A New Kind of Multi-functional Bed Based on Intelligent Control

Yunjie Peng, Xi Chen*, Kailong He, Junhao Shi, Kong Zhao, Qiukai Ying
(School of Mechanical and Automotive Engineering, Shanghai University of Engineering Science, China)

Abstract *— With the development of time, people's economic conditions are getting better and better, and the demands for qualities of life, especially for intelligent household environments, are constantly increasing. As one of the necessary sets of furniture in family life, the design of beds also tends to develop with intelligent control. A few multi-functional beds have appeared on the market at present, but functions of most are simple and highly monotonous, and there are still a lot of demands that haven't been realized or satisfied. This project designs a new kind of multi-functional bed based on intelligent control and the synchronous belt transmission, which can automatically change the sheets and sterilize with ultraviolet radiation at the same time. The safety fence and the embedded table are added for the disable or to provide convenience of people with special needs, which function will greatly satisfy the needs of the market.*

Keywords — *multi-functional bed, intelligent control, synchronous belt transmission, ultraviolet radiation, safety fence, embedded table*

I. INTRODUCTION

Nowadays, science and technology have touched almost every aspect of life. With the development of computer, network, control and other technologies, smart domestic products are constantly updated[1,2]. As an indispensable furniture in family life, the design of beds changes with people's needs. A lot of intelligent multi-functional beds have already appeared on the market at present, but the functions are duplicated in most cases, while a lot of demands are still not met. Besides most of smart beds are set only for a specific group, and do not consider those users who usually have special requirements, such as those who lack the abilities to take care of their own life including old people and the children. The old persons that move inconveniently and children are usually vulnerable, while the bed-sheets easily breed mites and bacteria if they are bedridden for a long time which is harmful to health greatly. So people should change bed-sheets frequently. But it is not suitable for every family, for the way that kill mites on market are time-consuming and strenuous apparently. The elderly or children also need to be taken care of in daily life, and have high demands of assistant devices for reading and eating. Due to the people usually have to go out to work lacking enough time and energy to look after their children or parents, the family members really need intelligent bed design to provide convenience. So this paper designs a new kind of multi-functional bed based on intelligent control, which can quickly change the sheets through the synchronous belt wheel transmission saving time and effort. Simultaneously the hidden ultraviolet germicidal lamp inside the bed can effectively remove mites and bacteria, and prevents ultraviolet radiation damaging skins and causing cancers. There are flexible barriers which can provide support and preserve the integrity and beauty of the bed, cooperating with the hidden folding table saving space.

II. THE STRUCTURAL DESIGN OF THE NEW INTELLIGENT BED

A. Overall Structure

This device is a new type of multi-functional intelligent protective bed designed through synchronous belt wheel drive and transmission system. The main structure includes: synchronous belt wheel drive and transmission system 1, hidden ultraviolet sterilization lamp, telescopic guards 2, embedded lazy table 3, and basic frame of the bed body.

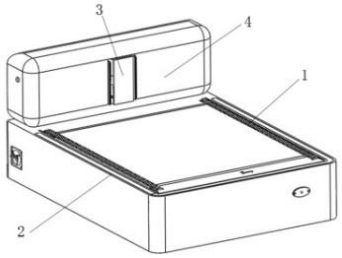

Fig.1Overall structure of the device 1-Synchronous pulley drive and transmission system; 2-Telescopic guards; 3-Embedded lazy table; 4-Bedside structure

B. Synchronous Belt Wheel Drive

Tail coupling at the end of the bed is connected with both ends of the 42-axis stepper motor, and the other end with the rigid shaft. The rigid shaft is fixed inside the bed as bearing bracket, with one end at the head of the bed and the other end linked up to the bearing through the belt wheel. The special synchronous belt is fixed with four magnetic buckles. There is a special sheet with four corners set up corresponding magnetic buttons on one side of the belt. In order to prolong the life of the special sheets and clean easily, the surface of magnetic button is wrapped with waterproof material. The other side of the belt is placed with PVC foam board equally with

magnetic buttons at four corners. Three thin-film pressure sensors are installed on the mattress between the special sheets and the PVC foam board. The pulleys at the end and head of the bed are connected by a special synchronous belt, and the 42-axis stepper motor at the centre of the bed drives the entire synchronous belt wheel[3-6]. When the special bed sheet is laid flat on the mattress, the positions of the special bed sheet and PVC foam board can be changed quickly at the end of the bed.

Fig.2 Rendering of Synchronous belt wheel transmission model

Fig.3 Rendering of UV lamp model

The specific operation method is: the user stands at the end of the bed, and fixes two magnetic buttons on the sheet with the corresponding magnetic button bottom on the belt. When press the switch to start the motor, the synchronous belt wheel works and changes the bed sheet in a short time. If someone is lying in the bed or the object is put on the bed, the membrane pressure sensor receives the signal beyond the limit, and then gives instructions to stop the synchronous belt pulley for maximum safety.

Fig.4 Model of telescopic guards

C. Hidden Ultraviolet Germicidal Lamp

The hidden UV sterilization lamp is installed in the centre of the bed bottom plate[7], and the switch is located on the bed tail plate. The user only needs to press the switch and the sheet will be automatically transmitted into the inside of the bed to conduct sterilization service for up to 30minutes.

D. Telescopic Guards

Rising of the flexible protective barriers realized by the linear motor fixed on the bracket. Through wireless remote control, two guards can rise and fall independent of each other. It is easy to adjust guards' height freely which also do not affect the appearance. Besides, protective barrier has self-locking function which can assure user's safety.

E. Hidden Folding Lazy Table

The side panel of embedded lazy table is connected with the roof by pin-connected foldable structures, and can turn up or down through a 90-degree angle. The pin-connected foldable structures with the function of self-locking can fix the side panel and roof in the horizontal position for eating, reading and so on as a lazy table.

