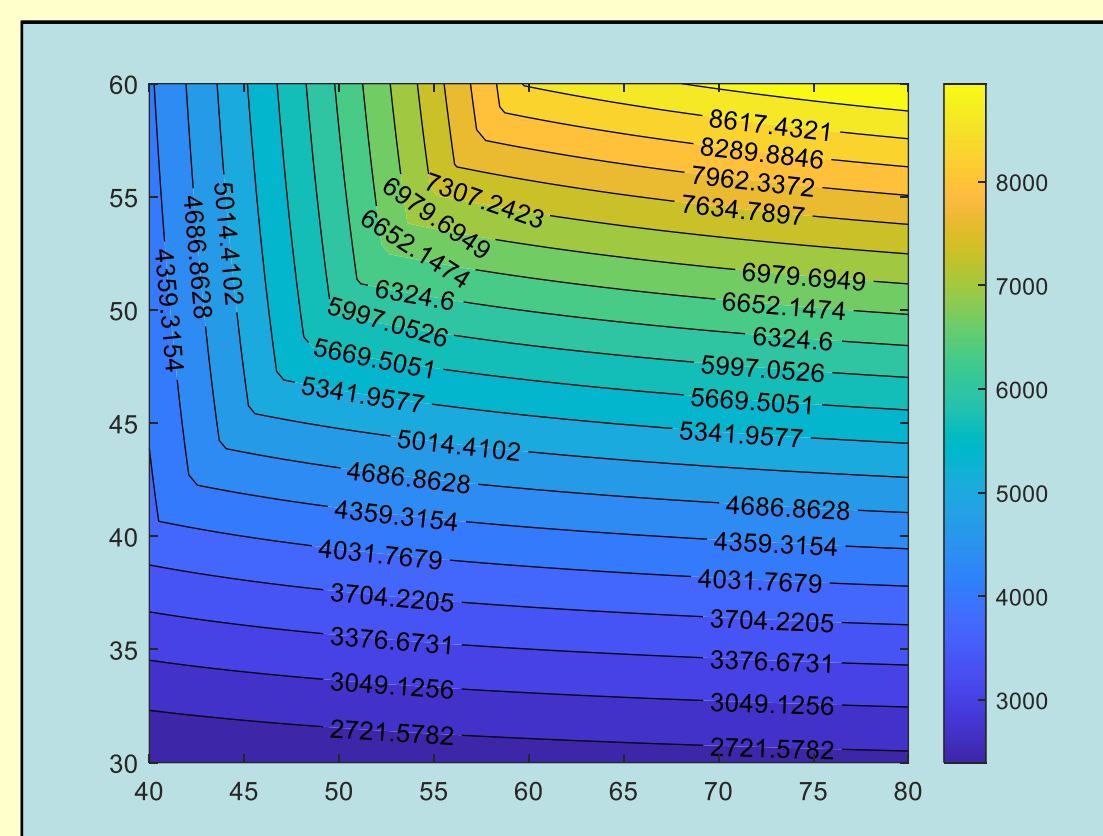


Fig. 5. Peak output torque at different dimensions of a and b .

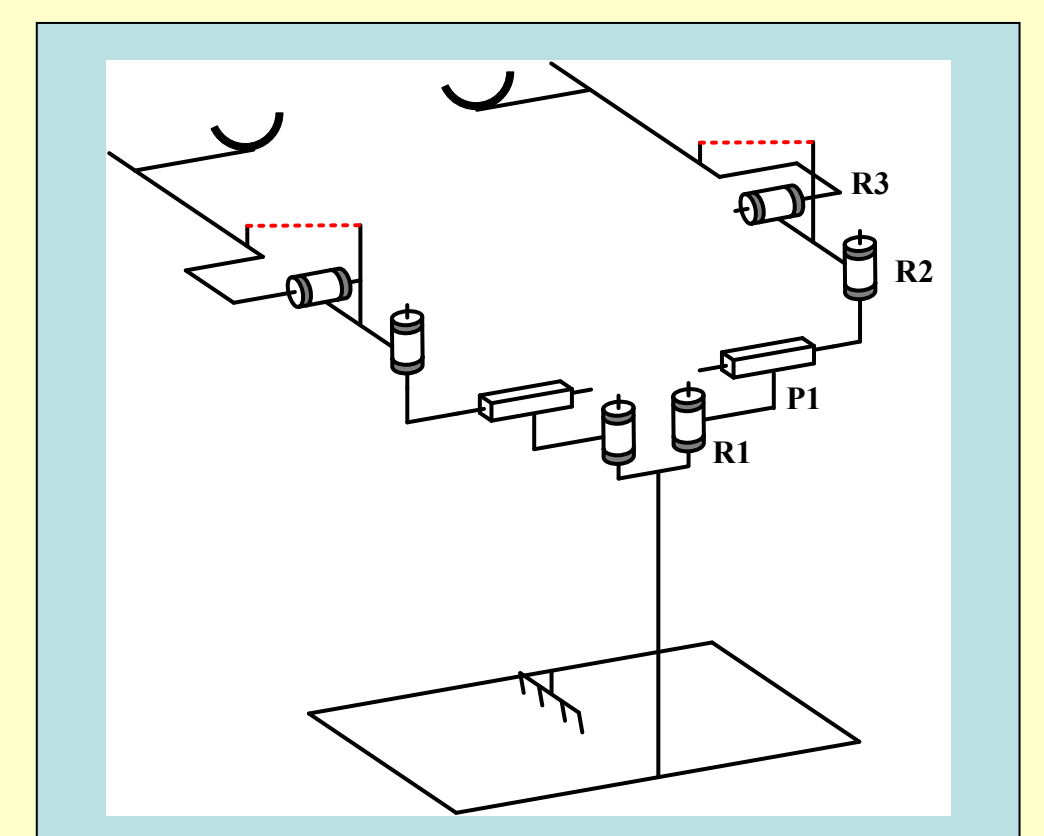


Fig. 6. A passive kinematic chain with redundant DoFs.

Summary

Upper limb exoskeletons can provide workers with assistance, becoming an effective solution to reduce the prevalence of WMSDs. This paper introduces a novel passive upper limb exoskeleton able to assist workers with overhead assembly tasks. The exoskeleton proposes two key mechanisms: (1) a torque generating mechanism capable of generating adjustable torque profiles to suit the arm position required for overhead work, and (2) a shoulder alignment mechanism consisting of a passive kinematic chain with redundant DoFs. Numerical optimization was performed to obtain better output torque profiles. A prototype is worn with wearing comfort and provides upper limb assistance, which can be used in industrial for overhead assembly tasks.