

New Multi-functional Smart Bed based on Modular Design

Zhenting Zhu^{#1}, Meihua Zhang^{*2}, Xiangyijie Zhao^{#3}, Shengnan Luo^{#4}, Xue rui Qi^{#5}, Pengkuan Wang^{#6}, Liqiang Zhang^{#7}

School of Mechanical and Automotive Engineering, Shanghai University of Engineering Science, China

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Abstract - Based on the modular design, this paper describes the schematic design and module design of the multi-functional smart bed, as well as the realizable bed temperature induction control, the manual control of storage cabinets, the induction control of night lighting, the remote control of folding table and projector and other functions. The smart bed is integrated with sensors, which can not only personalize sleep health data management but also achieve integrated smart home control to a certain extent. The experiments show that all expected functions are working well.

Keywords — smart bed, intelligent control, scissor-type structure, hidden lazy table

I. INTRODUCTION

As an extension of the "bed," the smart bed has been endowed with new contents in both connotation and extension. It is not only a tool for sleep but also a new lifestyle centered on sleep, realized by information and networking technology on the aspects of sleep-related relaxation, entertainment, health, and so on[1-4].

With the continuous and rapid growth of China's national economy and the improvement of people's living quality, either food culture or online shopping, both fully reflect the modern people's control of time. It is worth thinking about how to make full use of resources and integrate them to improve the convenience of life. At present, the smart bed on the market is mainly to improve the quality of sleep, enhance the comfort and multi-function (storage, massage, office, leisure) combined, But those products occupy a lot of space, and the price is expensive. In addition, smart home gradually enters the market. It will be the mainstream in the future all over campus and dormitory[5]. So it is necessary to study a smart bed with a smaller size and bigger power. This paper designs a new multi-functional smart bed, which combines leisure and entertainment, based on the bed and sets the table, projector, and smart induction night light all in one. It remains not only the traditional practical functions but also more comfortable, safe, and convenient.

II. STRUCTURE DESIGN OF MULTI-FUNCTIONAL SMART BED

A. Overall structural design

This multi-functional smart bed is divided into three modules: (I) bedside table module, the bed body (II) module, the module (III) end of the bed ark, as shown in figure 1. Each module, respectively, has different functions, will assist people in requiring those functions.

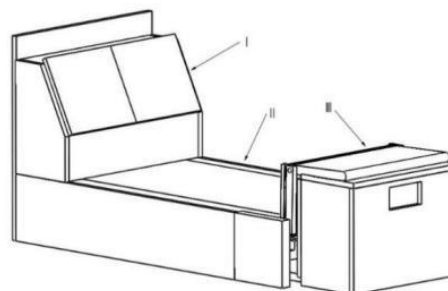


Fig. 1 Basic structure of multi-functional smart bed

a) Modular structure of bedside table

The nightstand module comprises a headboard, two side panels of a nightstand, a bottom plate of a nightstand, a front side plate of a nightstand, a top plate of a nightstand, and a switch panel, as shown in Figure 2.

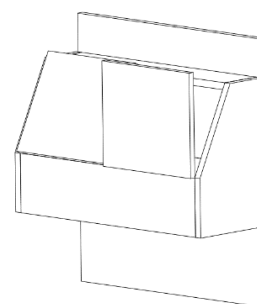


Fig. 2 Schematic diagram of head of the bed

The headboard is vertically arranged, and the top plate and bottom plate of the nightstand is horizontally and transversely mounted on the headboard. The top plate, the bottom plate of the nightstand, and two vertically mounted side plates of the nightstand jointly form the empty cavity of the nightstand, which can be used for storage. The front side plate of the nightstand is respectively connected with two side plates of the nightstand and the bottom plate of the nightstand. The switch panel is obliquely installed and



connected with the front side plate of the nightstand by a hinge.

