Research and Development of Intelligent Wheelchair Hybrid Drive System

Deng Baoqing, Wu Delin, Gong Fan, and Wang Yushu

***Abstract*—With the improvement of people's living standards, elderly people with mobility difficulties or people with disabilities due to some reasons need an intelligent control wheelchair that integrates drive control and human health status detection system. Based on embedded STM32 hybrid drive system of the intelligent wheelchair, STM32F103ZET6 on embedded microcontroller as the control core, comprehensive electronic, electrical and mechanical, such as sensing, communication, and the simulation technology, to control, driving, obstacle avoidance, positioning, GPS/GSM function module in the form of structures, such as circuit, using PWM technology, PID algorithm and software programming, can realize to precisely control the driving wheel; At the same time, the system makes use of the high precision characteristics of the main controller to realize the accurate detection of human temperature, blood pressure and heartbeat. The Hybrid Smart Wheelchair can be operated manually or automatically, and can monitor important indicators of human health in real time. The test results show that the drive control system and the human health testing system can reach the preset indexes, and it has the advantages of safety, reliability, complete function, flexibility and stability compared with similar products. Hybrid driven intelligent wheelchair has broad market prospect and high research and development and application value.**

***Index Terms*—STM32, intelligent wheelchair, drive control system, human, health detection system.**

I. Introduction

In the past, it was almost impossible for many elderly and disabled people to go outside and see the scenery without the company of family members or acquaintances. Later, manual wheelchairs appeared, which enabled some people with mobility difficulties to use manual wheelchairs as walking AIDS, turning the wheel with both hands instead of using their feet to walk. Because the wheelchairs can only be driven by the hands, they can only be used for short distances and on relatively smooth roads, which greatly limits the range of movement and requires a lot of effort. In this case, it is almost impossible to use the hand to drive the wheel forward and can only move in a small range of walking tools, so it is necessary to design a powerful driving system to replace the hand drive.

Electric energy can be seen everywhere in our life. It has the advantages of no pollution, high efficiency, convenient transportation, convenient use and convenient conversion, which makes the application of electric energy in all aspects, and it is a very good choice to use electric energy as the driving energy of wheelchair. As long as there is electricity, the wheelchair can keep moving forward, which not only greatly saves manpower, but also expands the scope of activity of people with mobility difficulties. The use of high-power motor drive can also make the wheelchair drive on a certain steep slope. With single chip microcomputer as the control center, the drive circuit can drive the high-power motor to make the wheelchair travel, and the reliable drive system has become the key to the stable progress of the wheelchair.

Although the intelligent wheelchair has a high degree of intelligence, there are still deficiencies and areas to be improved, and this study will make up for some deficiencies, so that the wheelchair can be further upgraded to make it more intelligent and humane. Intelligent drive is only the basis of intelligent wheelchair. If more functions are added on this basis, such as human temperature detection, human blood pressure detection, remote monitoring, etc., it may be able to more comprehensively protect the health of wheelchair users and make the guardians of wheelchair users feel more assured to let them go out on their own. Through this design can master and consolidate the relevant theoretical knowledge of driving system and electronic technology, as well as a variety of components related to the design of the circuit, and cultivate their own application ability, innovation ability and independent work ability in the actual work.

This system main function: intelligent wheelchair USES STM32 [1], Internet, sensors, advanced technology such as GSM [2], bluetooth, GPS [3], not only can achieve accurate smoothly implement sit, stand, the three kinds of sports, but also can achieve by manual, automatic, voice three kinds of control mode, control forward, backward, turn left, turn right, stop, five kinds of running state, and dangerous to be able to send out alarm signal, and send text messages to their guardians, realize remote monitoring, at the same time can also [4].

II. System Total Design

This design of intelligent wheelchair drive control system, wheelchair can choose the operation mode of manual operation mode and automatic obstacle avoidance mode. The switch between manual control mode and automatic driving obstacle avoidance mode is realized by pressing the button. The manual operation mode is controlled by joystick and Bluetooth control of mobile phone. The speed level of the wheelchair can be controlled by pressing the button. The overall design diagram of the drive control system is shown

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in Fig. 1 [5].

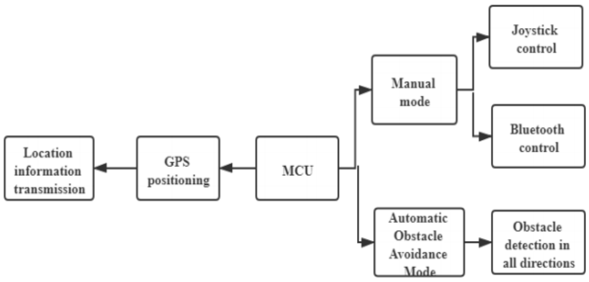

Fig. 1. Overall design diagram of the drive control system.

