Multi-functional indoor elderly standing seat

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Abstract. As China’s running enters an aging society, the number of people over the age of 60 is growing rapidly, and the number of "empty-nesters" living alone and widowed is growing at an unprecedented rate. The elderly living alone are the vulnerable groups of the elderly, their own control of the environment and the ability to cope with sudden situations, and no one to take care of, it is easy to accident. Therefore, to create a peaceful, peaceful, happy old age, so that they live in peace and security, happy to spend every day, is a major task we have to take on. Based on the above background, the team members studied and designed a new type of power-assisting device - multi-functional indoor power-assisted chair. The device has the characteristics of light body, clever structure and low cost, including two function modules, auxiliary sitting and auxiliary walking. The coordination and cooperation between the various agencies effectively prevents the accident when the elderly are alone at home, which has high practical value and promotion value.

1. Research background and significance

1.1 Research background
At present, there are many countries around the world showing the trend of population aging. It will also be a great challenge for humanity on economic and social issues. In China, with the rapid rise of people's living standards and the rapid development of health care, Chinese life expectancy has been extended, the proportion of the elderly population is also rising. In 2017, the population of the population aged 60 and over was 240.9 million, or 17.3% of the total population, of whom 15.831 million were aged 65 and over, or 11.4% of the total population. The number of people over 60 and over 65 increased by 0.6 percentage points over the previous year. By 2020, the elderly population is expected to reach 248 million and the ageing level will reach 17.17%, of which 30.67 million will reach the population over 80 years of age, and 300 million people over the age of 60 will reach by 2025, while China will also become an ultra-old country.

However, while the proportion of the elderly population has increased, we are not yet able to solve the safety problems of the elderly very well. It is well known that as people age, their physical functions will decrease dramatically. This leads to the elderly, whether in daily life, or in the face of unexpected situations, are prone to safety accidents. As far as picking up the stand-up action is concerned, it is one of the most common body
movements and one of the basic movement postures that people need to complete for their daily activities. But for many older people, it's hard to get up. Because they often face muscle soreness, motor control disorders, and damage to joint bone degeneration. Once the elderly fall or fall to their bodies when they stand up, they are most likely to be accompanied by other diseases that threaten their lives. This makes it necessary for them to use external forces in their lives to safely and easily complete their daily activities. However, most of the elderly people in our country live alone, often without children to take care of and accompany them. The old-age care of the elderly has become a difficult social problem.

Based on the above background, a booster device to assist the elderly in carrying out daily activities is designed.

1.2 Research significance
(1) Helping elderly people with limited legs and feet to stand up from their seats and assist ingenuity in the toilet, enhance the ability of the elderly to move at home alone, so that older people live with more dignity. Effectively reduce the occurrence of safety accidents, to ensure the safety of the use of the elderly use at ease, children at ease.
(2) Respond to the call of the age of helping the elderly to love the old and to improve the well-being of the elderly in their later years.
(3) The current market is missing such products, the design has a broad market value.

2. Overall design

2.1 Mechanical structure design
Mechanical mechanism design is the core of the research of old-age products, and the study of mechanical structures that meet safety, compactness and lightness, low cost and low maintenance is the focus of research. The mechanical structure of the system mainly includes: cushion opening and closing device, the brake device connected to the rear wheel, under the premise of ensuring the safety of the elderly to assist the elderly to stand and sit down lifting device, sitting bucket automatically device. The chair frame incorporates a variety of mechanical structures. The four-bar lift mechanism helps to complete the mutual transformation of sitting and standing postures. The rudder drives the gear rack control upper seat cushion open and close, the elderly can sit on the upper seat cushion to go to the toilet. Equipped with a double brake device, the chair can be slowed down or stationed in an emergency. The automatic seat-to-seat device simplifies the installation process of the toilet bucket, making it more convenient for the elderly to start at night.

2.2 Control system design
The control part of the support chair adopts the modular design concept, and the communication between the control modules is realized by class bus, where the total control of the control system is realized using the STM32F103C8T6 development board. STM32F103C8T6 is a resource-rich, powerful, small-size microcontroller, its resources can be fully qualified for the control of the stand chair. According to the needs of the support of the support ingress, we divide the entire control system into three modules according to function: remote control module, seat lift module, chair surface opening and closing module.

