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The Design of Intelligent Fan Based on Stm32

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Abstract: As the intelligent home industry grows rapidly, this intelligent fan overcomes two significant challenges of traditional fans: the lack of automatic speed adjustment and the need for manual fan oscillation. The fan uses the STM32 micro-controller as the main control chip, which integrates the DS18B20 temperature sensor, PWM technology, and relevant algorithms to achieve intelligent speed control based on different temperatures. The system also tracks the user's position by using three infrared sensors at different locations, and adjusts the direction by using a servo motor, thus realizing intelligent orientation control.

Keywords: STM32 Micro-controller, Intelligent Orientation Control, Intelligent Speed Control, Sensors.

I. Introduction

The intelligent fan represents the combination of technological innovation and environmental awareness, aiming to provide an efficient and comfortable air circulation solution. In modern society, people are increasingly aware of the energy crises and environmental problems, especially in countries with lower economic development but higher living standards, where the issues of energy consumption and environmental impact are more prominent. Therefore, the intelligent fan has become a popular and accepted solution.

Environmental awareness is rising, especially in Europe, and people are looking for eco-friendly alternatives. Conventional air conditioners emit a lot of greenhouse gases, which damage the atmosphere. As a result, people are choosing intelligent fans as a green option because they use less energy, work better, and save more power. Intelligent fans not only provide comfortable air circulation, but also cut down on energy use and lessen the negative effects on the environment.

This design is based on embedded technology, sensor innovation, and control algorithms, and it aims to achieve speed and direction control for intelligent fans. It overcomes the limitations of traditional swing head fans, which have a narrow steering angle, by using advanced chip control and automatic adjustment features. It can track the human body's movements and adjust the wind speed according to the external temperature changes. It uses intelligent modules such as temperature sensors, human body sensors, and liquid crystal displays, and the STM32 micro-controller acts as the central control unit, which enables complete control and optimization of the intelligent fan.

Intelligent fans are a new technology that shows the progress and the awareness of environmental protection. They give people more intelligent, easy, and green ways to circulate air. This paper explores how intelligent fans are designed, how they work, and how they can save energy and protect the environment. Intelligent fans can also adjust their speed and direction according to the user's needs, making the living environment more comfortable and sustainable. This paper also provides some important insights and ideas for future development.

II. Design and Implementation of IntelligentFan

This system can control the speed and direction of fans intelligently. It uses a temperature detection module to measure the indoor temperature, and then adjusts the motor output and fan speed accordingly. It also uses a human body detection module to locate the people in the room. The micro-controller analyzes the data from this module and controls the servo motor precisely, making the fan oscillate according to the human presence.

2.1 Hardware System Design

The intelligent fan's hardware system mainly includes four components: the STM32 micro-controller, the temperature detection module, the human body sensing module, and the display module. This paper uses the STM32 micro-controller made by STMicroelectronics as the main control module. This chip has powerful functions, fast processing speed, and works on a low voltage range from 1.8 to 3.3V. It has benefits like low power consumption, high reliability, and cost-effectiveness.

The temperature detection module uses the DS18B20 temperature sensor, which can directly change temperature into a digital signal. This sensor has great features like low power consumption, small size, and strong anti-interference abilities. The human body sensing module uses the HC-SR501 infrared detection sensor, which is automatically controlled by infrared technology and widely used in automatic control. Figure 1 shows the overall design of the hardware system.

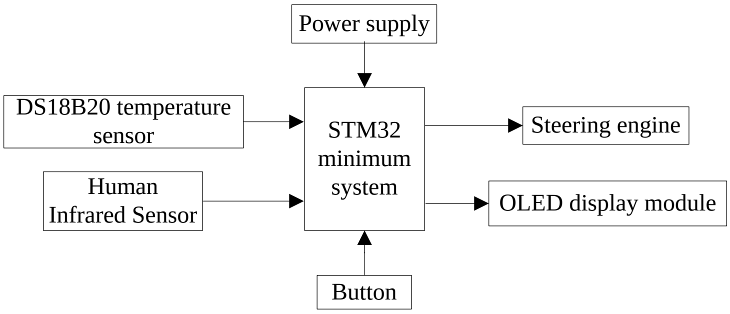


Figure 1 The overall design of the hardware system

2.2 Temperature Sensor Module Design

The temperature sensor uses the DS18B20 temperature sensor, which has a "one-wire bus" interface. It was made by an American company called Dallas Semiconductor. The DS18B20 can measure temperatures from -55°C to 125°C with an error of 0.5°C. This makes the temperature readings accurate, and lets the fan change its speed by itself, giving users the best comfort. Figure 2 shows how the DS18B20 works.