When selecting the joystick control mode, its operation mode and function are the same as the previous electric wheelchair, through the joystick can control the wheelchair movement in all directions; When choosing the Bluetooth control mode, the Bluetooth of the mobile phone is connected with the Bluetooth of the wheelchair to realize the remote control of the movement direction of the wheelchair through the wireless way. When the automatic obstacle avoidance mode is selected, the automatic obstacle avoidance mode is mainly composed of five ultrasonic modules, which can detect obstacles in different directions. By measuring the corresponding data and distances of obstacles in different directions, these data are processed to make the judgment at the logical level. When the indicators set in the program are met, the wheelchair is allowed to enter the corresponding operation. No matter whether the wheelchair is in manual mode or automatic mode, when the gyroscope detects that the wheelchair is in an abnormal state in a certain period of time, the location module is used to locate the longitude and latitude of the location of the wheelchair. After the location is completed, the longitude and latitude of the location is sent to the designated mobile phone number through the SMS module.

Human health monitoring system can monitor the body temperature, blood pressure and heart rate, body temperature by temperature probe sensor temperature data into the MCU [6], MCU and can also collect the blood pressure sensor sent the value of blood pressure and heart rate value, MCU will be processed data display on the OLED screen, real-time monitoring of the human body temperature, blood pressure and heart rate. The design diagram of human health monitoring system is shown in Fig. 2 [7].

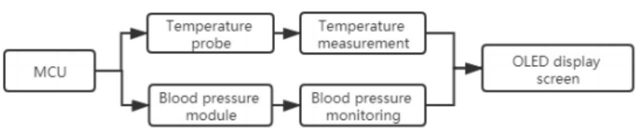

Fig. 2. Design diagram of human health monitoring system.

III. Main Hardware Circuit design

According to the functional requirements of this topic, by comparing the performance of different types of hardware, choose the function module suitable for this system, draw the hardware circuit PCB diagram.

A. Main Control Module of the System

The control chip used for both the drive system and the human health monitoring system in this design is STM32F103ZET6, as shown in Fig. 3 [8].


Fig. 3. STM32F103ZET6 core board.

This chip development board resources are very rich, support peripheral function, its serial communication port and the number of timers are more. In the software design, can write the corresponding program let the chip output PWM wave, so that you can achieve the control of the speed of the wheelchair motor. The chip has a very rich external pin, up to 144 I/O ports, which can be designed to solve wiring problems. The internal flash has 512KB, which is enough memory to drive the design of the system, and can work under 5V voltage. After voltage conversion, it can also be used to power other peripherals. The STM32 chip runs much faster than the 52 chip, up to 72MHz, which allows the CPU to run at high speeds. At the same time, STM32 is support JTAG debugging and SWD debugging, and the corresponding tool selection J-Link, can be rapid debugging, can be modified in a short time to complete the program. In the drive control system, many modules need serial port communication with the chip, so you can choose STM32F103ZET6 with multiple serial ports as the core control chip of the system design.

B. Drive System Module

The system selects the model XY-15AS 15A motor drive board as the drive system. The drive board almost all circuit protection in one, can effectively improve the safety of the motor work, greatly save time cost, simplify the connection of circuit lines, reduce errors.

Fig. 4 is the connection diagram of the motor drive module. In1 and In2 interfaces mainly control the forward and reverse rotation of the motor and the brake of the wheelchair, and are connected with the I/O port of STM32 which controls the forward and reverse rotation of the motor. PWM interface as a drive module to control the speed of the motor signal input, and need to be connected with STM32 PWM output I/O port; 5V0 interface is the power interface provided by the drive module, which can provide 5V power supply for STM32 single chip microcomputer. The COM interface of the driver module needs to be connected with the corresponding STM32 power supply ground interface. The black port of the 9-36V rechargeable battery is connected with the wheelchair motor, and the blue port is connected with a fuse and the power supply.

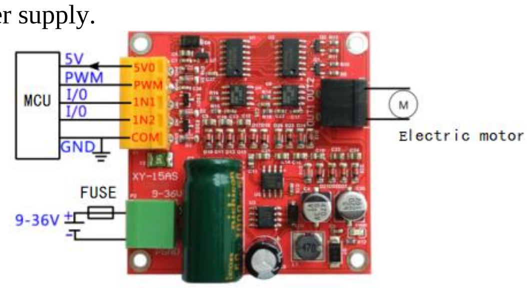

Fig. 4. Wiring Diagram of Driver Module.

C. Obstacle Avoidance Module

In this paper, the ultrasonic module RCWL-1603 is selected to achieve obstacle avoidance function. This type of ultrasonic module has many advantages, which can realize long-distance detection, the detection distance is up to 800cm, so that the wheelchair can safely avoid obstacles with a certain speed, so as to ensure the safety of users. The measurement accuracy of this model module is also very high, the error is 0.5cm, can clearly identify the position of the obstacle, and make the correct operation in time. Operating voltage is 5V or 3.3V. Working at 5V, the measuring distance will be longer.

