Design and implementation of remote experimental control platform

Chenyang Wang1*, Zijian Lin1, Ruikai Li1, Chen Chen1
1 South China University, Hengyang, Hunan, 421000, China
*20184620119@usc.edu.cn
Corresponding author’s e-mail: 1316838759@qq.com

Abstract. Based on the Internet of Things technology, our team has developed a remote wireless control experimental device based on the Internet of Things, which combines traditional experiments with Internet of Things technology. In the example experiment in this paper, the rotation angle of the corresponding motor on the experimental device is changed by means of buttons in the intelligent terminal APP. At the same time, the physical clamping and pushing control function of the control hub is exerted by mechanical push rod, bayonet and other workpieces, and then the pushing force and rotating force are provided by the motor for the push rod. Finally, the wireless camera is used to monitor the instrument panel and transmit the image data information via the wireless communication module to achieve remote control.

1. Introduction
In this paper, single-chip computer is used to control each motor in the device layout, and Wi-Fi module and mobile communication module are added to the single-chip computer. With the help of wireless local area network or ordinary communication signal, data can be exchanged. On mobile/PC side, app is connected with each other to achieve the purpose that users can control the experimental instrument with the help of corresponding intelligent equipment.

2. Experimental cases
The following is a detailed description of mechanical control, circuit control and real-time monitoring, taking SX2-2.5-10NP box-type resistance furnace as an example.

2.1. Mechanical control part
Overall idea: First, the stepper① drives the gear wheel ② to start running, so that the gear drives the rack to move horizontally in the groove. Gear ② and gear ③ are connected together through the base, so gear ② can drive gear ③ to move in the direction of groove. Gear rotation can drive the vertical rack up and down. The movement distance of the bottom rack can be controlled by the number of turns of the rotating gear. Therefore, gear ③ can control three vertical racks separately, and the upper and lower translation of vertical rack can control the adjustment of buttons to control the temperature of electric furnace. The rack next to the gear ③ corresponds to the adjustment of temperature. There is also a motor directly above gear ⑤ which drives the rack in the vertical direction to move up and down. The control corresponds to the opening and closing button of the electric furnace. The stepper④ and ② is used for the motor. The cylindrical gear has a modulus of 2Mn and the gear has 17 teeth. The rack and the
The gear can engage to drive [1]. Representation of serial number: ① stepper, ② gear, ⑤ gear, ③ circuit through base, ④ circuit motor.

Figure 1. Overall Structure Diagram

2.2. Specific structure, function and principle of main components and functional units

The main components are 42 steppers, gears, racks, shafts, Rack rack, rack bases, instruments, cylindrical gears. Progressive function controls the operation of gears and controls working time and speed in combination with electronic control knowledge. The gear also drives the rack to rotate so that the rack moves flat [2]. Base Rack: Control the movement of the base so that the gear can move to the position of the rack. The remaining vertical racks: drive the button to move (control button). The shaft can connect the stepper to the gear. Rack rack is used to connect the rack, three of which can engage three racks, and the movement of the rack-driven base enables the corresponding position of the button to control the movement of the button. The rack base is used to fix the rack, which is the fixed positioning structure of the rack. The rack base enables the rack to be fixed meticulously at a specific position, so that the rack and pinion can control the translation of the base more smoothly. Cylindrical gear: Cylindrical gear engages with the rack to drive the gear so that the rack can stop at a specific desired position to achieve a control of knob rotation and switch. The gear and rack can engage [4].
2.3. Overall working principle diagram

Figure 2. Overall Structure Diagram

2.4. Job characteristics
The operating characteristic is that the motor drives the operation of gear tooth chain. Since the rack and the gear are always engaged, the rack will move at the same time. The translation in the groove can reach the position reached by the rack by the speed of rotation and the number of turns of the gear. The rotation of the knob of the external temperature control panel can be pulled by the translation of the vertical rack up and down to achieve the purpose of precisely controlling the knob of the external temperature control panel [5].

3. Circuit control part

3.1. Overall system design
As the main part of system control in the overall operation procedure, electronic single-chip computer is very important for the control ability of electronic circuit. In order to get the maximum value of single-chip computer, the designer needs to integrate the communication technology into it, and properly select a single-chip computer model with advanced functions. Fully consider the basic functions of single-chip computer, such as operation speed, timer, calculator, memory, performance, I/O port, serial port, etc. In addition, besides encapsulation mode, confidentiality performance and anti-interference performance are also reasonably specified. For example, the system has built-in control functions such as spe
ed of operation, temperature of rated operating range, automatic low-voltage alarm, clock pulse genera
tor and microcontroller reset. At the same time, the designer also needs to consider the length of develo
pment process, development tool limitation, programmer technical level, scientific research cost, syste
m technical support and after-sales service, etc. According to the above factors, STM32 can be selected
as the core component, flexible programming and diversified control ports are adopted, and the calcula
tion accuracy of single-chip computer is controlled.