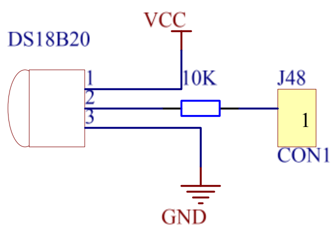


Figure 2 Schematic diagram of DS18B20 circuit

2.3 Human infrared detection module design

The HC-SR501 is an infrared-based automatic control module that uses a high-sensitivity LHI778 probe from Germany. It has excellent reliability and low voltage operation. For this intelligent fan, the sensor sends a high signal when a person is in its sensing range, and a low signal when a person leaves. This helps to find out if there is someone in the room and where they are. The STM32 micro-controller controls the servo motor, which moves the fan according to the sensor's input. This design has three HC-SR501 infrared sensors for better human body detection. Figure 3 shows how the

HC-SR501 sensor works.

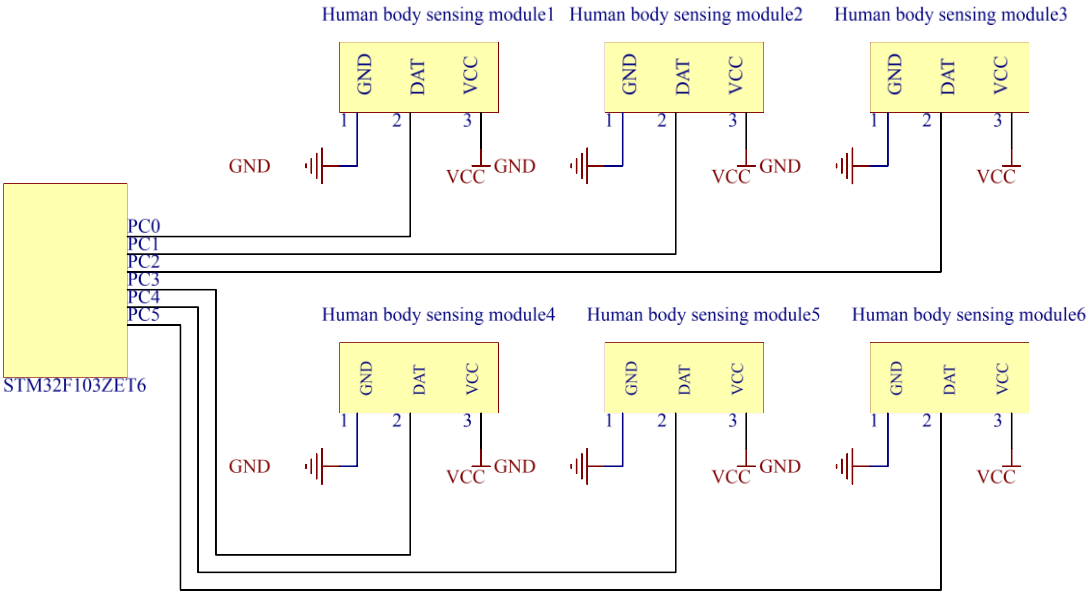


Figure 3 The circuit schematic diagram of HC-SR501 infrared sensor

2.4 Servo Module Design

The SG90 servo was used in this design and it was connected to the PA0 of STM32. The position (angle) servo works from -30°C to 60°C in operation temperature and from 4.8V to 6V of working voltage. It is good for control systems that need constant and stable angle changes, and it can make the fan turn intelligently. The STM32 micro-controller finds out where the person is by checking the output level of the HC-SR501 human infrared sensor. Then, it controls the SG90 steering gear to make the fan turn as needed.