The remote control module uses wireless communication technology to distinguish different commands by remote control of different keys and different press lengths. Its judgment of the length of the key makes the operation of the chair more flexible and more in line with people's usage habits.

The seat lift module is pushed up and lowered with two pusher motors. In the process of double puter lift, the two-bar attitude is measured in real time by gyroscope, ultrasonic ranging sensor, etc., and fed back to the STM32 development board. Adjust the speed of the two putter motors in real time based on the information feedback from the sensor, keeping the sides in sync and in balance.

The seat surface opening and closing module is driven by two turboworm motors. It does not
require the motor operation status in the process, only through the limit switch to ensure that the start ingress and end point of the movement is accurate.

3. Module design

3.1 Four-bar lift module

![Figure 1. Structure of the four-bar lift module](image)

The four-bar lift module is made of a four-link mechanism and a lower-level connecting pad. Figure 1 is a three-dimensional diagram of the four-bar lift module. The connection method is, four connecting rods are connected by the active hinge, the rod 1 is fixed on the seat frame, the end of the rod is connected with the plate with the toilet opening, the two sides of the four linkages are connected together through the plate, the two pushrods provide power, to achieve the cushion pre-determined trajectory of lifting, pushrod pusher 250mm. Seat cushion vertical direction maximum 210mm lift and relative to the horizontal direction of 30 rotation angle, in the process of lifting the angle of rotation is more suitable for the human body standing process needs, and according to the needs of different height elderly people, their own decision to lift the height, to meet the differences of the elderly requirements. The connection plate has a slotinhole in the middle, the hole distance is 70mm, the diameter is 210mm, the size meets the design requirements of the toilet seat cushion.

3.2 Seat pad opening and closing module

![Figure 2. Structure of the cushion opening and closing module](image)
The cushion opening and closing module consists of two cushions, a rail slider, a gear rack and eight support rollers. When the machine acts as a seat, the seat pad is closed, and when the elderly go to the toilet, the old man can control the seat cushion open through the remote control to reveal the connection plate below, the old man can sit on the open seat cushion on the toilet. When the cushion is opened, the gear is turned by the worm worm sterrated motor, the gear engages with the rack, and the seat cushion is moved horizontally. The 8 support rollers are arranged evenly, providing support for the two cushions, so that the cushions are subjected to uniform force and avoid deformation.

3.3 Travel module
The travel module consists mainly of the front-facing universal caster, the rear directional wheel and the brake device. The universal caster is connected to the frame by an aluminum tube and comes with a brake section. Before using the booster chair, the front wheel must be braked to ensure the safety of the user. The armrest brake is connected to the rear wheels and has two functions: deceleration and stop-stop. The brake part has two handles up and down, when the user on the handle, the lower handle will automatically get stuck to achieve the purpose of stationing, at this time even if the handle is released, the chair is also in the state of stationing. When lifting the handle up gently, the lower handle buckle is released and the chair is able to operate normally. The multi-function booster chair uses frictional braking, with the brake handle connected to the brake line, which is connected to the brake pads. Through the upper lift brake so that the brake line to drive the brake pad rotation, brake pads and the rear wheel contact to produce friction, so as to achieve the function of slowing down the brake.

4. Feasibility analysis

4.1 Rack Structure
The frame mainly bears human weight, using Ansys software to perform static analysis of the frame, found that the current structure can withstand up to 150 kg of external force, to meet the design stiffness, strength requirements.

4.2 Seat push
In the process of pusher motor to promote cushion lift, the cushion trajectory is analyzed by Adams software, the maximum lift height of the cushion is 230mm, the maximum rotation angle is 30 degrees, can be effectively assisted.

5. Innovation point
(1) The innovative application of the four-link mechanism, through the analysis and calculation of the mechanism, determine the length of each rod, and finally design the linkage structure that can move along the predetermined trajectory.

(2) This design cleverly combines the support, toilet and walking, can effectively help the elderly active at home alone to carry out daily activities, is a multi-functional mechatronic device.

6. Conclusion
Through the analysis of the existing situation of the market for the elderly products, combined with the problems encountered by the elderly in real life, we design a mechanical device that can help the elderly to stand, go to the toilet and walk, which provides a great help for the daily life of the elderly and makes the old people live happier in their later years. Compared with the existing market, it is found that the device has great market prospects and hopes it will help more older people.

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