The RCWL-1603 ultrasonic module has a variety of working modes, including serial port mode, PWM mode, GPIO mode and Auto GPIO mode. It can switch between these modes to choose the correct mode to work.

Five ultrasonic modules are used in the driving system, and each module is the same with four pins, as shown in Fig. 5. Pins PB6 and PA0 are used in module 1; Pins PB7 and PA1 are used in module 2; Pins PB9 and PA6 are used in module 3; Pins PB5 and PA7 are used in module 4; Pins PB12 and PB0 are used in Module 5.

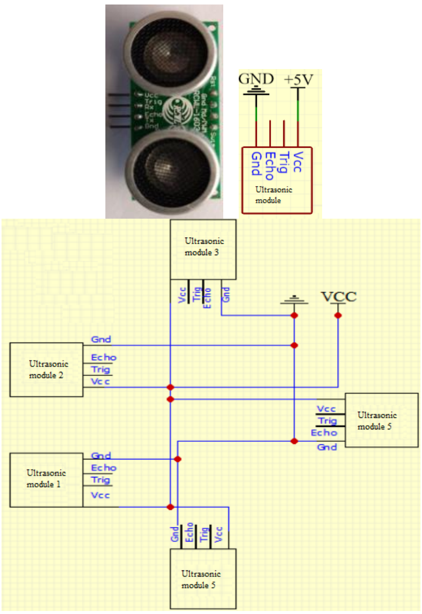

Fig. 5. Ultrasonic module diagram.

D. Direction Control Joystick

Direction control joystick can be pushed forward, back and left and right four directions, can also be understood as the X-Y coordinate axis composed of four directions. And the rocker interior is composed of two sliding potentiometer actually, the rocker is equivalent to the sliding arm, when rocking, equivalent to the position of the sliding arm on the adjusting potentiometer, the resistance value of its potentiometer also gets the corresponding change. After the resistance value of the potentiometer is changed, through the analog-to-digital conversion, the voltage value at this time can be read to know which direction the joystick now refers to. In this way, the steering joystick can control the direction of the wheelchair.

The joystick module has five pins, namely SW, Y, X, VCC and GND, as shown in Fig. 6. The VCC pin is connected to the power supply 5V, the GND pin is grounded, the X axis pin is connected to PC1, and the Y axis pin is connected to PC0.

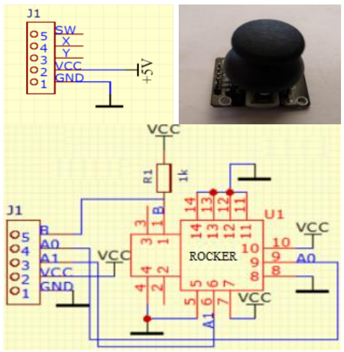

Fig. 6. Joker module diagram.

E. Bluetooth Communication Module [9]

The Bluetooth module works under the voltage of 5V, and the TXD and RXD in the module should be connected with the RXD and TXD in the STM32 microcontroller respectively, because the module needs to carry out serial port communication with the STM32 module. In addition, the Bluetooth of mobile phone is connected with the Bluetooth module of STM32F103 through APP, so as to realize the remote control of the wheelchair.

Pins used in the module are GND, VCC, TXD and RXD respectively, as shown in Fig. 7. VCC pin is connected to 5V, GND pin is grounded, the module uses serial port 5, RXD pin is connected to PC12, TXD pin is connected to PD2.

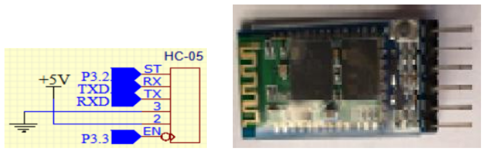

Fig. 7. Bluetooth communication module diagram.

F. GPS Positioning Module

The positioning module is ATGM332D, which supports dual-mode satellite positioning, namely GPS satellite positioning and Beidou satellite positioning. This module has many advantages, such as: high sensitivity, low cost, low power consumption. The module positioning supports single system positioning of BDS/GPS/GLONASS satellite navigation system, as well as multi-system combined hybrid positioning, QZSS, SBAS system and A-GNSS.

The ATGM332D module is powered by a 5V power supply. In the case of a 5V power supply, the accuracy can reach 2.5m, the tracking sensitivity is -162dBm, and the cold start capture sensitivity is -148dBm. The first positioning time is about 32 seconds, and there are antenna detection and antenna short-circuit protection circuit in the module, to ensure the safety of the module. The ATGM332D module also uses the serial interface to communicate with the MCU, so only the TXD and RXD pins in the ATGM332D module are connected with the lead pins RXD and TXD of the MCU respectively to realize the communication.

