Intelligent Robot Design to Assistance the Elderly in Toilet

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Abstract. To assist the elderly people living alone to go to the toilet and ensure their safety, based on the Fischer component, an intelligent robot device is designed to assist the elderly in toilet use. The whole device has a simple structure, convenient control, diversified functions, simple operation, is friendly to the elderly, and can better meet the life and health needs of the elderly living alone. It also provides a direction for the robot's physical design.

Keywords: The elderly toilet assistance; Robot design; Fischer components

1 Introduction

As China's aging process accelerates, the proportion of senior citizens is expected to reach 38.6 percent by 2050 [1-2]. Because of the deterioration of physical function, the elderly spends more time at home and their range of activities is limited [3-4]. For the elderly living independently, assisted-standing devices are especially important. Toilet is one of the Spaces where the elderly is most likely to have accidents. Traditional wheelchairs for the elderly provide some convenience for the disabled and the elderly [5-6]. In view of the above problems, this paper designed a kind of intelligent robot for the elderly to assist them in toilet, which can overcome the characteristics of high energy consumption and poor mimicry of users of unpowered walking devices [7-10]. The robot aims at assisting the elderly to go to the toilet, considers the needs of the elderly's mobility, nursing and safety protection at home, and combines modular design to reduce the manufacturing and use costs of the robot and provide convenient services for the elderly.

2 Overall Design Scheme

The intelligent robot is equipped with daily care modules, including fan cooling module and foot massage module. The elderly can make a mobile request to the voice call of the robot. After receiving the information, the robot will move to the current location

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of the elderly in combination with indoor navigation. When the robot detects obstacles in the process of movement, it automatically brakes and gives an alarm. And the robot adjusts the height of the handrail through the auxiliary standing module, so that the elderly can stand up and move to the seat by holding the handrail. When the old man moves to the toilet, the robot can move the cushion to the rear space of the backrest. The structure of the elderly toilet assist robot is shown in Figure 1

3 Mechanical Module Design

3.1 Auxiliary Sitting Module

The auxiliary standing module is completed by the combination of pedals and handrails, as shown in Figure 1. When the elderly want to stand up, the pedal will be retracted along the rack to the bottom of the seat for the elderly to step on the ground. The handrail adopts screw slide block structure and shear fork mechanism. The motor drives the gear, drives the screw to rotate through the gear meshing, the screw slider moves, so as to drive the movement of the rod to achieve the lifting of the armrest plate. The elderly can stand up through the handrail.

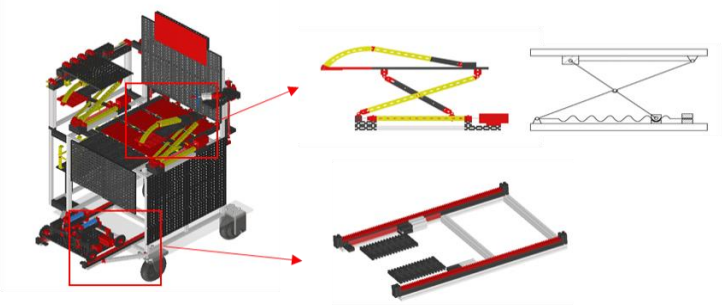


Fig. 1. The auxiliary standing module

3.2 Auxiliary Toilet Module

The auxiliary toilet module is mainly realized by lifting cushion. The foldable cushion is shown in the lower right of Figure 2, and the turbo-worm lifting mechanism is shown in the upper right of Figure 2. When the elderly goes to the toilet, the coding motor is turning, so that the rope on the winding wheel is off, the motor drives the worm to rotate, the turbine slider moves up along the worm, and the cushion is pulled to the back of the wheelchair.