There is a built-in heater in the module of the head of the bed. When the "temperature + pressure" signal is detected, the internal heating device will be turned on. So that the cushion of the bed head is heated. And the nightstand adopts the structure of a single-sided opening, and the built-in cavity has enough space to put some small devices, such as the wireless keyboard, wireless mouse, remote control, lazy desk controller, etc. The switch panel to be the backboard as well forms a certain Angle with the bed body, so people can be able to lean on it when resting. The projector of the bed tail cabinet module provides convenience for the leisure and entertainment of users better.

b) The bed body module

The bed body module includes a bed panel, a bed bottom plate, and a mobile tabletop mechanism, as shown in Figure 3. The bed panel and bed bottom plate are divided into two layers, which are installed between the bedside cabinet module and the bed tail cabinet module. The mobile tabletop mechanism comprises a tabletop board, a backing board, two support units, a moving unit, and a support steering gear. Both sides are also provided with a bedside plate, and the bed bottom plate is connected with the bedside plate, bed panel, and a certain gap between the bedside plate to form a track. The support unit is located in the track, and the side plate of the bed is equipped with a night light. The bedside light is simple, portable, low power consumption, and has high practicability and cost performance, which can play an important role in daily life.

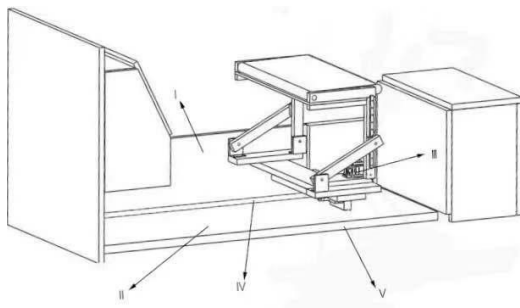


Fig. 3 Schematic diagram of the bed body

The track hidden on both sides of the bed can be used for the lazy table to launch and stop, the lazy table is fixed on the bottom of the table chute, the chute is fixed on the bottom plate, the center of the bottom plate is installed with a card slot, the center card slot is the active slider, the rest are the side slider. After the instruction is given, the motor will rotate and drive the card groove through the conveyor belt so as to achieve the purpose of active sliding block and sliding groove moving on the track. Relative to the traditional lazy desk needs to be stored by themselves is not convenient, through the design of the sliding groove and mobile desktop mechanism will be automatically stored lazy desk. It also has a detection function. Three flexible membrane pressure sensors are installed between

the special sheet and the bed board to detect whether the bed is manned or not. When the pressure sensor at the bottom of the bed does not feel the pressure from people on it, it will automatically put away after 30 minutes. At the same time, it can also provide a basis for the night light and provide convenience for people.



Fig. 4 Flexible pressure sensor

The mobile desktop mechanism is shown in Figure 5. The mobile unit comprises a supporting plate transversely arranged along with the bottom plate of the bed, including a sliding block, a stepping motor, a leading screw, and a second shaft seat. The two ends of the support plate are respectively connected with two support units. Both ends of the leading screw are installed on the bottom plate of the bed through the second shaft seat, and the leading screw is arranged along the radial direction of the bed body module. The stepper motor is mounted on the leading screw through a slider, and the stepper motor drives the slider to move forward and backward on the leading screw. The support plate is installed on the top surface of the stepping motor through the flange. The sliding block is specifically an aluminum alloy coupling. The movement of the aluminum alloy coupling on the leading rod changes the rotating sports suit of the stepping motor into the linear motion along the leading screw and pushes the stepping motor body and the support plate installed on the stepping motor to move together.

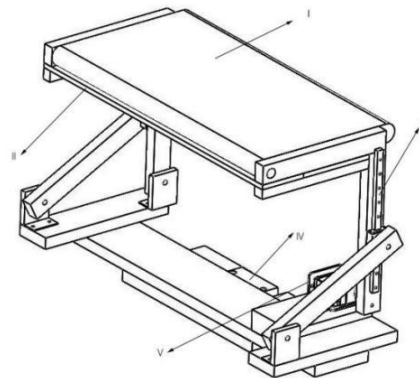


Fig.5 Mobile desktop mechanism diagram

c) Bed tail cabinet module structure

The bed tail cabinet module comprises a cabinet body and a projector. The cabinet body is provided with a through-hole, and the projector is installed in the cabinet body. The picture can be projected onto the wall through the window structure of the bed tail cabinet, as shown in figure 6.