The ATGM332D module has four pins, namely VCC, RX, TX and GND, as shown in Fig. 8. VCC pin is connected to 5V, GND pin is grounded, and ATGM332D module uses serial port 2, RXD pin is connected to PA2, TXD pin is connected to PA3.

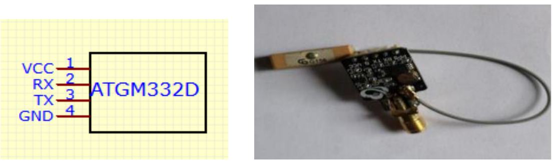

Fig. 8. ATGM332D module diagram.

G. GSM SMS Sending Module

The short message sending module uses GA6-mini module, which needs 5V power supply. Under normal power supply, the built-in indicator light on the module will enter the speed of uniform flashing, the flashing speed is very stable, and the flashing brightness of the indicator light is also very saturated, which proves that the module power supply is normal, at this time has reached a stable working state. On the contrary, if the brightness of the LED is strong and weak, it means that the power supply of the short message module is not stable. In this state, the module may send a message wrong, for example, when sending a short message, there may be a failure to send; When you try to receive a short message, you may fail to receive it.

The GA6-mini module supports the use of mobile, Unicom and global GSM network, supports serial port multiplexing in accordance with the GSM07.10 protocol, and supports standard AT and TCP/IP command interfaces. The phone card slot of the module uses the Micro SIM card. The module not only supports SMS message sending, but also supports voice communication.

The GA6-mini short message module uses four pins, respectively TXD, RXD, GND and VCC, as shown in Fig. 9. The design to use the MCU serial port 3, where VCC pin connected to 5V power supply, GND pin ground, RXD pin connected to PB10, TXD pin connected to PB11 [10].

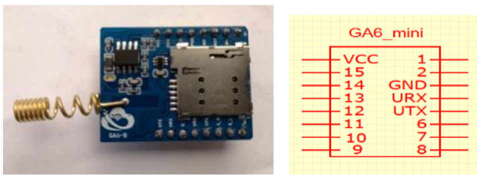

Fig. 9. Diagram of GA6-Mini module.

H. Protection Circuit

A 20A fuse is connected in series between the power supply and the drive module to prevent the possibility of the power supply reverse connection or the power supply voltage exceeding 37V causing the module to be burned out, playing the function of overvoltage protection and undervoltage overcurrent protection circuit.

TVS (Transient Voltage Suppression Diode) protection electrical appliances contain electrostatic sensitive components, using the P-N junction reverse breakdown working principle, can be electrostatic high voltage pulse into the ground. In the circuit design, the TVS protection appliance and the protected component are parallel, when there is instantaneous pulse generation, there will be short circuit, large voltage into this component will not damage the circuit line. When the high voltage is gradually reduced and the instantaneous pulse disappears, the TVS will automatically change to a high resistance state and the whole circuit will be restored to normal voltage.

IV. Main Software Design

The main controller of the drive control system and the human health monitoring system is the microcontroller with the model STM32F103ZET6. Intelligent wheelchair can realize the function, can use the PWM technology and PID algorithm, write the corresponding program, and finally through running the function module program, to achieve the precise control of the driving wheel. At the same time, this design uses the high precision characteristic of STM32F103ZET6 main controller to realize the accurate detection of human temperature, blood pressure and heartbeat [11].

A. Main Program for CPU

The drive system in this design is divided into two control modes: automatic obstacle avoidance mode and manual control mode, as shown in Fig. 10. In the automatic obstacle avoidance mode, the wheelchair uses ultrasonic sensors to avoid obstacles in each direction, and the wheelchair will drive in the opposite direction.

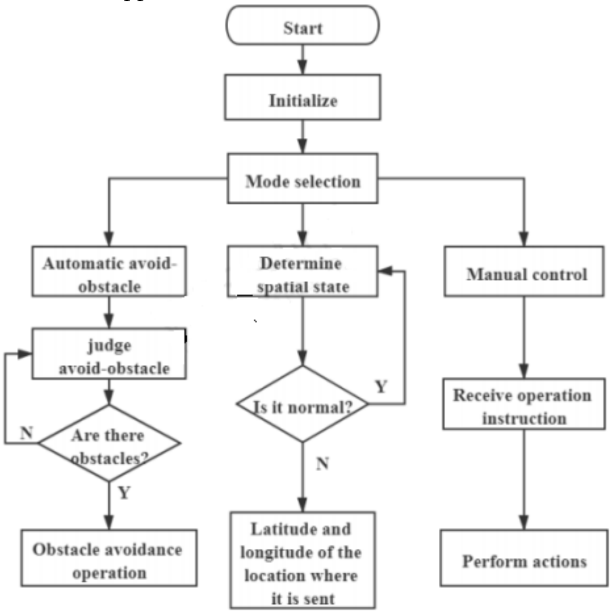

Fig. 10. Driver system program design flow chart.