2.5 Motor Drive Module Design

This design uses the ULN2003 motor driver chip, which can drive relays and other loads directly. It works with a 5V TTL level input, and can produce an output up to 500mA/50V. The ULN2003 belongs to the high-voltage, high-current Darling ton series, which has seven silicon NPN Darlington transistors. Figure 4 shows the motor drive circuit configuration.

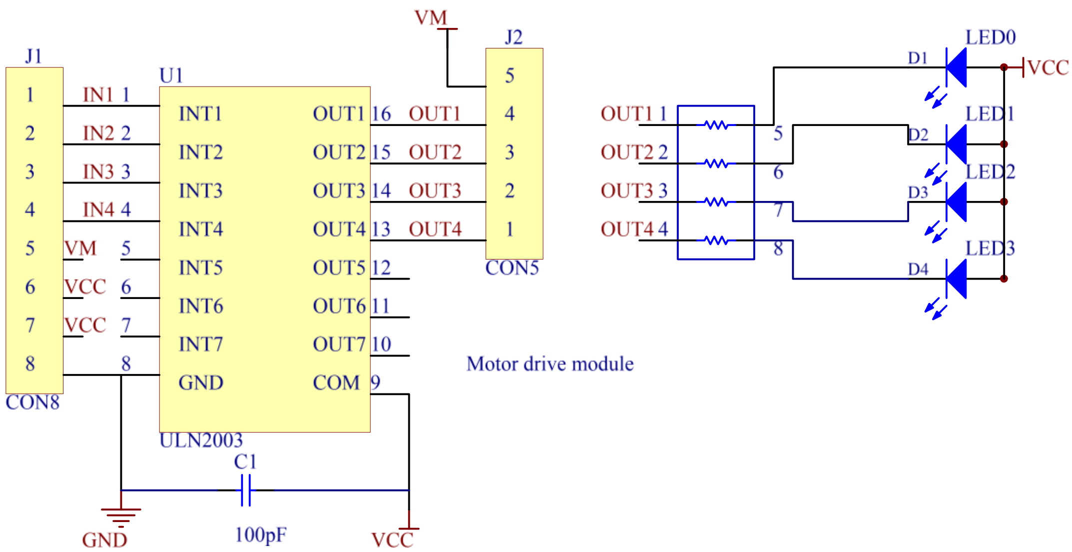


Figure 4 ULN2003 motor drive design diagram

2.6 OLED screen module design

This design also uses an SSD1306 driver with a built-in controller. This driver is often used in organic light-emitting diode (OLED) dot-matrix graphic display systems. It shows the wind speed and temperature data on the screen, making it easy for users to see through the I2C communication protocol. Figure 6 shows the design of the OLED screen module.

