Design and manufacture of multi-function electric nursing bed

Shigang Wang, Wei Shi, Yinghuai Liang, Longjun Huang, Zhanqiang Huang

School of Electrical and Information Engineering, Guangxi University of Science and Technology, Liuzhou, 545006, China

*Corresponding author’s e-mail: 446986768@qq.com

Abstract. With the acceleration of population aging, the service of nursing industry is facing severe challenges. Medical and social insurance systems are facing unprecedented pressure. Therefore, the demand for nursing beds for elderly patients is increasing. In view of this phenomenon, the basic structure and functional principle of the multi-functional electric nursing bed designed for the elderly who lack self-care ability and the patients with mobility inconvenience are discussed in detail. Based on ergonomics, the overall design of nursing bed was carried out. According to the relevant standards and research results, the design principles and functional requirements of nursing bed were formulated, and the overall design of nursing bed body was completed. The top-down method was used to complete the design of nursing bed control system. The bed can help patients to turn over, sit up, bend knees, and defecate and other functions, solve many inconveniences in the process of nursing patients, thereby improving the service of nursing industry, and effectively promoting the development of medical and health care.

1. Introduction

At present, we can see in the market are simple nursing beds, which rarely see multi-functional and self-care furniture nursing beds. Multifunctional nursing bed is based on the sufferings suffered by patients who have been bedridden for many years [1]. It adopts a unique double folded surface structure. The bed surface is a special cushion structure. The bed surface can be set up to adjust freely into horizontal and horizontal space. It has the functions of getting up, changing medicine automatically and hanging bottle rack device [2]. According to the actual situation of patients, the height of the bed is designed to improve the quality of life of patients and solve the problems [3].

The purpose of this design is to solve the technical shortcomings of general nursing bed and provide effective nursing for patients or the elderly [4]. At the same time, some entertainment functions can be added, such as remote control shelves, bookshelves and sundry tables. Effective combination of electric nursing bed and modern home can increase entertainment function, so that patients can get care at home, and relax their body and mind through entertainment function, which is conducive to the rehabilitation of the disease [5].

The design has the advantages of reasonable structure, easy operation, light weight, beautiful appearance, easy operation and full automation. It is easy to popularize and bring good economic benefits. It has become a fashionable, convenient, fast, multi-functional and intelligent nursing home.
2. System design
The multi-functional nursing bed includes storage cabinet, multi-functional automatic bottle hanger, bookshelf, toilet disposal bucket, transmission shaft, universal wheel, remote control, etc. The base and supporting foot are made of channel steel or square steel and the cross section of the column is hollow round steel, which can greatly reduce the weight of the bed itself. There are three parallel longitudinal beams on the bed frame. The front longitudinal beam, the middle longitudinal beam and the rear longitudinal beam are arranged from the head support frame to the tail support frame. The bed plate is composed of the head-to-back plate, the bed-to-back plate and the movable bed plate. The end of the bed-to-back plate and the movable bed plate are articulated to the middle longitudinal beam. The main body of the multi-functional nursing bed is made of new material plate, channel steel or square steel, which can reduce the weight of the bed itself and increase the load. The screw is used as the main fixing tool for the combination and connection of each part, and the contact area is increased to achieve the most stable effect [6].

2.1. Design scheme of storage cabinet
There is a lot of room left in the bed, which causes unnecessary waste. Installing a storage cabinet on the side of the bed is convenient, practical and space-saving. The size of the storage cabinet is as follows: sliding track is installed below. Considering that it has less use value for patients, there is no automatic control system installed to save costs.

2.2. Design scheme of multi-functional bottle hanger
The main innovations of the multi-functional bottle hanger are "automatic lifting", "heating of liquid medicine", "alarm without liquid medicine" and "anti-skid fixing". Using the original bottle hanger mechanism to make some improvements, make it produce essential changes, with powerful functions, not only overcome the shortcomings of ordinary bottle hanger can not move up and down by itself, so that patients have more space for movement, but also have a large number of special functions, so that patients can get better care when lifting bottles.

2.3. Design scheme of bookshelf
The bookshelf adopts three-storey and three-sided closed structure. There are two options for installation on the bed.

