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A Humanized Intelligent Seat

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Abstract *— With the arrival of the smart home upsurge, aiming at personalized life, we hope to design a humanized smart seat to facilitate people's life from many aspects. The seat is designed in terms of multi-function characteristics, including three functions: seat mode, leisure mode (half lying mode), and sleep mode. The three modes can be switched by using a button on the chair handle. It has different humanized functions in different modes. The bottom of the seat is also integrated with a pair of mobile wheels; users can control the seat through the armrest of the joystick movement posture. In addition, the time users sit on the chair can also be coordinated, and the statistical results will be sent to the APP of the user's mobile phone at regular intervals every week.*

Keywords *— Smart seat, Humanized control, Three modes.*

I. INTRODUCTION

With the in-depth development of the Internet and the arrival of the era of the Internet of Things, the smart home industry has exploded with unprecedented market potential [1]. At the same time, due to the continuous improvement of people's living standards, the demand for a living environment is also increasing, and the smart home industry has become a hot new industry. New consumer groups represented by the post-80s and post-90s pursue customized and personalized home decoration design, and increasingly become the main force of home decoration industry consumption. They need to fully show personality and maverick, the pursuit of quality life and personalized home decoration design, the pursuit of simple but not simple, low-key but luxurious design style. Accordingly, the intelligent home outfit is more and more favored by a young family. At present, the domestic smart home market is mainly aimed at high-end user groups, such as villas, smart communities [2], etc. At the same time, the smart hotel and smart office market are growing fastest, while the development of the ordinary residential smart home market is very slow. The most important reason why smart home is difficult to enter ordinary homes is the high price. At present, the cost of a smart home is generally more than 100,000 yuan, and the public it is more difficult to accept this price. At present, there are few smart seat products commonly used for home life in the market, and most of them are applied in restaurants, automobiles, medical fields, etc. For the daily life of the general population, there is little product design in this aspect. Therefore, on the basis of reducing the cost, we aim to produce a kind of intelligent seat that can be used in ordinary home life and achieve high comfort. This document is a template. An electronic copy can be downloaded from the conference website. For questions on paper guidelines, please contact the conference publications committee as indicated on the conference website. Information about final paper submission is available from the conference website.

II. OVERALL SCHEME DESIGN AND WORKING PRINCIPLE

A. Overall scheme design

Intelligent furniture integration system in intelligent desk and gesture more intelligent chair STM32 center plate installation, intelligent at the same time, touch screen and the raspberry pie is installed on the desk, chairs, and tables via bluetooth module connection, in order to realize the integrated control of all parts of function modules, including: table leg lift adjustment, lifting and rotating cabinet calls, sketchpad Angle adjustment, tea set to receive a call, back and leg posture transformation, mobile chair wheel [3-4], etc. The overall functional design is shown in Fig. 1. The mechanical model is shown in Fig. 2.

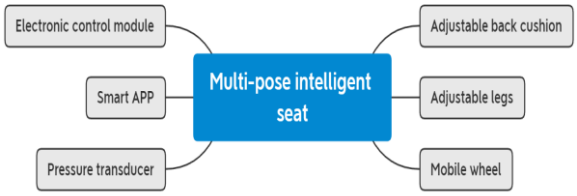

Fig. 1 Seat function design drawing

Fig. 2 Mechanical model

B. The demonstration of the chair automatic adjusting leg plate scheme

Most of the adjustable chairs on the market require manual adjustment, and the operation when changing the chair posture is often very troublesome, especially when the user is concentrating on work or study; the tedious adjustment is very inconvenient. In the meantime, very few chairs can have leg department adjustable prop up, have also be fixed Angle more, the chair that little part can adjust automatically is used at high-grade sofa chair, luxury car more, their structure is the complex price is expensive, do not apply to the broad crowd. Therefore, we first designed a chair that only relies on the push rod and the rotating shaft to complete the independent posture transformation. The back and legs are independent transformations instead of linkage, and can be personalized to adjust their respective angles. The hinges with strengthened strength and the push rod (as shown in Fig. 3) are selected. The push rod with the hinge can realize the Angle change of the user's leg and back, and the push rod has the self-locking function, so there is no need to worry about the problem of supporting force. In addition, considering the high machining cost, cumbersome structure, and high lubrication requirement of the shaft, the design scheme was further optimized, and the standard hinged part, as shown in Fig. 4 was adopted to replace the shaft, which was cheap and simple to install.

