A Control System of Electric Wheelchair

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Abstract. This paper designs a control system for electric wheelchairs, including: main controller, sensor module, power management module and auxiliary module. The sensor module includes position sensor; power management module includes power supply and power self-starting device. The starting device acts as a power switch and is in a normally open state to disconnect the power supply. When the self-starting device is under pressure, the switch is closed and the power is turned on; after the system is powered on, the position sensor takes the seat position information of the electric wheelchair user in real time. Sending to the main controller, the main controller determines whether the user is in a safe position according to the received position information. If in the safe position, the main controller controls the power control module to supply power to the driving device of the wheelchair; if it is determined that the user is not in a safe position, then the main controller controls the power control module to not supply power to the driving device of the wheelchair, and the main controller controls the voice module in the auxiliary module to issue a voice alarm signal that is not in a safe position. Through the system designed in this paper, the user's safety and convenience are improved.

1. Introduction
According to relevant statistics, there are about 83 million disabled people and 150 million old people in China, which is the country with the largest number of people with physical dysfunction in the world. The huge population base will make the aging problem become a serious social problem troubling us in the next ten years. It has become an important and urgent task to promote the development and improve the condition of the disabled.

At present, for the lower extremities of standing and walking ability is weak or loss of the disabled and the elderly, in daily life, when they need to solve electric wheelchair travel and rehabilitation, the intelligent wheelchair as a kind of mobile robot, mainly used to assist the elderly and disabled People's Daily life and work, is one of the weakening of the body function to them compensation[1]. Traditional electric wheelchairs cannot sense whether the human body is sitting in the correct position of the wheelchair, nor can they judge the road conditions of the driving environment, which brings safety hazards to people using electric wheelchairs[2]. Aiming at the existing problems in the amenity of tennis wheelchairs, researchers from Dalian Jiaotong University designed tennis wheelchairs with ergonomics theory from the aspects of seat system, driving system and riding comfort of tennis wheelchairs[3]. Researchers from Tianjin University of science and technology put forward a design scheme of a stand-up electric wheelchair mechanism, analyzed its working principle and established a mathematical model[4]. Researchers from China University of Mining and Technology designed a walking wheelchair that integrates the functions of wheelchair and walking. Relying on the strength of the intact upper limbs of the human body, the wheelchair can travel on the road [5]. The author designs an intelligent auxiliary device, which can be used to turn on the power when the user of the
wheelchair is in the correct sitting position, and the wheelchair runs normally when the user is in the sitting position. When operating the wheelchair, the user will be reminded of obstacles encountered, alert when encountering uphill and downhill, and accelerate or decelerate the wheelchair according to the slope of the ramp. It can effectively improve the daily living conditions of wheelchair users, and bring them a new and safe lifestyle, which is conducive to improving their rehabilitation level and comfort of driving wheelchairs.

Figure 1 Schematic diagram of electric wheelchair system

2. Control system design of electric wheelchair
Power wheelchair start and obstacle avoidance system, as shown in figure 1, including: main controller, sensor module, power management module and auxiliary module, sensor module includes position sensor; The power management module includes the power source and the power source from the starting device. The self-starting device ACTS as the power switch and is in the normally open state to disconnect the power supply. When the self-starting device is under pressure, the switch closes and the power source is switched on. When the system is powered up, the position sensor sends the ride position information of the electric wheelchair user to the main controller in real time. The main controller determines whether the user is in a safe position based on the received position information. If the user is in a safe position, the power supply control module of the main controller will control the power supply to the drive device of the wheelchair. If it is judged that the user is not in a safe position, the power supply control module of the main controller will not supply power to the drive device of
the wheelchair, and the voice module of the auxiliary module of the main controller will send a voice alarm signal that is not in a safe position.

3. Sensor module
Position sensor installed in the electric wheelchair control arm, and the distance from the back of a chair is not more than 10 cm, the position sensor is infrared detection module, including infrared transmitter and infrared receiver, respectively, relative Settings on the left and right sides armrest, when receives the infrared transmitter launch infrared light, the infrared receiver to receive the light signal is converted to electrical signals, and the electrical signal real-time transmission to the main controller, main controller receives the signal, judge the user has not yet in a safe place; When the user blocks the infrared light emitted by the infrared transmitter, the infrared receiver cannot receive the light and no longer sends the electrical signal to the main controller. At this time, the main controller judges that the user is in a safe position.