(1) Fixed the bookshelf directly to the bed, which is convenient to install and save material; however, because of the heavy weight of the bookshelf itself, it is a great burden on the stability of the connecting parts, and it is easy to cause the instability of the bed, and even cause the phenomenon of rollover.

(2) The weight of the bookshelf is supported by a universal wheel at the bottom of the bookshelf. Considering that the connection between the bookshelf and the bedplate is too tight, it is easy to cause the dynamic wheel of the main body of the bed to go empty and can not effectively control the movement of the bed; or it can not play the role of supporting the bookshelf. After many tests, the connection between the bookshelf and the bedplate adopts a long hole and the fixed screw is not tight, so that the main body of the bed only plays an auxiliary role in fixing.

2.4. Design scheme of controllable bed plate
The upper surface of the multi-functional nursing bed is consistent with that of most nursing beds in the market, which is divided into three boards altogether; No. 1 board is the power board to support the upper part of the body to rise; No. 2 board is the load-bearing board to support the whole body weight of the patient's buttocks (when No. 1 board and No. 3 board are not in the same plane as this board, that is, when No. 1 and No. 3 board are in working state); No. 3 board is the decrease of the patient's legs. It is convenient for patients to eat, activate collaterals and blood vessels, and promote blood circulation.
Threaded screw is used for control. The motor is driven by L298 drive module, which contains two H-bridge high-voltage and high-current full-bridge drivers. It can be used to drive inductive loads such as DC motor, stepping motor and relay coil. It is controlled by standard logic level signal. It has two enabling control terminals, which are allowed or prohibited without the influence of input signal. The device works with a logic power input, which makes the internal logic circuit work at low voltage. It can detect resistance and feedback the change to the control circuit. The two threaded screw rods are connected together with steel tubes to control the same speed of the motor. It is controlled by a relay to ensure that the motor of the two threaded screw rods rises or falls at the same time.

3. Control system design

3.1. Power supply
As shown in Figure 1, the switching power supply of 12V 10A is used as the power supply of the whole bed. Because the key components of the switching power supply work in the high frequency switching state, its energy consumption is very low. The efficiency of the switching power supply can reach 80%~90%. It has nearly doubled compared with the ordinary linear regulated power supply. At present, it has become the mainstream product of the regulated power supply.

The main control chip uses STC microcontroller, which is a low-power, high-performance CMOS 8-bit microcontroller with 8K in-system programmable flash memory (as shown in Figure 2). With a smart 8-bit CPU and a programmable Flash on a single chip, STC89C52 provides a highly flexible and effective solution for many embedded control applications. It has the following standard functions: 8k-byte Flash, 512-byte RAM, 32-bit I/O port, watchdog timer, built-in 4KB EEPROM, MAX810 reset circuit, three 16-bit timers/counters, a 6-vector 2-level interrupt structure, full duplex serial port, and low price.

![Figure 1. Switching power supply and control circuit](image1)

![Figure 2. Minimum system board used](image2)

3.2. Screw drive
As shown in Figure 3, the motor is driven by L298 drive module. L298N is a high voltage and high current motor driver chip produced by ST Company. The chip is packaged with 15 feet. The main features are: high working voltage, maximum working voltage up to 46V; high output current, instantaneous peak current up to 3A, continuous working current 2A; rated power 25W. High voltage and high current full bridge driver with two H-bridges can be used to drive inductive loads such as DC motor, stepping motor and relay coil, adopt standard logic level signal control, and have two enabling control terminals, which allow or prohibit the device to work with a logic power input without being affected by the input signal, so that the internal logic circuit part can work in a low power supply. Voltage down work; can be connected with external detection resistance, the change feedback to the control circuit. Using L298N chip to drive the motor, the chip can drive a two-phase stepping motor, a four-phase stepping motor and two DC motors.

3.3. Infrared remote control
In remote control, we use infrared remote control. Infrared remote control is the most widely used way of communication and remote control.

