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Design of a Multi-Functional Hair Washing and Healthcare Bed for the Elderly

Lirong Huang, Liuyuan Huang, Honglei Chen
School of Mechanical and Automotive Engineering, Shanghai University of Engineering Science, China

Abstract
This paper presents the design and development of a multi-functional hair washing and healthcare bed, specifically engineered to address the challenges faced by elderly and individuals with limited mobility in maintaining personal hygiene. Traditional hair washing methods often cause discomfort and pose safety risks. Our innovative design integrates four core modules: a Support Module, a Washing Module, an Adjustment Module, and an Auxiliary Module. Key features include an ergonomically designed headrest, an app-controlled automated postural adjustment system, a temperature-regulated water circulation system, and robust safety mechanisms. The bed is constructed from durable, hygienic, and comfortable materials.

Keywords: *Elderly Care, Hair Washing Bed, Mechanical Design, Ergonomics, Healthcare Equipment*

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I. INTRODUCTION

Population aging is a global trend. In China, the population aged 60 and above reached approximately 249 million in 2018, with about 18.3% (over 40 million) being disabled or semi-disabled [1]. For this demographic, routine activities like hair washing become significant challenges, often requiring assistance. Traditional methods, such as bending over a sink or using a basic basin, can cause severe neck and back strain. Existing hair washing chairs or beds often suffer from complex operation, inadequate comfort, and limited functionality [2, 3]. Maintaining personal hygiene, including hair care, is crucial for the dignity, self-esteem, and overall well-being of the elderly. There is a clear market need for a product that is not only functional but also prioritizes user comfort, ease of use, and safety[4]. This paper details the mechanical innovation behind a multi-functional bed designed to meet these needs through an integrated, user-centric approach.

II. MECHANICAL DESIGN

Our design process was centered on solving identified user pain points. The final product is decomposed into four synergistic modules, the overall structure is as shown in Figure 1.

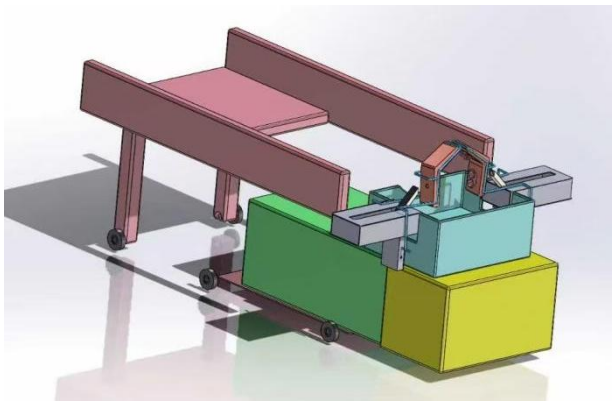

Figure 1: Overall structure

2.1 Support Module

This module forms the foundational structure of the bed,as shown in Figure 2.

Bed Frame:Constructed from high-strength steel to ensure stability and durability, capable of supporting user weight and operational stresses. The base is fitted with anti-slip pads to prevent unintended movement during use.

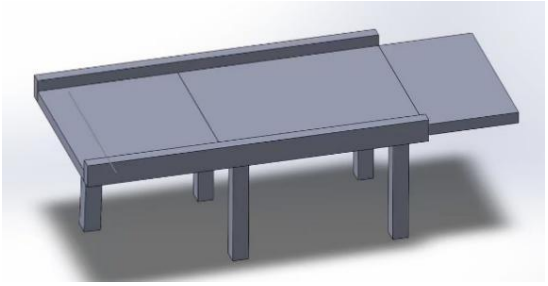

Figure 2: support frame

Headrest: Ergonomically contoured to fit the natural curve of the head and neck[5,6]. It is crafted from soft, elastic materials like memory foam to provide comfortable support and alleviate cervical pressure. The design includes auxiliary support structures to stabilize the head during washing.

2.2 Washing Module

This module handles the core hair washing function,as shown in Figure 3.

Washing Basin:Made from lightweight, durable plastic or anti-bacterial stainless steel for easy cleaning. Its shape is designed to snugly fit the head, preventing water spillage. The rim is lined with soft rubber to enhance comfort.

Water System:Features a temperature-controlled water inlet (faucet or spray head) with a clear temperature display to prevent scalding. The drainage system consists of a quick-draining, sloped pipe with a filter mesh at the outlet to prevent clogging by hair. Pipes are designed to be detachable for easy maintenance.