Fig. 3 Mechanical model

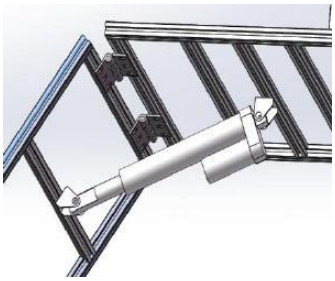

Fig. 4 Model installation

C. Demonstration of electric control module scheme

STM32F103C8T6 is used in the electronic control core control chip of the intelligent chair. According to the project requirements, a multi-pose PCB circuit board of the intelligent chair is drawn. The motor drive, relay, and other modules are integrated to reduce the space occupied by the electronic control components and facilitate program control and wiring. The electronic control components of the smart seat are shown in Fig. 5. On the circuit board of the intelligent chair, there are two motor drivers, a Bluetooth module, pressure sensor, wireless module, and receiving module. All the pins are directly connected with the STM32 master control. At the same time, the CAN communication interface is also introduced to connect the C620 electric adjustment, so as to drive the 3508 motors.

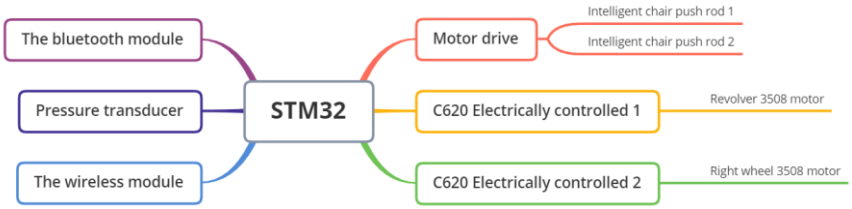

Fig. 5 Electronic control component

D. Working principle

The desk and integrated chair system can be controlled by APP or by pressing buttons. There are four buttons on the main page of APP, which are: free control, work mode, entertainment mode, and nap mode. When the user presses the "working mode" button, the seated posture will be restored to the initial state; In "entertainment mode," the intelligent chair automatically adjusts the Angle of the chair back and foot support, and the armrest automatically changes to support the user's arms. In "nap mode," the intelligent chair will automatically adjust to the position of lying down; When the user presses the "free control" button, all the functions of the intelligent chair can be controlled separately. The controllable part of the intelligent chair includes the back of the chair and the foot support, and a rocker installed on the arm of the intelligent chair can independently control the pitch and autonomous movement of the chair, which is convenient for users to adjust the angle of the back of the chair and the distance between the table.

III. THEORETICAL DESIGN CALCULATION

A. Mechanical module design

The multi-posture intelligent chair plays the role of supporting the user's human body. Its components include a seat cushion, leg bracket, adjustable back cushion, mobile wheel group, etc. Therefore, the aluminum profile with high-cost performance and sufficient strength is adopted as the frame. Based on the consideration of ergonomics, the multi-posture intelligent chair is designed, as shown in Fig 6.

Fig. 6 Multi-pose intelligent chair object

B. The calculation of leg support plate and adjustable back cushion

The touch screen module on the desktop controls the leg support plate of the chair and the adjustable back cushion. By triggering the button on the touch screen, the mode switch can be carried out with one key to realize three-mode changes (office, entertainment, and rest). Switch from Fig.7 and Fig.9 to Fig.8 and Fig.10, and switch from office mode to nap mode. The user presses the button, the corresponding touch transfer corresponding instruction, through the table microcontroller Bluetooth module to send data to the microcontroller, chair of the corresponding task, due to perform a push rod elongation or shortening of 1 ms task execution time, define a variable COUNT, perform a task from 1, suppose you want to change electric draw stem and 70 mm stroke volume (electric putter at the rate of 70 mm/s), set when COUNT from 10000 to stop the task, namely changes 10 s time, stop the value by changing the COUNT, in order to achieve the change of the three states.