The motor module of this product uses Huirui ESP8266. The advantage of this product is super-hig
h configuration and strong compatibility. It carries 4 MB Flash and 100 KB memory. The commands s
upported by the system are Python, Javascript, C language, Lua and so on. In addition, ESP8266 motor
control module system has its own external interface, which can be used to combine the system with
mobile phone APP or computer terminal, and finally achieve the purpose of man-machine command A
C feedback.

3.2. software design
The system is written using common C language instructions, including motor module and wireless
connection module.

3.2.1. Programming of motor module
First set an initial position for the motor, then set the number of turns according to the actual experime
ntal position of the button. When the button is pressed on the APP, the motor drives the gear to the app
ropriate position in accordance with the established procedure. If you press the same button next time,
the push rod will remain in its original position. If you press another button, go back to its original pos
ition and follow the established procedure to reach the corresponding position (this function will impro
ve commissioning in future feedback).

3.2.2. Wireless Connection Information Transfer Module
ESP8266, as the UART-WiFi transmission connection module with lower power consumption, needs t
o connect to the wireless network for the first time through physical equipment and set up the Internet
or LAN communication, so as to select a practical shortcut mode in three modes: AP mode, STA mod
e and STA+AP mode. At first, initialize the peripherals and protocols used. When the device is connect
ed to the cloud server through key configuration, the device will receive data points, status and other i
formation sent from the cloud or APP side. After receiving, the data received is sent to MCU by proto
col frame format. MCU terminal stores the data received to the buffer, and then grabs the buffer every
other time. After grabbing the buffer correctly, it carries out in-depth analysis, pushing and action exec
ution, and implements its own logic according to corresponding events of data points. The MCU side p
ackages the sampled sensor data into a protocol stack frame format and transmits it to the device, whic
h also uploads the data to a cloud server. The flow chart is as follows:
3.3. software design

Cloud platform, developed in PHP language, uses SQL Server server as data storage. The cloud platform can support online operation, data recording (sensor statistics, sensor data statistics, historical commands, etc.), security alarm and other function.

Wi-Fi/mobile communication signals can be used as communication media by APP/client. Different communication modules can meet the needs of different people, and making choices according to local conditions is beneficial for the popularization of intelligent material link experimental instruments in universities and various scientific research sites.

With regard to WIFI communication, ESP8266 is selected in this system. Through AT command, the WIFI module is automatically connected to the bright cloud platform, at the same time, communication technology exchanges real-time data with each other.

Mobile phone APP product customer operating system uses HTTP to send requests to the platform. After the highlighted cloud platform receives the data, it will perform cloud computing processing and send the processing result data to the customer mobile phone APP client. After that, the customer only needs to operate the APP client to resolve the problems.

The biggest value of the SIM800C module is that it establishes a communication internet of things application system together with the control server, which truly realizes the limitation that the WiFi module does not rely solely on fixed wireless network signals for short-range transmission. In addition, the Bluetooth connection module can be used for short-distance data transmission, as most smart phones are equipped with Bluetooth and can support four device modes, i.e. normal operation mode, operation mode, shutdown mode and production mode without network connection. At the same time, the equipment mode can be refined into five working modes: GSM/GPRS hibernation mode, idle mode, GSM wireless communication mode, real-time standby mode and GPRS data normalization link mode. Sim800C module only needs to connect GSM module and electrical switch with single-chip computer, and then 3 single-chip computers are programmed with simple logic control logic. At this stage, the development of GSM module can use the mobile network signal to control the point-to-point data of TCP/IP protocol, thus truly realizing the wireless remote intelligent control.

4. Real-time monitoring

4.1. software design
The AI chip of this product is Jinzhi K210 and K210 of Jianan Science and Technology, which have the advantages of low energy consumption and flexibility. In terms of calculation, K210 can provide 1TOP calculation support at 0.3W, fully adapting to the low power consumption constraints in this scenario. In machine vision, the chip is based on self-developed neural network accelerator KPU, which can accomplish image classification task based on neural network and achieve real-time classification of detected objects. Compared with ARM and other architectures, K210 uses RISC-V architecture (figure), carries FPIOA field programmable IO array, and supports mainstream AI programming frameworks such as TensorFlow, Keras, Darknet, Paddle Paddle and Cafe. Based on these factors, K210 is selected as the core component of this design.

5. Conclusion
In a word, the newly developed remote experimental control device can reduce the difficulty of experiments, help the experimenters to complete all dangerous tasks and promote the quick results of experiments. In addition, after the upgrade of the server platform, the control app which can be matched with the lab equipment number will provide functions such as data processing, curve plotting, lab record, etc. to facilitate the progress of experiments, so as to benefit the scientific researchers.

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