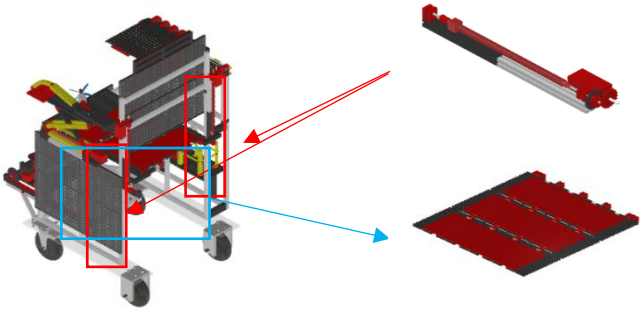


Fig. 2. The auxiliary toilet module

3.3 Daily Care Module

The daily care module consists of a cooling fan module and a foot massager module controlled by a touch screen. The cooling fan structure is shown in Figure 3. This module mainly uses worm gear, worm drive, and swing rod mechanism. The motor under the fan drives the worm to rotate and changes the transmission direction through the gear coordination so that the fan above has the function of left and right swing wind. The foot massager module is located under the seat, as shown in Figure 4. When the elderly need foot massage, two motors drive multi-level gear and crank connecting rod mechanism to drive the massage roller movement, through the middle of the slide block can control the motor speed to adjust the massage intensity.

Fig. 3. The fan module

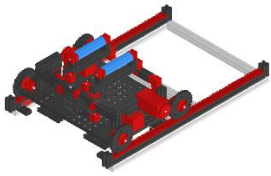


Fig. 4. The foot massage module

3.4 Additional function module

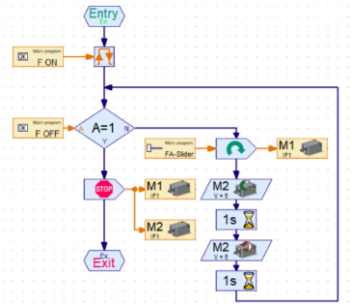
Additional functional modules include the sliding table modul and storage Space module, lighting fixture module and emergency call module. The table can be moved back

and forth by sliding rails and turned forward by double hinges. The storage module can place the elderly's mobile phone, water cup, medicine box and other daily articles.

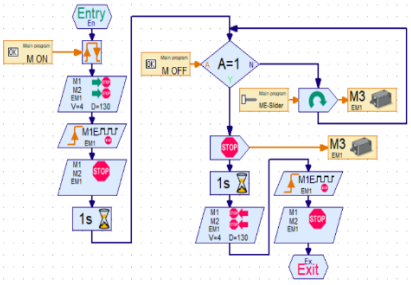
4 System Software Design

4.1 Module subroutine design

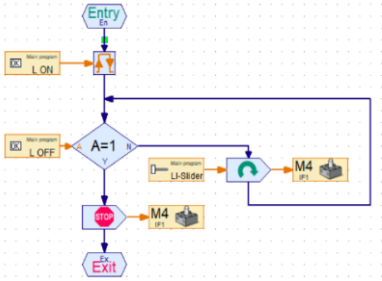
The cooling fan program is shown in Figure 5(a). The fan can be adjusted up and down, with head shaking control and wind power control. The "F-ON" and "F-OFF" buttons on the touch screen are used to control the opening and closing of the fan, and the speed of the motor can be controlled through the slider in the middle to adjust the wind speed. The foot massage procedure is shown in Figure 5 (b). The massager is driven by multistage gears and crank linkage mechanism, the massager is opened and closed by touch screen control, and the motor speed can be controlled by the slider in the middle to adjust the massage force. The lighting control program is shown in Figure 5 (c), which can be opened and closed by the touch screen, and the brightness is controlled by the slider.



(a)The cooling fan program



(b)The foot massage procedure



(c)The lighting control program

Fig. 5. Subroutine module

4.2 Indoor mobile navigation module

To realize path planning, real-time position detection is required by sensors. In this paper, the binocular vision sensor T265 is used to locate the indoor environment with SLAM and record the path to obtain the current position information of the toilet robot. The computer combined the position information according to the planned path to drive the toilet robot to the designated position, and complete the indoor navigation function.

5 Conclusion

In this paper, according to the needs of the elderly to live independently and go to the toilet, the toilet robot adopts a modular design. It includes an auxiliary standing module, toilet assistant module, daily care module, indoor navigation module, and additional function module. The modern motor control system is skillfully combined with the traditional chair, the mechanical structure is cleverly designed to assist the toilet and foot massage, and the indoor navigation and voice recognition technology enable the elderly to move freely in the room. It provides a reference for the design and application of intelligent elderly robots.

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