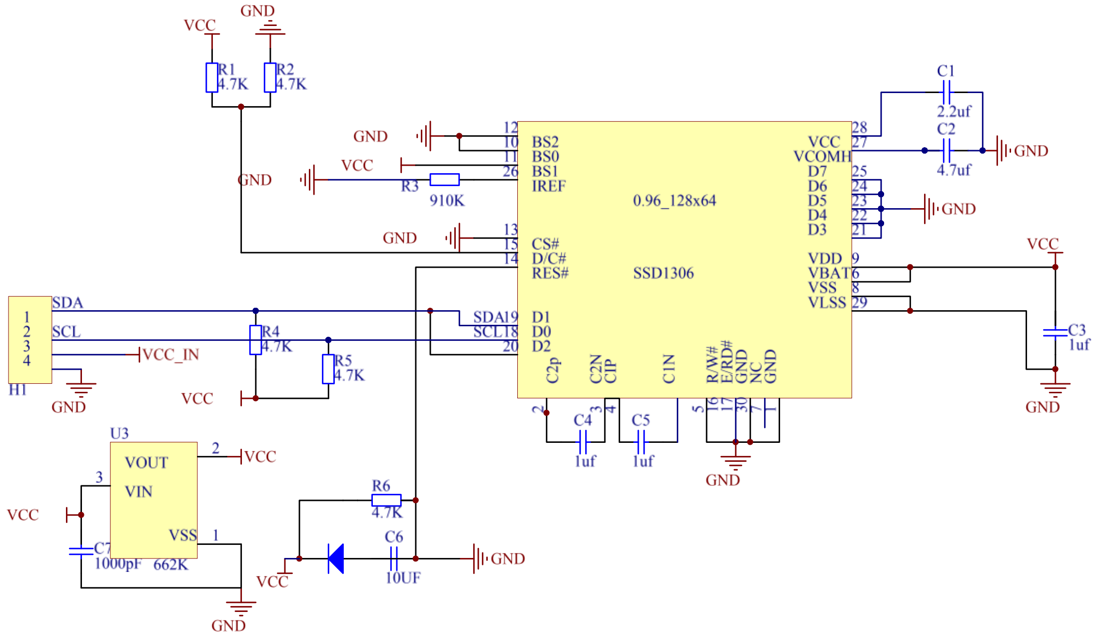


Figure 5 The design of OLED screen module

III. Software Design

In this design, the STM32 micro-controller is programmed in C language using the Keil5 development software. Keil5 has powerful features for C language software development, such as a clear and intuitive interface, a compiler, a packager, and a debugger. It makes programming easier and more enjoyable for users.

3.1 Overall program design

This design consists of several key subroutines, such as the DS18B20 temperature sensing and OLED display subroutine, the SR501 human infrared sensing subroutine, the motor direction setting subroutine, and the wind speed setting subroutine. The main program is built by repeatedly calling and nesting these subroutines. In the programming process, each subroutine is first written separately, and then its functionality is realized by calling it in the main program.The primary system program flowchart is depicted in Figure 6.

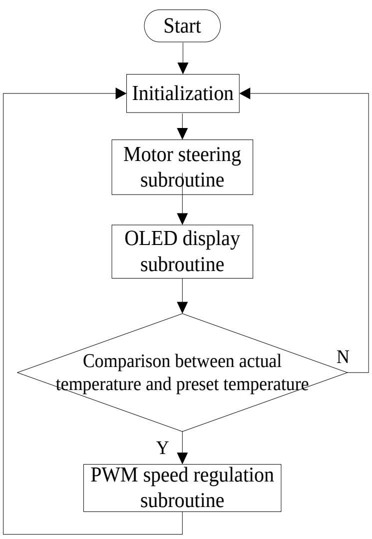
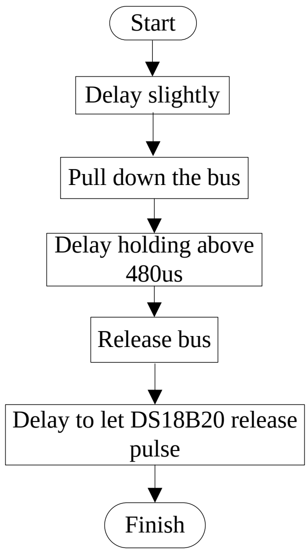


Figure 6 The primary system program flowchart

3.2 Temperature acquisition and display design

The DS18B20 temperature sensor needs to be initialized before measuring temperature, and Figure 7 shows its flowchart. The STM32 micro-controller gets the data from the DS18B20 through a single bus. Then, it shows the temperature information on the OLED screen, making it easy for users to see the temperature data. Figure 8 shows how the temperature is acquired and displayed.



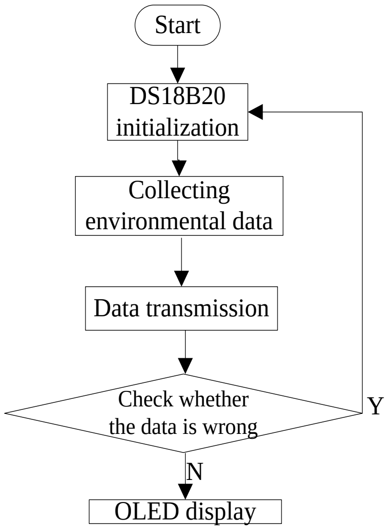


Figure 7 DS18B20 initialization Figure8 Temperature acquisition and display

3.3 PWM speed control design

This design uses PWM (Pulse Width Modulation) speed control technology. PWM control makes a pulse signal that changes its duty cycle based on the temperature. The signal high percentage in a cycle changes, matching different duty cycles. The PWM control chip sends a duty cycle that matches the fan's speed ratio, making PWM speed control work well. Figure 9 shows the PWM speed regulation flowchart.

