Standing Device for Assisting Elderly People Indoors

Haoming Yang*, Jingle Yu and Li Yang
School of Haoming Yang, Jingle Yu and Li Yang, Wuhan University of Technology, Wuhan, China

*Corresponding author: 741200191@whut.edu.com

Abstract. The device is mainly to solve the problem of difficulty for the elderly indoors to get up. The coordinated cooperation of the screw rod and the electric push rod is mainly used to realize the fitting of the motion end of the device to the motion curve of the elderly when standing, thereby further improving the comfort of the elderly. Make the device more adaptable. In addition, the device is also equipped with a voice drive device, and the operation of the voice control device realizes man-machine coordination.

Keywords: Assisted standing, adaptive, personalized.

1. Background
With the deepening of the aging of the Chinese population, the growth rate of the proportion of the elderly in my country has been higher than the world average. Most elderly people live in indoor scenes such as homes or nursing homes, and most elderly people have a certain ability to take care of themselves. However, due to the decline of the muscle strength of the lower limbs of the elderly with age, the knee joint torque is insufficient and the knee cartilage damage is intensified. The arm muscles and leg muscles degenerate. Therefore, the elderly will have difficulty in standing, and most elderly people need to use standing aids.

At this stage, auxiliary standing devices are products based on research, the most common auxiliary standing electric chairs and pure mechanical auxiliary standing supports on the market. Pure mechanical assisted standing equipment has a single function and has the risk of slipping and easy loss of balance. The level of automation and safety and quality problems need to be solved urgently, which cannot meet the needs of use. The auxiliary standing electric chair has weak adaptability and cannot adapt well to elderly people of different body types. It is inconvenient to operate and lacks humanized design, which makes it difficult to achieve the ideal use effect. In addition, such equipment is often expensive, which is not conducive to large-scale promotion. Based on the above background, we have proposed a device for assisting the elderly in standing indoors. The device can be self-adjusted to adapt to elderly people of different sizes, and the humanized design meets the needs of the elderly.

In view of the existing devices that assist the elderly in standing in my country, it can be seen that there is still a large gap in assistive devices for the elderly living alone. Therefore, in order to adapt to the serious aging situation in my country, the research and design of auxiliary standing devices suitable for the elderly living alone, it is of great significance to improve the happiness index of the elderly in our country and adapt to the aging society. For this reason, the design of this project’s multi-scene standing device for the elderly mainly addresses the following questions: 1) Whether it can assist the elderly living alone to complete the standing function in multiple indoor scenarios; 2) the stability of the...
device structure and the ease of operation 3) Whether the device can adapt to elderly people of different sizes; 4) Whether the device is intelligent and can be adjusted according to human intelligence, so as to assist the elderly more conveniently.

![Figure 1. Schematic diagram of the device body.](image1)

2. Mechanical design

The main function of the auxiliary standing module of this device is to finally fit the movement trajectory of the harness to the trajectory of the human body during the standing process through the cooperation of the screw rod and the electric push rod, thereby providing auxiliary support for the elderly during the standing process from the waist and back of the elderly. Force, the institutions involved in the work process are mainly multi-bar mechanisms:

![Figure 2. Diagram of multi-bar mechanism.](image2)

Due to the different body parameters of different elderly people, the main factors affecting the movement curve of the center of gravity during the elderly are the length of the elderly’s thighs and the distance between the elderly’s hip joints and the ground in the standing state. In order to make the device more comfortable and meet the needs of the elderly's special motion trajectory, the device can adjust the speed ratio of the screw motor and the electric push rod to achieve the motion trajectory of different slopes. We made the elderly standing by referring to the human body data. The motion range of the body's center of gravity during the process allows the device to meet two boundary conditions. Therefore, the device is more adaptive.
Adjust the device to the height adjustment mode, and adjust the controller to the set motion speed ratio of the screw slider and the electric push rod, so that the entire device can achieve height adjustment within a certain range in the vertical direction. So as to adapt to the height of multiple scenes in the family, making the elderly more natural and comfortable in the process of completing standing.

3. Control system design
In order to make the device more convenient and intelligent, the project team added an electronic control part to the device. At the same time, the existence of the electronic control part also improved the accuracy and reliability of the device. The project team carried out the reliability design of the electromechanical equipment and control system of the device, so that the device can not only improve the sensitivity as much as possible, but also self-lock and stop working in time when an accident occurs. The electronic control part of the device uses Arduino as the main control board to accurately control each electronic control hardware. It is mainly divided into auxiliary functions such as an auxiliary standing part, a movement control part and a load. The specific control process is as follows:

![Control flow chart](image)

4. Simulation check
The simulation analysis shows that when the device acts as a temporary seat and needs to help the elderly finish standing, the slider on the screw rod needs to move 100mm in the reverse direction, so the size of the screw rod needs to be greater than 442mm, and the slider itself is considered Therefore, the final design screw size is 487mm. According to the human body size, when the human body sits down, the depth of the seat is in the range of 400mm-494mm, and the size of the thigh is in the range of 399mm-501mm. Theoretically, the traction point needs to move 400mm in the horizontal direction when helping the elderly to stand. You need to move at least 400mm in the straight direction, but according to the characteristics of the three stages in the human body’s natural standing movement, the most difficult stage for the elderly to stand is from stage 1 to stage 2, so the traction point is in the horizontal and vertical directions the distance required to move is less than theoretically. Through investigation and simulation analysis, it is known that the horizontal movement distance of the towing point is finally determined to be 300mm, and the vertical movement distance is 100mm. Therefore, it is finally determined that the strokes of the two push rods are 100mm and 250mm. Through simulation analysis, we know that the size of the device roughly meets the needs of different elderly people.
Figure 4. The device assists the movement curve of the center of gravity of the elderly when standing.

The red line in the figure above is the movement curve of the center of gravity of the body (center of gravity of the hip joint) during the standing process of the elderly with the assistance of the device. The colored lines are the movement curves of the body's center of gravity of elderly people of different body types standing without assistance. By adjusting the initial position and speed ratio of the push rod and the screw rod, the area of the moving interval can almost cover the color line area, that is, the size of the device can meet the assistance needs of elderly people of different sizes.

5. Conclusions
The main function of the device is to assist the elderly to complete the process of standing indoors from multiple scenes. The screw and electric push rod can cooperate to achieve the fitting of the displacement curve of the center of gravity of the elderly during the standing process, and by controlling the screw motor the speed and the speed ratio of the two putters can fit a variety of curves, so as to adapt to the elderly of different body types and different rising heights indoors. The device combines ergonomics, has a good effect on assisting standing for the elderly, and has a broader application prospect.

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