As shown in Figure 4, infrared remote control transmits control signals by using near infrared rays with wavelengths ranging from 0.76 to 1.5 microns. Commonly used infrared remote control system generally distributes two parts, transmitting and receiving. The carrier frequency of infrared remote
control is 38 kHz, which is determined by the 455 kHz crystal oscillator used at the transmitter. At the transmitter, the crystal oscillator should be integer frequency division, and the frequency division coefficient is generally 12. Generally, the oscillation frequency of the crystal oscillator at the transmitting end is determined. The output state of the receiver can be roughly divided into five forms: pulse, level, self-locking, interlocking and data. "Pulse" output is a "valid pulse" output corresponding to the output terminal when pressing the key of the transmitter. The width is generally about 100 ms. In general, besides several bits of data output, the receiver should also have a "data valid" output so that the later stage can fetch data in time. This output form is generally used to interface with single-chip computers or microcomputers. In addition to the above output forms, there are "latch" and "temporary" two forms. The so-called "latch-in" output refers to the output of each signal sent by the transmitter, which is "stored" by the receiver until a new signal is received; the "temporary" output is similar to the "level" output described above. The remote control coded pulse consists of preamble, 8-bit user code, 8-bit user code, 8-bit operation code and 8-bit operation code. By checking the user code, each remote controller can only control one device action, which can effectively prevent interference between multiple devices. After the encoding, there must be the counter-encoding of the encoding, which can check the correctness of the encoding reception, prevent misoperation and enhance the reliability of the system.

3.4. System control design
The system uses S3C2440 as CPU and has five 16-bit registers on S3C2440. Because embedded IO has many multiplexing functions and pins are very precious, we also use serial port function to reduce the waste of IO pins. In addition, the integrated USB HOST controller in S3C2440 processor supports two USB host communication ports, which conform to the specification of USB 1.1 protocol. It is used to collect video information and usb1.165m wireless network card. The following modules are described:

As shown in Figure 5, the hardware structure of the CPU module of the embedded computer includes the core CUP, JTAG debugging circuit, USB interface, storage circuit, reset circuit, etc. A small embedded system is composed of an ARM core embedded CPU S3C2440 and peripheral expansion elements. Run the Linux operating system. The main application fields of ARM processor are industrial control, Internet device, network and modem device, mobile phone and other multimedia and embedded applications. S3C2440 is a 32-bit RISC processor developed by Samsung Company. It adopts ARM 920T core, supports WINDOWS and LINUX operating system, and has built-in SDRAM controller, LCD controller, SD controller and AD converter. It can easily expand the required equipment without adding peripheral components. Memories are divided into FLASH memory and SDRAM memory. FLASH memory is a kind of non-volatile memory, which can not lose data after
power failure. So it's used to save OS, applications, and important data. The program memory in the circuit adopts K9XXX08UOA-PCB0. Its capacity is 256 Mbytes, compatible design is adopted in the circuit, and different capacity memory can be used according to the need. SDRAM is a kind of random access memory. Data is not saved after power failure, but its reading and writing speed is very fast. Therefore, it is generally used as the running space of the program. After the system boots, the program in FLASH is decompressed and run in SDRAM to improve the running speed of the system. In the circuit design, K9F1216U0A with 32 MBytes capacity is selected. Two pieces are used to form a 64M, 32-bit storage system. The reset circuit provides power-on reset and key reset for CPU and peripheral equipment. A special reset chip MAX8860EUA18 for American Credit Corporation is used. The circuit is simple in structure, reliable in reset and provides standard 20 PJTAG debugging interface. You can download BOOTLOADER program on the burner board and run the Linux operating system. The main application fields of ARM processor are industrial control, Internet device, network and modem device, so it is generally used as the running space of program. After the system boots, the program in FLASH is decompressed and run in SDRAM, and the data will not be lost after power failure.

4. Conclusion
Multifunctional nursing bed is based on the sufferings of patients who have been bedridden for a long time. It adopts a unique double folded surface structure. The bed surface is a special cushion structure, which enables the bed surface to be set up in a horizontal or horizontal space at will. It has the functions of getting up, drowning (flushing and closing to reduce indoor odor) and other nursing beds. The side of the nursing bed is specially designed as a physiotherapy magnetic cushion. It can stimulate blood circulation, improve nursing level, improve patients' quality of life and solve a series of difficult nursing problems. Multifunctional nursing bed is designed for the special needs of patients, disabled persons, paralysed patients and pregnant women who can not take care of themselves.

This design effectively combines multi-functional nursing bed with modern home, increases entertainment function, so that the cared person can get care at home, at the same time, can relax the body and mind through the entertainment function of the home, which is beneficial to the recovery of the illness.

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