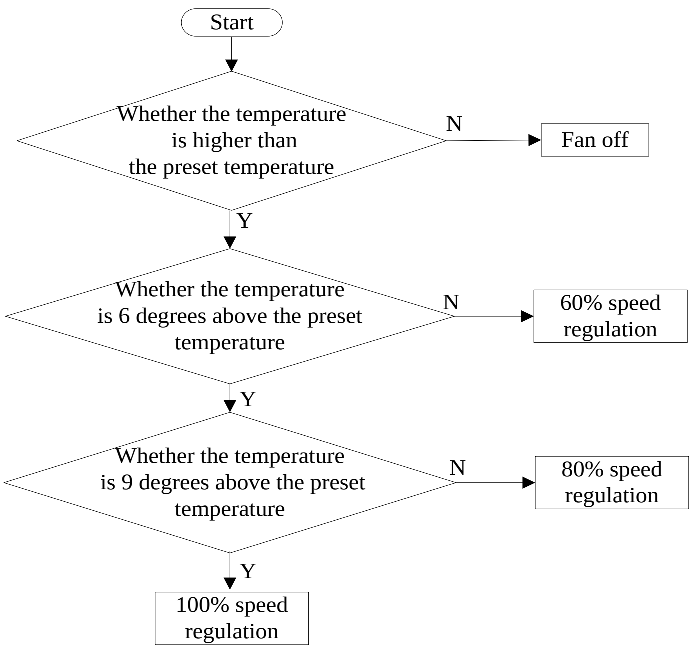


Figure 9The PWM speed regulation

3.4 Tracking model design

The sensor works in automatic sensing mode, and it sends a high level when it finds someone in its sensing range. At the same time, the micro-controller tells this signal to the motor, which starts tracking and steering actions. When someone leaves the sensor's range, the sensor delays turning off the high level, changing the output to low, and making an interrupt. Figure 10 shows how the human body sensing process works.

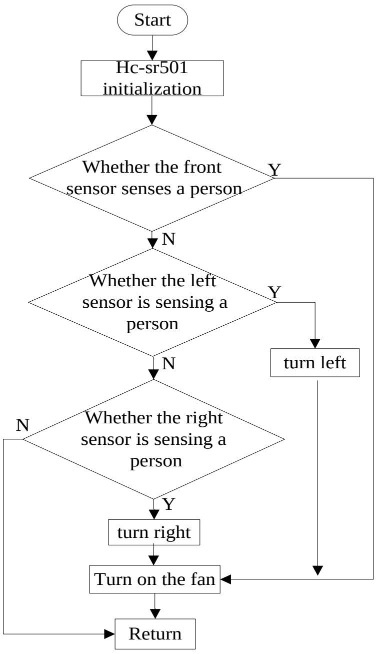


Figure 10The human body sensing program

IV. System Testing

We tested the fan's temperature sensor in different thermal environments, and we saw how the fan's speed changed accordingly. We recorded and compared the relationship between fan speed and temperature. Figure 11 shows this relationship, which proves that our speed regulation effect works well.

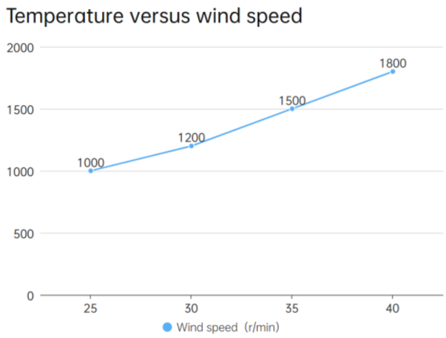


Figure 11 Temperature versus wind speed

We also simulated human body movement by moving the body sensor around. We wanted to see if the fan could adjust its airflow direction by itself based on human movement. We recorded and compared how the fan turned with the human body's position. Table 1 shows this comparison. The test results matched our expectations, confirming that our fan's intelligent direction adjustment works well with simulated human movement.