While avoiding obstacles, the wheelchair can also receive manual operation instructions. The main purpose of this is to avoid unexpected things that may occur during the automatic obstacle avoidance process, so that the manual operation can be corrected in time. In the manual control mode, the operation of the intelligent wheelchair is the same as that of the electric wheelchair on the market, but the wheelchair in this design can also receive the wireless operation of Bluetooth, and use the mobile APP to issue control commands to control the wheelchair; When the wheelchair rolls over, the abnormal spatial status of the wheelchair will be detected for many times. At this time, the coordinates of the abnormal occurrence of the wheelchair will be located and sent to the designated mobile phone number through the form of SMS.

The human health status detection system designed in this paper simultaneously measures the body temperature, blood pressure and heart rate. The sensor transmits the measured data back to the control chip, and then displays the processed data on the OLED screen, as shown in Fig. 11.

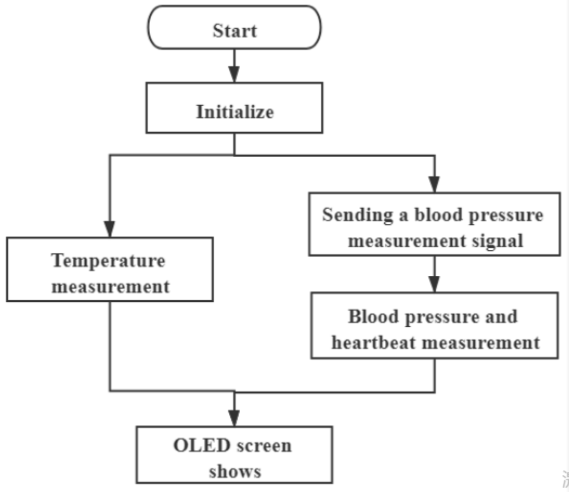

Fig. 11. Program design flow chart of human health status detection system.

B. Procedures for Detecting Body Temperature

Because DS18B20 digital temperature sensor has only one signal line for data transmission, it is necessary to use different configurations of the input and output of I/O port.

First you need to enable the clock of the I/O port used, and also enable the clock of the corresponding pin of the I/O port. The input of the I/O port is configured as pull-up input and the output is configured as ordinary push-pull output, and the frequency is set to 50MHz.

After initialization, the measured temperature is obtained by the function ds18b20_getTemperture (). Because the unit of temperature measured by DS18B20 digital temperature sensor is not Celsius, the function DS18B20_start () is needed to convert the temperature, and finally the body temperature is measured.

C. Human Pulse and Blood Pressure Testing Procedures

The human pulse and blood pressure detection module needs to communicate with the MCU to process and read the data measured by the module in real time.

Program design to enable the serial port clock and the corresponding pin clock, the corresponding serial port TXD is set to TXDGPIO_MODE_AF_PP mode, RXD is set to GPIO_MODE_ain mode, and the frequency is set to 50MHz. Because higher transmission rates are needed, set the baud rate to 115200 to reduce latency. A stop bit needs to be set, others need not be set, and finally enable the serial port.

Since the read data is to be received in the interrupt service routine, it is also necessary to configure the interrupt related registers of serial port 2. Because we need to use the serial port interrupt for interrupt processing related procedures, so we need to open the corresponding interrupt, but also set the serial port interrupt channel. In multiple interrupts, the interrupt priority is set to execute the program sequentially, so preemption priority is set to 2. In STM32, you also need to set the level of the subpriority, so set the subpriority to 2. After setting the interrupt priority, it is necessary to enable the IRQ channel so that interrupt processing can be realized. Then initialize the VIC register, and finally write the functions that need to be realized in the interrupt process in the serial port interrupt service program, so that the corresponding serial port can realize interrupt processing and receive data.

D. OLED Display Control Program

The OLED module is mainly used to display the values measured by sensors processed by the control chip. First of all, it is necessary to clear the OLED screen. The 128x64 dot matrix screen used in this design needs to clear each dot matrix. After the OLED screen is initialized, the desired content can be displayed.

Initialize SSD1306: Enable the I/O port clock and pin clock, configure the I/O port to push-pull Output mode and set the frequency to 50MHz.

After initialization, the Chinese that needs to be displayed on the screen is displayed in the specified location with the function oled_showChinese (). The OLED_ShowChar () function displays a character at a specified position. This function differs from oled_showChinese () in the amount of memory required to display it.

