An intelligent shower chair for the elderly

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Abstract. The Utility Model Discloses A self-service Shower Chair for the elderly, which is designed in accordance with the difficulties encountered by the elderly in bathing, the utility model can realize the functions of assisting the elderly to sit down and stand up, full-direction shower, back rubbing massage, articles storage and convenient carrying. The utility model has the advantages of simple structure and convenient operation, the balance arm is used to realize the space fixed position of the shower head, and the push rod is used to realize the height adjustment of the seat to assist the elderly to start work The back self-help back-rubbing mechanism uses a three-slider double-crank structure to enable the elderly to easily realize back-rubbing operation. Multiple functions, simple operation, more friendly to the elderly, to meet the physiological and psychological needs of the elderly.

1. Introduction

As the elderly population is increasing year by year, the proportion of the elderly population is increasing, and our country is gradually entering the population ageing. Due to the problems of family centrality, insufficient human resources in old-age institutions and lack of social support services, more problems are encountered in the six activities of eating, dressing, going to and from bed, going to and from the toilet, bathing and moving around the room, among them, 90.8% could not take care of themselves.

The government and all sectors of society are also paying more and more attention to the living conditions of the elderly. Social capital to the elderly service, care industry began to flow, the market appeared a variety of elderly bath AIDS. However, most of them are expensive, single function and poor experience. Based on the present situation, the device designed a kind of self-service shower chair for the elderly, aiming at the difficulty of the elderly when they take a bath, the utility model can realize the functions of assisting the elderly to sit down and stand up, full-direction shower, back rubbing massage, articles storage and convenient carrying. The utility model has the advantages of simple structure and convenient operation, the balance arm is used to realize the space fixed position of the shower head, and the push rod is used to realize the height adjustment of the seat to assist the elderly to start work The back self-help back-rubbing mechanism uses a three-slider double-crank structure to enable the elderly to easily realize back-rubbing operation. Multiple functions, simple operation, more friendly to the elderly, to meet the physiological and psychological needs of the elderly.

2. Mechanical Structure Design

The mechanical structure of the shower chair is mainly composed of a balance arm clamping module, a seat lifting module, a seat back angle adjusting module and a multi-angle back rubbing module.
2.1. Seat lift module

The mechanical structure of this part is mainly provided by the power source of the electric putter. When the old man needs to sit down, the electric putter pushes the Parallelogram to move, and the seat is lifted while keeping the surface of the seat parallel, when the old man sits down, the electric push rod controls the four-bar mechanism to drive the seat bottom plate to move down horizontally to complete the purpose of assisting the old man to sit down and ensure the old man to be stable and safe in the process of using.

2. The parallelogram can keep the seat partially level, while the chair can be lifted to help the elderly stand up by controlling the electric putter to push the four bar linkage when they need to get up. The auxiliary part can be operated by an old person, and the different old people can control the actual push distance of the push rod according to their own actual situation, in order to assist their own standing and sitting.
At work, the putter pushes the four-bar mechanism up and the seat is raised to the position of the hip of the normal person. The old person only needs to sit back slightly to reach the chair, and the arm can provide good protection for the old person. As the old man sat down, the push rod was compressed and the height of the chair gradually decreased as the weight of the old man moved to the chair.

When the old man gets up and leaves the chair, with the center of gravity gradually leaving the chair, the push rod is gradually pushed out, assisting the old man to get up and stand until the old man fully stands up and leaves the chair, thus realizing the function of assisting the old man to get up and down the bath chair.

2.2. Balance arm clamping module

The utility model is mainly used for liberating the hands of the elderly in the process of bathing, so that the height and orientation of the shower can be controlled by the hands all the time, and at the same time, the utility model can be used for bathing the elderly in different postures.

![Figure 4. balance arm clamping module](image)

The design is mainly based on the design of the lamp arm used by dentists. It is composed of two spring four-bar mechanisms which are connected with each other. At the end of the mechanism, a clamping mechanism is used for holding the shower head. Under the non-working state, the four-bar mechanism closes and occupies less space, when working, the four-bar mechanism is pulled by the old man manually to realize the unique on the same plane, and then the whole rotation of the balance arm can be realized through the base at the connection with the seat.

By adding a spring into the four-bar mechanism, the gravity of the mechanism itself and the gravity of the shower head can be counteracted, so that after the old man moves the shower head to a proper position, the stability of the mechanism can no longer be affected by gravity, the utility model can free the hands of the old man when he showers, avoid holding articles for a long time, and improve the feasibility and comfort of the old man when he showers by himself.

![Figure 5. structure Diagram of balance arm clamping module](image)
2.3. Seat back angle adjustment module

The module is made up of two symmetrical four-bar mechanisms with the electric push rod as the power source. The folding and unfolding of the chair back and armrest are realized.

In the non-pretend State, the push rod is contracted to the shortest point, the back of the chair is fully folded, greatly reducing the space occupied by the device in life. When the old man needs to use it, the push rod can be extended by remote control, the back of the chair and the armrest can be unfolded, so that the old man can sit normally, in the use of the elderly to adjust the need for the angle of the chair back just through the remote control push rod expansion and pause in the right place can be.