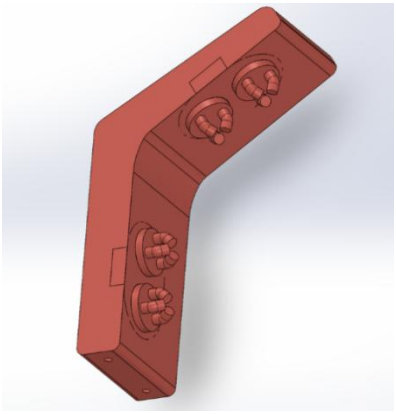

Figure 3: Washing Basin

2.3 Adjustment Module

This module provides customizable positioning for optimal user comfort and caregiver access, as shown in Figure 4.

Bed Angle Adjustment: Utilizing electric or hydraulic actuators, the bedhead can be raised from 0° to 60°, allowing the user to be in a comfortable semi-supine or reclining position. The bed foot is also adjustable. The entire bed surface can be tilted to guide water flow efficiently into the basin.

Basin Adjustment:The washing basin can be rotated and tilted within a certain range to perfectly align with the user's head position, ensuring water flows directly into the basin without splashing.

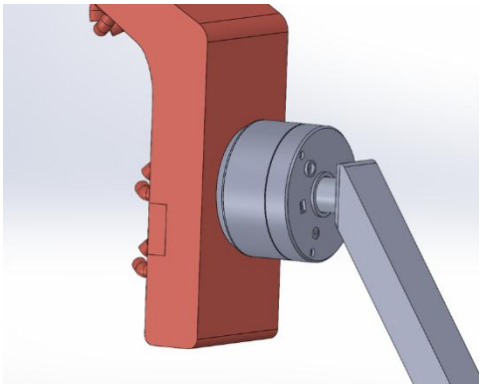

Figure 4: Basin adjustment

2.4 Auxiliary Module

This module incorporates critical safety and convenience features.

Safety Guardrails:Made from lightweight yet sturdy aluminum alloy with an anti-slip surface. They are height-adjustable and can be folded down for easy user access and raised during operation to prevent falls.

Storage:Includes built-in drawers and shelves for storing shampoo, towels, and other care items. A storage pouch is attached to the guardrail for small, frequently used objects

III. INNOVATION AND ADVANTAGES

The proposed design offers several distinct advantages over existing solutions:

Enhanced Comfort:The ergonomic design and use of premium materials (memory foam, soft rubber) significantly improve user comfort compared to hard, flat surfaces.

Simplified Operation:An intuitive smartphone application provides simple control over all adjustment functions, lowering the operational barrier for caregivers.

Improved Safety: Integrated safety features like adjustable guardrails, anti-slip bases, locked casters, and water temperature displays comprehensively mitigate risks.

Multi-Functionality & Portability:The bed integrates washing, massage, and care functionalities. It is designed for practical use with foldable parts and a detachable basin, facilitating storage and mobility.

Hygiene and Eco-Consciousness:The use of anti-bacterial materials and an efficient, cleanable drainage system promotes hygiene. The design prioritizes recyclable materials where possible.

IV. CONCLUSION

This paper has detailed the mechanical design of a novel multi-functional hair washing and healthcare bed. By adopting a modular approach focused on ergonomics, safety, and ease of use, this design effectively tackles the limitations of current products on the market. It provides a practical, comfortable, and dignified solution for assisting the elderly and individuals with mobility impairments with their personal hygiene routines. This innovation holds promise for improving the quality of life for users and easing the burden on caregivers.

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REFERENCES

[1]. Wu, M. (2018). Taking good care of the disabled elderly is the guarantee bottom line of "support for the aged". Chinese Elderly, P23.

[2]. Yu, D., & Wang, Y. (2016). Social value-driven sustainable innovation and design strategies. Journal of Nanjing Arts Institute (Art & Design), P02.

[3]. Yu, D., Yi, X., & Wang, Y. (2017). Design research of elderly shopping cart based on user experience. Packaging Engineering, P12.

[4]. Li, S., & Zhang, W. (2023). The trend of population aging and the demand for long-term care in China. Population Research, 47(1), 45-60.

[5]. Chen, H., & Liu, F. (2022). Application of ergonomic principles in the design of household medical devices for the elderly. Journal of Machine Design, 39(4), 120-125.

[6]. Zhang, Q., & Zhou, Y. (2020). Modular design of smart nursing beds based on functional analysis. Modular Machine Tool & Automatic Manufacturing Technique, (5), 80-83.