E. Joystick Control Program

Because the rocker is by changing the potentiometer resistance value to change the size of the voltage, by detecting the size of the voltage value to determine the rocker's position, so the need to use analog electronics in the analog-digital conversion, the need to convert the analog signal into digital signal, in order to switch the rocker voltage. In STM32, ADC has two channels, which are conventional channel and injection channel. However, the injection channel has a higher priority than the regular channel, so the regular channel sampling can be interrupted preemptively, and the regular channel sampling is not performed until after the injection channel sampling has been performed. The STM32 ADC can be triggered by timer capture, EXTI line and software trigger, that is, when the relevant registers are configured, it is only necessary to turn on the sampling directly, so that the sampling operation can be performed [12].

Since the analog-to-digital conversion is used, the corresponding registers need to be configured. Start ADC clock and enable I/O port clock, GPIO port is set to GPIO_MODE_AIN mode. After completing the setting of the mode, the ADC clock needs to be enabled and the frequency dividing factor ADC1 needs to be set here. After the clock setting is completed, in order to prevent errors during execution, there is a need to reset the frequency dividing factor. The ADC1 clock frequency cannot be set to exceed 14MHz. Next, you need to set the ADC's mode configuration. You need to set the data alignment, trigger mode selection, and single mode conversion. After that, AD conversion is started. In order to make the measured data more accurate, reset and calibration should be performed before starting. AD calibration should also be performed at the same time. After setting, start analog-to-digital conversion. At the end of the analog-to-digital conversion, you can read the ADC1_DR value to know the rocker position of the potentiometer voltage value [12].

F. Ultrasonic Obstacle Avoidance Program

Ultrasonic module has Tring, Echo, VCC, GND four pin, can get the main measurement data in Echo and Tring, through Tring to control the ultrasonic emission, using Echo to wait for ECHO trigger. When TRING emits a high level, wait for more than 10 μ s before emits a low level. In doing so, the module emits an ultrasonic wave. After that, the level corresponding to the ECHO pin changes from low to high. After sending, the pin will go low. Because the level of ECHO pin is high when ultrasonic wave propagates, that is to say, the time from sending ultrasonic wave to receiving ultrasonic wave is the time taken by ECHO pin at high level. Distance = speed times time, so the time taken by the high level is multiplied by the speed at which the ultrasound travels through the air to get the distance. However, the time of high level includes the two processes of ultrasonic wave from sending to receiving. Therefore, the distance between the ultrasonic module and the obstacle should be the calculated distance before divided by 2.

Initialization operation: enable ECHO pin clock, configure ECHO GPIO as GPIO_MODE_IPD mode.

Because the time taken by an ECHO pin at a high level is calculated, its pin is also multiplexed as a timer, thus enabling the timer's clock at the same time. When setting the timer, it is necessary to set some parameters related to the timer. The timer and the counter use the same register. The automatic reload value of the counter should be set to ensure that it can be automatically reloaded after the counter is full, and the pre-divider is also configured. Also, set the timer to count up mode. Finally, you need to set the input capture parameters. And configured for rising edge capture, without filtering, select the input side to map the corresponding pin. Once this is done, the timer is initialized, and the timer starts when the ECHO is switched to a high level. Enable the clock corresponding to TRING and configure the pin corresponding to TRING in push-pull output mode.

Ultrasonic obstacle avoidance module to determine whether there is an obstacle: the need to get the distance between the module and the obstacle, in advance to set a threshold, when the measured distance is less than the preset threshold value will be judged as an obstacle. After obtaining whether there are obstacles in different directions, this result is used to carry out fuzzy processing. There are many values in the fuzzy table, which needs to compare the obtained result with the set value, and then carry out the corresponding operation, this is shown in Table I.

TABLE I: OPERATION FUZZY CORRESPONDENCE TABLE

C1	C2	C3	C4	C5	operation
1	0	0	0	0	left front
0	1	0	0	0	Right front
0	0	1	0	0	before
0	0	0	1	0	before
x	x	x	x	1	stop
1	1	0	0	0	right
1	0	1	0	0	right
1	0	0	1	0	left
0	1	1	0	0	right
0	1	0	1	0	left
0	0	1	1	0	before
1	1	1	0	0	right
1	1	0	1	0	left
1	1	1	1	0	after
0	0	0	0	0	before

G. Bluetooth Control Program

Using Bluetooth to achieve remote operation control, connect the Bluetooth module on the SCM through the Bluetooth of the mobile phone, and send the corresponding control command to STM32. After STM32 receives the instruction sent by Bluetooth of the mobile phone, the SCM will interrupt and read the received information. After reading the received information, the information is judged and analyzed before deciding which operation the wheelchair should perform. For Bluetooth using serial communication, the register corresponding to the serial port should be configured first. ENABLE DEBUG_USART_APBxClkCmd; DEBUG_USART_GPIO_APBXCLKCMD;ENABLE GPIO port clock, configure GPIO as GPIO_MODE_AF_PP mode, RXD as GPIO_MODE_IN_FLOATING mode, its baud rate is set at 115200, high baud rate can accelerate the speed of data transmission, reduce the error caused by delay. You need to set a stop bit, but not a check bit, and enable GPIO after setting it to input and output modes. After initializing the serial port, for the receiving and sending operation of Bluetooth, it is also necessary to configure the corresponding interrupt service function, which is written in this function. When the interrupt comes, Bluetooth needs to perform the operation corresponding to the received information, and also set the value corresponding to the movement of the wheelchair back and forth, left and right, and then start the interrupt. Because multiple interrupts are involved in this design, it is necessary to set the corresponding interrupt priority [13].