Since the power source is the push Rod, and the whole mechanism controls the movement of the four-bar mechanism through the extension and contraction of the push Rod, there is no specific angle on the adjustment of the angle of the back of the chair, and the old man can choose the most suitable angle of the back of the chair for use, improve the comfort level of the elderly when using the device.

2.4. Multi angle back rub module

In the traditional design of shower chair, one of the outstanding problems is that it is difficult for the elderly to clean the back of the chair. In this design, because of the balance arm module, the operation of the shower behind the elderly can be realized, however, due to the difference of bathing culture in different areas, some old people need to scrub behind the back, so the scrub module is designed on the back of the chair.
Figure 8. multi-angle back rub module

The module is mainly composed of two pulleys and three rods. By pushing and pulling the Rod at the Front End, the up and down motion of the Rod at the back of the seat can be realized. The module has a good operation of simple self-locking design, in non-working state when the Operation Handle Droop, driving direction and the direction of movement of the rear slider parallel, so can not transfer the direction of force perpendicular to the guideway, the mechanism can not move, the whole mechanism is in self-locking state under the action of gravity.

In the working state, the two old people only need to hold the handle and lift the handle, then contact the self-locking state, and then carry out the back-rubbing function before and after use, just need to put the handle down again to restore the module to its original state.

Figure Group 9. multi-angle back rub module self-locking state (left) and working state (right)

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3. Organization of the Text

3.1. analysis of back rubbing labor-saving mechanism

According to the characteristics of the series combined force amplifier, the amplification factor is the product of the amplification factor of each device, i.e.:

\[ i = \frac{F_o}{F_i} = i_1 \cdot i_2 \cdot i_3 \]  

(1)

The kinematic analysis of the first toggle force amplifier is a symmetric deductive mechanism of a single orthogonal bar. The force amplifier ratio is:

\[ i_1 = \frac{\cos \theta}{\sin \theta} \]  

(2)

The second toggle force amplifier can also be obtained, because one end is fixed, it is called orthogonal double toggle force amplifier, and the ratio of the force amplifier coefficient can be calculated as follows:

\[ i_3 = \frac{L_1 + L_2}{L_1} \]  

(3)

Considering the loss of mechanical efficiency, the equivalent friction angle of the hinge pair is \( \theta \), and the transmission efficiency of the lever is \( \eta \), usually 0.97, where:

\[ \theta = \arcsin \left( \frac{2r}{lf} \right) \]  

(4)

The radius of the hinge axis is 6 mm, the center distance of the two hinge holes on the hinge is 100 mm, and the friction factor of the hinge pair is 0.1. Thus, the actual force-increasing Coefficient of the six-bar force-increasing mechanism is obtained:

\[ i_p = \frac{\eta(L_1 + L_2)}{2L_1} \left( \frac{1}{\tan(\alpha + \theta) \tan(\beta + \theta)} + 1 \right) \]  

(5)

According to the variation of pressure angle \( \alpha \) and \( \beta \) in initial and final states (\( \alpha: 22.6^\circ - 57.7^\circ \), \( \beta: 18.4^\circ - 26.1^\circ \)) and rod length \( l_1 = 600 \text{ mm, } l_2 = 600 \text{ mm} \), the actual force-increasing Coefficient ratio is calculated from the above formula: 5.2-7.4.

3.2. force analysis of seat support

The maximum mass of the human body is assumed to be 100kg.

The front and rear wheel loads were calculated with a 3:2 distribution.

The mass of the loading base is about 2kg.

The total is about 110 kg.
The forces acting on the supporting columns under no load are shown in Figure Group10:

\[
P_{Before} = 4 \times \frac{2}{3} \times 1100N = 2933N \quad (6)
\]

\[
P_{After} = 4 \times \frac{1}{3} \times 1100N = 1466N \quad (7)
\]

One for the Front Support Column by the Force;
Where the force on the Front Strut.
Force on the supporting column under full load:

\[
P_{Before} = 4 \times \frac{2}{3} \times 800 + 4 \times \frac{1}{2} \times \frac{2}{5} \times 1800N = 3573N \quad (8)
\]

\[
P_{After} = 4 \times \frac{1}{3} \times 800 + 4 \times \frac{1}{2} \times \frac{3}{5} \times 1800N = 3226N \quad (9)
\]

So check the front support column.
Because the brace column is mainly subjected to compressive stress and shear force, but the brace column is less affected by Shear Force, so the brace column’s compressive stress is checked and its stability is analyzed.

4. Conclusions
At present, the function of the assistant device of the old people’s shower is single, and most of the assistant devices are sitting simply, which can not solve the need of the old people’s shower. Compared with the traditional auxiliary device, the advantages of this device are:

1) the shower uses the sitting posture to reduce the force on the legs of the elderly, and is designed with stand up and sit up devices to provide the cushioning force when sitting and the Auxiliary Force when standing;
2) the balance arm can hold the shower head from different angles, free the hands of the old people and wash them in all directions without dead angle;
3) the back cleaning massage device solves the important difficulty of the old people bathing;
4) foldable design reduces footprint when not in use.

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