Table 1 The correlation between Human Body Position and Fan Direction

body position	direction
front	front
left	left
right	right

V. Conclusion

This paper introduces an intelligent fan that has "smart steering" and "smart speed regulation." It uses embedded technology, sensor improvements, and control algorithms to control the fan's speed and direction precisely. This system has many benefits, such as low energy consumption, cost-effectiveness, user-friendly operation, safety, and environmental friendliness. Our design is good at finding out where people are and turning intelligently in complex environments. It also gives users the best wind power based on the temperature around them, making their user experience and well-being much better. In future versions, we want to make our ambient temperature detection more accurate and our human body detection more flexible, so we can give users even more precise and high-quality services.

References

[1] Pobbathi H S , Prerana G M , Rao S ,et al.(2021). Smart Fan using IoT.*International Journal of Engineering Research & Technology*,

[2] Lee H J , Park J H , Song I S ,et al.(2019). Design of A Smart Fan Using Arduino[C]//*Proceedings of the Korean Society of Computer Information Conference*.Korean.

[2] Meshram, V. R. ,&Pocchi, R. . (2021). A review on wireless smart home automation using iot. *International Journal of Scientific Research in Science and Technology*.

[3] Rahman, M. M. , Zakaria, M. F. R. , & Sidek, S. N. . (2015). Sensory and control system for smart fan.

[4] Chen Zewei,LiuJianhao, Lin Yulong,Fan Jierun,Liu Wenjing. (2023). Intelligent humidification fan based on STM32 face tracking. Wireless Internet Technology(10).

[5] Luna, D. . (2010). Going beyond traditional cooling for telecom equipment with smart fan controls and high performance specifications. *Equipment Protection*.

[6] Shevatekar, P. P. , Chavan, M. , Albhar, K. , Koyate, P. , & Jadhav, N. . (2021). Evacuation route guidance and indoor navigation system using IOT. *Journal of emerging technologies and innovative research*.

[7] Miller, H. . (2015). Swatch, not a fan of smartwatches, patenting technology for them. BNA's Patent, *Trademark & Copyright Journal*.

[8] Lee, C. Y. , Huang, Y. K. , Lin, T. S. , Shieh, J. C. , Chou, J. J. , & Lee, C. Y. , et al. (2019). A Smart Fan System for Temperature Control in Plant Factory.*International Commission of Agricultural and Biosystems Engineering*.

[9] Zhong-Peng, L. I. , He-Ming, J. , Chuan-Xu, Z. , Sen, Z. , Zhi-Kai, X. , & Lu-Lu, Z. . (2017). Design of automatic temperature regulation fan system in plant factory based on single chip microcomputer. *Sci-tech Innovation and Productivity*.

[10] Dodake, P. , Kamble, P. , Kakad, K. , &Bhaladhare, S. (2019). Smart fan controlled by using IR remote. *Social Science Electronic Publishing*.

[11] Bind, A. ,Ashtankar, K. , &Chahare, M. . (2020). An iot based smart fan module. *International Journal of Innovative Research in Technology*.

[12] Zainal, Z. H. ,Chelvam, N. T. T. , Seman, M. N. F. , & Othman, W. A. F. W. . (2019). Design of a low-cost smart fan system using arduino uno (diy).*Technical Journal of Electrical Electronic Engineering and Technology*.

[13] Fan, J. R. , Razak, M. S. A. , Mohayadin, N. A. M. , & Othman, W. A. F. W. . (2019). Energy saving - motion activated smart fan design and implementation.*International Journal of Engineering Creativity and Innovation*.

[14] Ektesabi, M. , Gorji, S. A. , Moradi, A. , Yammen, S. , & Mahesh, R. V. K. . (2018). IoT-Based Home Appliance System (Smart Fan). 8th International Conference on Artificial Intelligence, Soft Computing and Applications.

[15] Stojkoska, B.L.R. and Trivodaliev, K.V., (2017). A review of Internet of Things for smart home: Challenges and solutions. *Journal of Cleaner Production*.

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