After the Bluetooth module receives the control command sent by the mobile phone, it will enter interrupt: UART5_IRQHandler(void). The system will read the operation information sent by the Bluetooth module from the mobile phone, and then judge what control command it has received in the interrupt service function, and then execute the corresponding operation.

H. GPS Positioning Program

The communication mode between ATGM332D module and MCU is serial port. The RXD pin is set to GPIO_MODE_IN_FLOATING mode, and the TXD pin is set to GPIO_MODE_OUT_PP mode. At the same time, the frequency is set to 50MHz, and the baud rate is set to 115200. High baud rate can accelerate the speed of data transmission and reduce the error caused by delay. You need to set a stop bit, but not a check bit, and then enable a serial port [14].

After initialization, the location information can be read by the function nmea_decode_test (). Nmea_parse () is needed to decode the extracted original information, and the received coordinates of the wheelchair's latitude and longitude can be obtained after decoding.

I. GSM SMS Sending Program

The communication mode between GA6-Mini SMS module and SCM is also serial communication. The RXD pin is set to GPIO_MODE_IN_FLOATING mode, and the TXD pin is set to GPIO_MODE_OUT_PP mode, and the baud rate is set to 115200. High baud rate can accelerate the speed of data transmission and reduce the error caused by delay. You need to set a stop bit, but not a check bit, and then enable a serial port. You also need to set the preemption priority and subpriority for using multiple interrupts. Because in the interrupt service function when the wheelchair space position abnormal to realize the message sending, so in the interrupt service function to write the message related procedures, but also configure the relevant registers, and then enable to interrupt the service function.

For the short message module, it is based on the AT command to achieve the corresponding operation, so only need to be the function to achieve the operation of the corresponding AT command sent to the short message module, so that the module will perform the operation of sending short messages. Then the corresponding latitude and longitude positioning information will be edited on the text message content to be sent. Before sending, the positioning information obtained at a time should be judged. Whether the information is empty will not be sent if it is empty, and it will be edited and sent if it is not.

V. System Model Making and Debugging

Before completing the whole project, a model car for functional debugging should be made first. Draw circuit schematic diagram and PCB diagram according to the system principle, as shown in Fig. 12. Through the simulation software, each function module is simulated. After the simulation is correct, the PCB board is printed and the components are welded. Finally, the components are assembled into a model car, as shown in Fig. 13. Through the model car hardware and software debugging, constantly improve the function of the system [10], [12], [13].

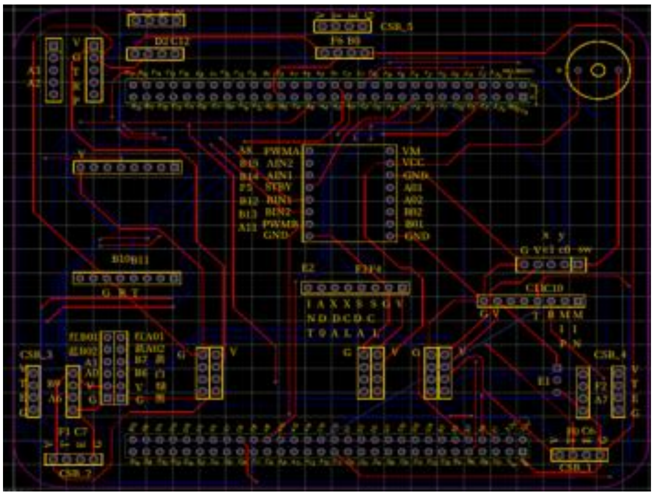

Fig. 12. Printed circuit diagram.

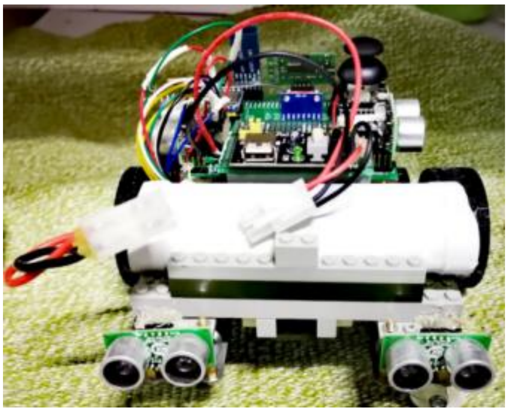

Fig. 13. System model car.