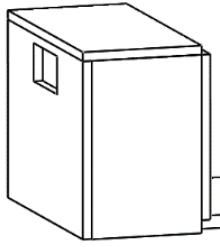


Fig.6 Schematic diagram of bed tail

The end of the bed ark also includes a hole switch mechanism, including hole baffle, crossing, bed end steering gear, the slider, the end of the bed slide rail, and bracket plate. Bracket plate is installed at the inner side of the cabinet, on the same surface where the through-hole is located, below the hole. The end of the bed steering gear is installed on the bracket plate. The end of the bed slide rail is installed on top of the support plate, as shown in figure 7.

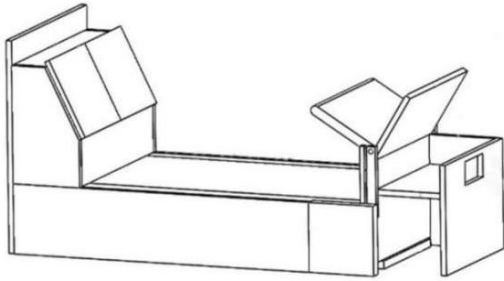


Fig. 7 Bed tail cabinet structure

The scissor fork lifting platform has a compact structure, large carrying capacity, strong versatility, and easy control, so it has been widely used in modern logistics, aviation loading, manufacturing, and maintenance of large equipment, and other circumstance[6].

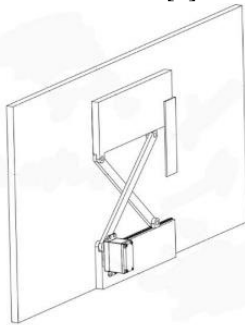


Fig. 8 Baffle structure

As shown in figure 8, there are two top points and two lower points on the cross bracket. The two top points are connected to the hole baffle, one connection is solid, and the other is mobile. One of the lower points is connected to the bed steering gear. The other is connected to the slider, which is attached to the bed slide rail. There is a damper bracket plate, which has the shape of L. The damper bracket plate is connected to one side of the hole baffle.

B. Control module

The Arduino development board is an open-source electronic prototype platform based on the Atmega328 MCU chip. It uses an ATmega16U2 chip for data transfer through a USB interface. Simply connect it to the computer through a USB cable; it would be feasible to communicate with the computer and upload the program. The USB port is used for the power supply as well.

The smart bed also includes a control module, which is equipped with a smart home network service system dedicated to the smart bed device. The module can be connected with the mobile phone through the Bluetooth module for data transfer. By voice interaction, the preset actions of designed functions will be performed[7]. It is highly flexible and can be used together with many Internet+ products such as smart furniture and smart home appliances, smart beds as well. The control module (terminal) works on a smartphone, computer, portable laptop, or even a cheap microcomputer, providing users with the various service experience.

The operation steps are as follows:

- 1) The terminal is connected to the control module through Bluetooth. The control circuit within the control module will return the environmental information of the current smart bed and other smart furniture to the terminal.

- 2) With a network connection, the terminal connects to a server. And then, the following steps can be performed intelligently under the control of cloud computing. A GUI is available as well for inputting instructions by pressing buttons. The GUI works even on offline mode, which means without a network connection.

- 3) After launch, the terminal remains in the standby state and waits for receiving instructions; The cloud database stores the voice fingerprint information of the current user. When a specific voice is recognized (through cloud computing), or a button is pressed, the corresponding command will be issued.

- 4) The instructions of the smart bed are included in the Smart bed class, including Power_on, Power_off, Desktop_lay, Desktop_rec, Brightness_adjustment, Temperature_auto, Projector_connect, etc., and are compatible with other smart furniture. Adding other extensible classes can also control other smart furniture. The terminal will send the command to the control circuit through Bluetooth, and the control circuit will launch the corresponding service according to the command.