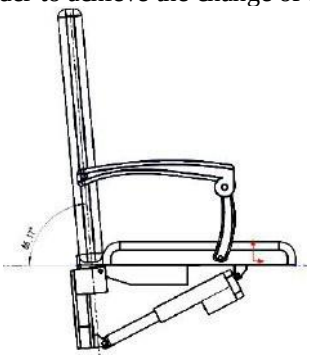

Fig. 7 Back Cushion - Silent

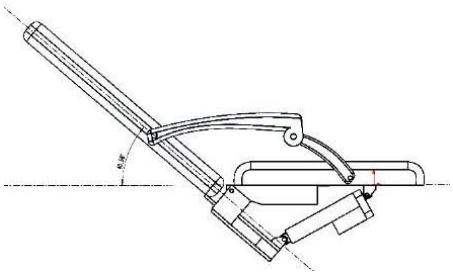

Fig. 8 Back Cushion - Enabled

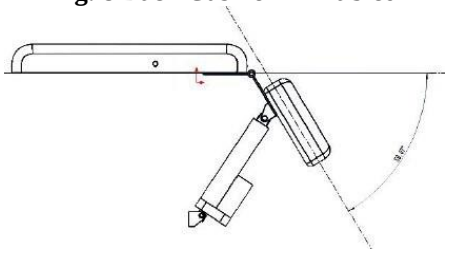

Fig. 9 Leg brace - silent state

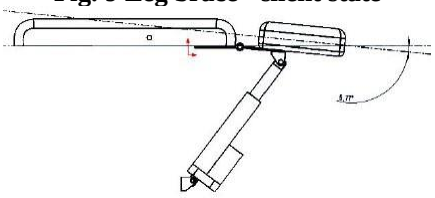

Fig. 10 Leg brace - enabled state

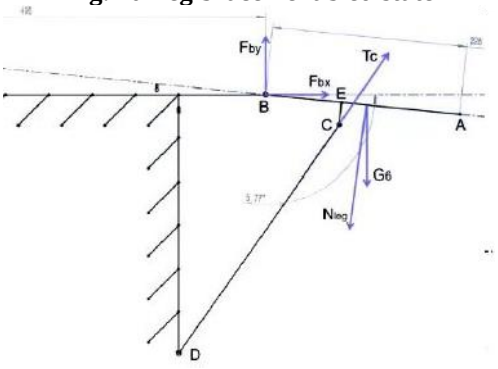

Fig. 11 Leg brace - mechanical model

In the mechanical analysis of the leg rest, the mechanical model shown in Fig.11 is adopted. Considering the influence of the weight of the leg rest mechanism, the geometric center of the leg rest mechanism is respectively taken as the position of its own gravity force. In summary, point B is obtained by using the force balance:

$$\sum M_B = 0,\ T_C \cdot L_T - G_6 \cdot L_6 - N_{leg} \cdot L_{leg} = 0 \quad (1)$$

Whereinto, the moment arm from the geometric center of L6 —BA bar to point A.

G_6 — BA rod, namely leg support gravity, the mass of the electric push rod is 200g.

L_{leg} — The moment arm from the geometric center of the load on the leg bracket to point A.

N_{leg} — The pressure of the load weight on the drawing board on the leg support is now set as 15kg (i.e., the weight of the user's shank is assumed to be 15kg).

L — The moment arm from T to B.

T_C — DC rod, that is, the electric push rod on the leg thrust, T_{CMAX} depends on the electric putter itself.

According to Equation (1), it can be calculated that, under the target load state, $N_{leg} = mg\cos\theta$, Electric bar force at leg bracket. $T_C = 187.31$N，It can meet the daily needs of users. Similarly, the thrust force of the electric rod is calculated under the target load state $T_b = 373.57$N，That is to meet the needs of users' daily life.

According to the product manual of selecting the electric push rod, when the speed of the push rod is 7mm/s, the maximum thrust that the push rod can provide can reach 850N, which meets the requirements of the above design products.

C. Circuit design of electronic control module

All motors or electronic control components are powered by 12V or 5V, and the total current will not be higher than 5A, so TPS5430 is used as the main control chip of the 12V to 5V step-down module, which can transpose the power from 12V to 24V into 5V to supply power to peripheral devices such as steering gear, relay, wireless module, and serial port screen. TPS5430 has a undervoltage blocking circuit. When the power is on, the internal circuit runs ineffectively and will not start until the input voltage exceeds the threshold voltage. The self-protection performance is good. The static voltage of the human body is 1500V, and the TPS5430 can withstand the electrostatic shock of 2000V.