Sensor module also include pressure sensors, pressure sensors are arranged separately in two areas of the wheelchair: sit face areas, back of a chair area, used to detect the user's body sit face pressure, back pressure, and to detect the pressure numerical real-time transmission to the main controller, the pressure of the main controller according to the received value to decide whether to report to the police or reduce the speed of the wheelchair. The road sensor module is used to detect road conditions. The traffic sensor module can be ultrasonic detector, as shown in figure 2, start the electric wheelchair and obstacle avoidance system of traffic sensor module includes the first 1 and 2 second ultrasonic detector, ultrasonic detector including 1 first ultrasonic detector installed in a wheelchair on the front foot pedal is lower than the height of the seat plate, at less than 10 cm seat plate height, the ultrasonic detector 2 installed at the bottom of the side before the wheelchair pedal, below the first ultrasonic detector 1 installation location it is advisable to 20 cm, system is turned on, The first ultrasonic detector 1 and the second ultrasonic detector 2 of the road condition sensor module send and receive signals to preliminarily identify the environmental road condition. Among them, the first ultrasonic detector 1 mainly detects obstacles in front of the wheelchair, and the second ultrasonic detector 2 mainly detects road conditions on the ground, as shown in figure 2. Both ultrasonic detectors send detection signals to the main controller.

4. Working mode of obstacle avoidance system
The reading and filtering process of ultrasonic sensor data is as follows: the ultrasonic detector sends and receives signals outward every other fixed period, and sets the value collected in the first period as the reference value. Reference values obtained method, ultrasonic detector in the first cycle of continuous data collection N signal (N is an integer greater than 1), and sent to the main controller, main controller the N data signal descending order, compare the first signal and a second signal, if the
difference is larger, such as the difference between more than 20% of the first signal value, will be the first signal is compared with the third signal, if the difference is small, such as difference of no more than 20% of the first signal value, will be either after the average value as the reference, the reference value compared with the next signal, if the difference is bigger. Use the reference value to continue to compare with the next signal. If the interpolation is small, take the mean value of the reference value and the next signal of the comparison as the reference value, repeat the above comparison steps until the last signal is compared, and take the final reference value as the signal reference value of the period. If all comparison completions are large, all data for the period are discarded. The data collected in the latter period is also N, and the reference value is determined by comparing the reference value determined in the previous period with the first signal of the later period, which is similar to the way described above. Through this process, interference items can be filtered out and useful data-reference values can be determined.

5. Auxiliary module

Auxiliary modules include speech synthesis module, OLED display module, key operation module, RTC battery module and counter. The above signals sent by the main controller to the auxiliary module are alarm signals. When the alarm signals are received that the wheelchair is not sitting properly or the posture is deviated, the speech synthesis module will send the alarm voice prompt "please sit still" to remind wheelchair users. After the system is turned on, the speech synthesis module starts, the OLED display screen enters the boot screen, and the speech module gives voice prompts, such as "welcome to use human body induction and obstacle avoidance system". When the ultrasonic probe of the sensor module detects an obstacle in front of the electric wheelchair, the main controller controls the voice module to issue a voice prompt, such as "danger in front, please slow down". When the ultrasonic probe detects a change in road conditions, the main controller control voice module issues a voice prompt, such as "please pay attention to road conditions". When the power management module detects that the battery voltage is lower than the set voltage threshold, the main controller controls the voice module to issue a voice prompt, such as "low power, please return to charge". In the invention, the main controller can get the corresponding electric quantity by looking up the table according to the detected power voltage value: for example, voltage above 24V -- full electric quantity, 23.5v voltage -- 80% electric quantity, 23V voltage -- 60% electric quantity, 22.5v voltage -- 40% electric quantity, 22V voltage -- 20% electric quantity. Therefore, according to the detected power supply voltage value, the main controller can determine whether the power supply quantity is lower than the predetermined threshold by inquiring the preset voltage-electric quantity comparison table. If the value is lower than the predetermined threshold, the main controller can control the display to display the prompt of low power quantity and control the voice module to issue the voice prompt of low power quantity.

6. Conclusion

Compared with existing technologies and products, an electric wheelchair starting and obstacle avoidance system proposed by the author has innovative self-starting device circuit and ultrasonic obstacle avoidance circuit design, which can improve the operability and safety of the control system. Circuit design is simple, software control is accurate, easy to operate and practical, which improves the safety and convenience of wheelchair users and effectively improves their daily living conditions.

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