A. Hardware Debug

The hardware debugging of the drive system needs to be done in two aspects: manual mode and automatic obstacle avoidance mode.

Manual mode debugging: wait for initialization of each module after power on, need to wait for a period of initialization time, because the positioning module and short message module need to go through a period of time before stable work. After the completion of initialization, it will default to manual mode, push the joystick to the front, and the wheelchair will drive forward. Try to move in all directions, and the corresponding operation can be realized to complete the joystick test. Then the Bluetooth control test is conducted. Before the test, the Bluetooth of the mobile phone is connected with the Bluetooth module, and the mobile APP is opened. The control operation of the mobile APP is the same as that of the joystick, and the direction of the joystick is changed to change the form and direction of the wheelchair. The following is the speed debugging test. Press the INT2 button to change the speed gear of the wheelchair. There are three gears in total, and each time you press it, you will increase one gear. Adjustment of speed can also achieve the corresponding function, complete manual mode debugging.

Automatic Obstacle Avoidance Mode Debugging: press the INT1 button to switch the wheelchair from manual mode to automatic obstacle avoidance mode. In the automatic obstacle avoidance mode, the wheelchair will keep moving, and when no obstacle is detected, the wheelchair will keep moving in that direction. When an obstacle is detected, the wheelchair avoids it and then moves forward. The function of avoiding obstacles can be realized in all directions, and automatic obstacle avoidance debugging can be completed.

Alarm mode test: After the wheelchair is overturned and waiting for a period of time, the corresponding mobile phone number will receive a short message about the location information of the abnormal wheelchair. Search the received location information online, and the query location is consistent with the test location, and complete the full debugging of the drive system.

The hardware debugging of human health testing system is mainly to debug the measurement of blood pressure module and temperature sensor.

Blood pressure measurement and debugging: the blood pressure will automatically stop updating during exercise due to the great influence of exercise state signal on blood pressure. When the signal is suitable for blood pressure calculation, the system will continue to update the blood pressure. The heart rate and blood pressure module should be attached to the arm of the human body. The module should be fully in contact with the skin of the human body, and then the blood pressure module of the new road should be fixed with a rubber band instead of a rope. After the module is initialized, wait a while and the diastolic, systolic and heart rate values will be displayed on the OLED screen.

Temperature measurement debugging: first of all, the DS18B20 digital temperature sensor probe is clipped to the armpit part of the human body. After the module is initialized, the temperature value will be displayed on the OLED screen immediately, and the value rises quickly at the beginning. After waiting for a period of time, the value of the stable value is the body temperature value, and the hardware debugging of the human health condition detection system is completed.

B. Software Debug

This design is programmed in Keil5 software. If 0 Error(0) and 0 Warning(0) are displayed after compilation, it means that the program is not wrong. I then connected the emulator, plugged in the MCU, downloaded the program and waited for it to download. Then start the software simulation. Click the debug icon of the software to enter the software debugging mode. Click Run at Full Speed to run the software simulation. When the simulation is complete, click the debug icon to exit debug mode. The whole software has been debugged.

VI. Summary and Outlook

The drive control system of intelligent wheelchair is the key to drive the wheelchair. A good drive system can make the wheelchair run smoothly. Human health detection system in the intelligent wheelchair has played a role in the icing on the cake, make the intelligent wheelchair more intelligent, after solving the problem of walking can also know the health status of the human body at any time. In the design of the intelligent wheelchair, many functions are implemented in a modular way. The main modules include the drive system module, the ultrasonic module, the automatic obstacle avoidance module, the Bluetooth remote control module, the GPS/GSM remote monitoring module and the temperature/blood pressure detection module. Modular design is conducive to the transformation and re-upgrading of intelligent wheelchairs. At the same time of reducing costs, it is conducive to the commercial production and manufacturing of intelligent wheelchairs, so as to better provide both economic and practical transportation tools for the elderly and the disabled.

The test results show that the drive control system and the human health condition detection system can reach the preset indexes, and the system has excellent performance, reliable, stable and flexible operation. The intelligent wheelchair in this design is different from the electric wheelchair in the market. The intelligent wheelchair in this design can choose the manual mode or the automatic mode. At the same time, it can also detect important indicators of human health in real time, which has good research and application value and broad market prospects.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Professor Deng Baoqing is in charge of the project. She is responsible for design scheme formulation, software and hardware function research and development, technical supervision, sample making; Lecturer Wu Delin is mainly responsible for the design of mechatronics engineering projects and the production and debugging of products; Associate Professor Gong Fan is responsible for the control circuit design and software development of the project. As the main participant, Assistant Engineer Wang Yushu was responsible for project planning, SCM simulation and sample making. All the authors approved the final version of the research paper.

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