- 5) The projector module will be in standby status when the terminal gets standby status. After the terminal is connected to the transmission line of the projector, issue the PROJECTOR_CONNECT command. The projector will start in the default mode of full interface replication, and you can enjoy comfortable entertainment or do your office job on the large screen.

The working flow chart is shown in Figure 9.

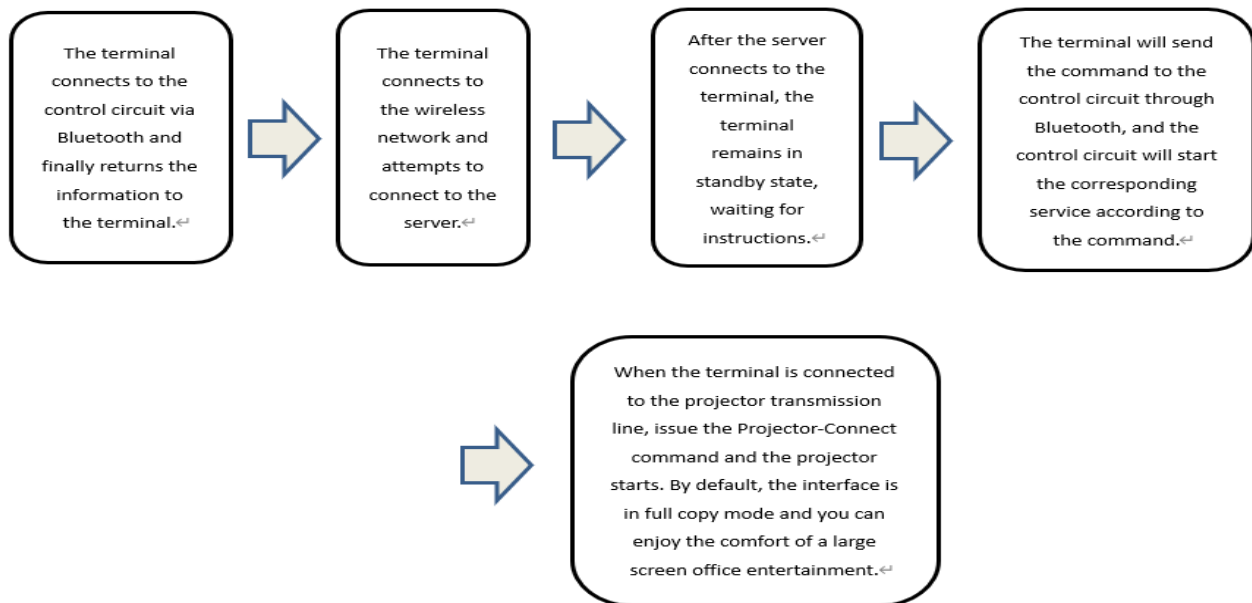


Fig.9 Working flow chart

III. EXPERIMENTAL RESULTS

The design of the smart lazy bed can be fulfilled by our settings. Bedside module: can accurately detect the pressure and temperature of the cushion so as to heat; Bed module: the mobile desktop can complete the movement and can be packed up at the end of the bed through the rotation of the motor. The auto pack-up function works as well by detecting the signal of pressure induction. Bed end module: when the mobile desktop moves forward, the window structure at the end of the bed will be opened to show the picture through the projector. Testing shows all parts of the smart lazy bed work normally, shown in Figure 10.



Fig.10 Prototype of smart lazy bed

IV. CONCLUSION

This paper introduces a new type of multifunctional smart bed. According to a large number of tests, the smart bed has the features that a stepper motor is able to drive the mobile desktop to move and can complete the auto pack up. Meanwhile, the projector with the window structure in the bed end cabinet automatically turns on when the mobile desktop moves forward so that users can watch the video, TV programs, and other entertainment items without moving, especially for people who are lazy, busy, and pay attention to efficiency. The smart bed not only saves time and labor but also has the design

advantages of night light, heating, and pressure induction-based auto pack up. This product has a positive effect on the further development of smart homes, and can also be used in nursing homes, hospitals, high-end hotels, and other places that need smart home features. We believe it has a good application prospect.

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