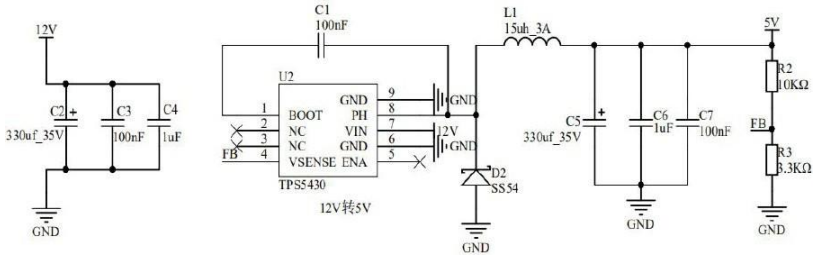

Fig. 12 TPS5430 Buck circuit

TPS5430 step-down circuit as shown in fig.12, based on this chip with basic BUCK circuit topology, including SS54 diode, 15 uh inductance, and 330 uf capacitance and Ω 10 k and 3.3 k Ω bleeder circuit. When the built-in switch tube of TPS5430 is closed, the diode D2 is closed. Since the input voltage VI is connected to the energy storage inductor L1, the input-output pressure difference (VI-VO) is added to L1, so that the current through L1 increases linearly. At this stage, in addition to supplying the load, a portion of the electrical energy is stored in the inductor L1 and the capacitor C5. When the switch tube is disconnected, L1 and VI are disconnected, but since the inductor current cannot be suddenly changed, a reverse electromotive force is generated on the inductor L1 to maintain the current passing through the same. At this point, the diode D2 turns on, and the electrical energy stored in the inductor L1 passes through the circuit composed of D2 to supply the load. Considering that the switching frequency of the switch tube will affect the stability of the power supply, the 100nfcapacitor is adopted as the feedback capacitor, and the switching frequency is reduced to 500kHz, so that the output ripple voltage of the power supply is extremely low.

To solve the power supply problem of SCM, we adopted the step-down module from 5V to 3.3V, and selected the LP5907MFX chip as the main control, with the maximum output current of 250mA, meeting the requirement of the power supply current of 50mA of STM32 SCM. The LP5907MFX uses innovative design technology to provide excellent noise performance without noise-by-pass capacitors and support the remote placement of output capacitors. Fig.13 shows the schematic circuit diagram of the LP5907MFX step-down. Two 22uF input filter capacitors are used to make the input ripple voltage lower than 0.5V to ensure the stability of the chip's power supply.

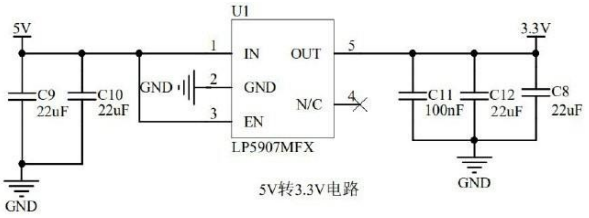

Fig. 13 LP5907MFX Buck circuit

IV. CONCLUSIONS

The smart seat is mainly used in the smart home market, which conforms to the development of the current era and follows the in-depth development of the Internet of Things, so as to improve the quality of daily life of users. In addition, the system can also be applied to office scenes to facilitate the working conditions of users. Through the multi-pose changes of the intelligent chair, the ergonomic chair posture can be adjusted for users. Therefore, the use of the intelligent desk and chair can provide users with a comfortable and secure office environment, and significantly improve work efficiency. Fig.14 is the office mode, Fig.15 is the entertainment mode, and Fig.16 is the rest mode.

Fig. 14 Working mode

Fig. 15 Entertainment mode

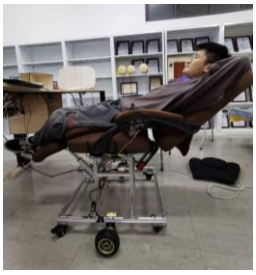

Fig. 16 A nap mode

The user-friendly intelligent chair has the advantages of the simple overall structure, relatively low cost, and wide range of user groups. Through preliminary tests, it can significantly improve the efficiency of office learning, meet the needs of users in different uses, and can be conveniently controlled through APP, so that users can get a comfortable and convenient smart home experience.

ACKNOWLEDGMENT

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