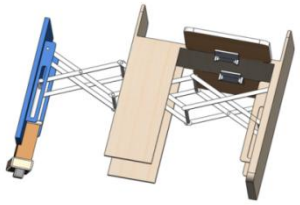

Fig.5 Embedded lazy table model

Fig.6 Embedded lazy table

The two ends of the scissor structure [8,9] are respectively connected to the front plate and back board fixed on the bed. The motor controls the deployment of the scissor structure. The roof forms the frame of the hidden lazy desk with the front plate and back board.

Motor switch locates at the head of the bed, which can achieve automatic control of extension and contraction of embedded lazy table.

F. Structure and Principle of Control Circuit

Arduino R3[10,11] is adopted based on micro-controller board of ATmega328P. Arduino R3 has 14 digital input/output pins, 6 of which can be used as PWM output and 6 as analogy input. The 16MHz crystal oscillator clock, USB connection, power jack, ICSP connector and reset button are selected[8]. The computer is used to supply power, download programs and carry out data communication through USB cable.

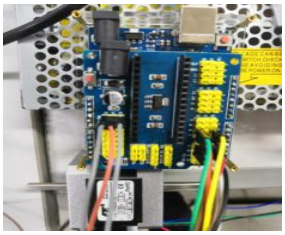

Fig.7 Arduino R3

III. DESIGN DETAIL

1. Three flexible film pressure sensors are mounted on the mattress between the special bed

sheet and the PVC foam board, to prevent security hidden danger caused by synchronous belt wheel drive when there are people or objects on the bed.

2. When the 42-axis stepper motor and the ultraviolet lamp inside the bed work, the heat generated is difficult to release. Therefore, temperature sensor and cooling fan are installed inside the bed. When the internal temperature of the bed is higher than the predetermined value, the device is turned on to dissipate heat.

Fig.8 The flexible pressure sensor

Fig.9 The cooling fan

IV. EXPERIMENTAL RESULTS

This new multi-functional bed can change the bed sheet quickly within 5 seconds by the synchronous belt wheel. Meanwhile, the hidden UV lamp can realize the sterilization function when the bed sheet is transported to the inner side of the bed. The telescopic guardrail and hidden lazy table run normally.

Fig.10 Rendering of model

Fig.11 Structure of the bed

When there are more than 100g objects on the bed, the thin-film pressure sensors will transmit the sensing signal to Arduino R3, which controls the switch to make the synchronous belt wheel stop working. When the temperature sensor senses that the temperature inside the bed is higher than 40 degrees, the cooling fan automatically turns on to cool down. When the temperature is lower than 40 degrees, the fan stops running.

V. CONCLUSION

A new kind of multi-functional bed based on intelligent control is introduced in this paper which can automatically change the sheets rapidly by the synchronous belt wheel transmission through experiment verification. Ultraviolet lamp at the same time is taken to sterilize the sheet in bed structure saving time and effort. It is beneficial to keep the people moving with difficult healthy, which also embodies the modern living conception. There are also protective fences, hidden lazy table and other devices to make the life of the elderly, children and their caregivers more convenient. This product has a positive effect on the further development of smart home, and can also be applied to nursing homes, hospitals, high level hotels, etc., which has good prospects for the application.

ACKNOWLEDGMENT

This research was partly supported by the Shanghai university student innovation and entrepreneurship project (Grant No. cs1901009).

REFERENCE

[1] Min Zhao, Pengyou Zhang, Wendi Xie. Research on intelligent bed based on Internet of things technology [J]. Electronic production, 2019, 373(09): 49+52-53.

[2] Ying Wei, Yitong Wu, Kai Chen, Xiaoxu Zhu, Qianying Shen, Zhihao Yang, Haoming Liu. Design of energy saving smart home system [J]. Electronic design engineering. 2019(11).

[3] Jianhua Guo, Hongyuan Jiang, Qingming Hu, Jiabo Li. Simulation analysis of interference and engagement of new herringbone tooth synchronous belt drive [J]. Journal of Jilin University (Engineering Edition). 2015(04).

[4] Bo Kang, Shouqiang Chen, Liangguo Hao. Research on the test-system of synchronous belt transmission accuracy [J]. Mechanical drive. 2009(05).

[5] Yuping Yang, Yun Wu, Qinglin Cao. Research on the influence of the eccentricity of the synchronous pulley on the rotary motion error of the synchronous belt [J]. Mechanical science and technology. 2002(04).

[6] Jinglong Li, Taofu Zhang. Synchronous belt drive and manufacturing of synchronous pulley [J]. Shandong machinery. 1996(03).

[7] Wei Zhou. High performance UV lamp system [A]. Daisuke Maruyama, Osamu Komatsu, Yoji Morozumi, Takeshi Tada, Takeshi Tada, Satoshi Nishibu, Akio Suzuki, Proceedings of the 10th International Conference on radiation curing in Asia [C]. 2015(07).

[8] Lei Liu, Weiguang Gao. Design and application of scissor type lifting platform [J]. Aviation Precision Manufacturing Technology. 2018(01).

[9] Feihu Zhao, Qiang Song, Guoliang Zhao, Sheng Luo, Xin Qi. Parametric modeling and optimal design of scissor type lifting platform [J]. Mechanical engineering and automation. 2018(02).

[10]Ning Fu, Hong Liu, Yulong Tang, Hui Shang, Yuan Gao. Design of intelligent irrigation system based on Arduino single chip microcomputer [J].Information and computer (Theory). 2019(08).

[11]Hongxing Tian, Chengcheng Tang. Design of voice interactive smart home system based on Arduino single chip microcomputer [J].Journal of Guiyang University (Natural Science Edition). 2018(04).