Research on Vehicle Temperature Regulation System Based on Air Convection Principle

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Abstract. The long time parking outdoors in the summer will lead to too high temperature in the car, and the harmful gas produced by the vehicle engine will stay in the confined space for a long time during the parking process, which will do great harm to the human body. If the air conditioning system is turned on before driving, the cooling rate is slow and the battery loss is large. To solve the above problems, we designed a temperature adjusting system based on the principle of air convection. We can choose the automatic mode or manual mode to achieve control of a convection window. In the automatic mode, the system will automatically detect the environmental temperature, through the sensor to complete the detection, and the signal is transmitted to the microcontroller to control the window open or close, in manual mode, the remote control of the window can be realized by Bluetooth. Therefore, the system has important practical significance to effectively regulate temperature, prolong battery life, and improve the safety and comfort of traffic vehicles.

1. Introduction
In today's society, the car has become an indispensable part of people's daily life, according to the Ministry of Public Security Traffic Management Bureau statistics, as of the end of March 2017, the national car ownership for the first time exceeded 300 million, with the people's living standards improve, car rigid demand remains strong, people on the vehicle comfort and safety performance requirements are also getting higher and higher. At present, most of the automotive air conditioning systems have a good regulating effect on the air quality inside the car during the travel, but the long time running of the air conditioning system when parking makes it easy for the car battery to run out and the car can not start. So outdoor parking causes temperature inside the car too high in summer and the harmful gas density remains high, the existing automotive air conditioning system can not regulate it reasonably and efficiently. In order to solve this problem, this project develops a set of automobile indoor temperature convection regulation system.

This system has designed a set of air convection structure with rainproof function based on air convection principle, and a set of detection and control system. The convection window can be automatically opened or closed according to the temperature. The system can also be manually controlled through the mobile phone Bluetooth. After opening the convection window, the air is convective, thus the temperature in the car is adjusted.
2. Proposed Method

Fig. 1 is the whole structure of the convection regulation system, which is mainly divided into two parts: the control system and the convection window. The control system includes a detector, a controller and a driver, which is used to detect whether the interior temperature reaches the preset value. If the preset value is reached, the control driver opens the convection window to achieve temperature regulation. In addition, you can manually control the driver by Bluetooth to turn on and off the convection windows. The convection window is designed and installed on the roof, the window cover is corrugated, and the top contains vent holes. Through the rotation of the core, the holes with grooves in the middle is communicated with the vent hole at the top, as a result, the high temperature gas in the car can be exchanged with the outside to adjust the temperature according to the principle of heat convection.

![Fig.1 Integral Structure of Convection Regulation System](image)

2.1. Research on HC-05 Bluetooth communication system

Because Bluetooth communication as a vital link in the whole system, we fully consider the requirements of stability, using the HC-05 Bluetooth module. HC-05 Bluetooth module is a high performance Bluetooth master slave serial communication module, and it can be paired with a variety of Bluetooth enabled computers, mobile phones, PAD and other intelligent terminals. The module supports a very wide baud rate range: 4800-1382400, and compatible with 5V and 3.3V microcontroller system. It has the advantages of easy to use, flexible connection and high performance price ratio. At the same time, HC-05 is an industrial grade product with stable performance and high reliability. The Master slave integrated Bluetooth serial port module is shown in Figure 2.

![Fig.2 Master Slave Integrated Bluetooth Serial Port Module](image)

The next step is to match Bluetooth module and mobile phone Bluetooth. The HC-05 Bluetooth module is set up as the slave device and mobile phone Bluetooth as the main equipment. After installing Bluetooth serial assistant, we just open Bluetooth debugging assistant interface, search for Bluetooth devices, and then select the keyboard mode, set keyboard instructions on it.

2.2. Research on the control system

According to the control requirements and control flow of the automobile indoor temperature convection regulation system, this research is based on SCM technology, sensor technology, motor drive technology, LCD technology and other technologies to develop the control of convection window system. The convection window can be automatically turn on or close according to the change of automobile indoor temperature, and realize the adjustment of automobile indoor temperature.

We use MCS-51 series single-chip microcomputer to design SCM control system, and use DS18B20 temperature sensor and limit switch design detection device. The DS18B20 data input / output pin connects SCM P1.5 pin. The limit switch 1 is used to detect whether the convection window is an open state and it connects the SCM P1.6 pin. If the limit switch 1 is closed, the
convection window is opened. The limit switch 2 is used to check whether the convection window is a closed state and it connects the SCM P1.7 pin. If the limit switch 2 is closed, the convective window is closed. We use stepper motor drive device, choose 28BYJ48 type four phase five wire stepper motor, and select ULN2003 Darin tube with high voltage and high current as the driving circuit. The ULN2003 IN1 ~ IN4 input pin connect to SCM P1.0 ~ P1.3 pin, and OUT1 to OUT4 output pin connects four phase line of stepping motor.

2.3. The convection window structure of convection regulation system
In order to realize the automatic adjustment of temperature in car and ensure the safety of products during outdoor parking in summer, a convection window structure installed on the roof with the function of intrusion and rainproof is designed.[2,3]

![Structural diagram of convection windows](image)

**Fig.3 Structural diagram of convection windows**

The overall structure of the convection window is shown in figures 3 and figure 4, consisting of a window cover, a window, rotating cores, louvers, bearings, fasteners, gears, and the like. Upward inclined riser vents are arranged on the window cover, and they can prevent the rain water and the invasion of the outsiders, thus avoiding the loss of the finance. For the purpose of not destroying the appearance of the car, the window cover is designed as a corrugated shape, and the longitudinal direction of the corrugation is consistent with the longitudinal direction of the vehicle in order to reduce the running resistance of the car.

![Convection Window Core Structure and Its Components](image)

**Fig.4 Convection Window Core Structure and Its Components**

The core structure of the convection window is shown in Figure 4, which is a shaft part with middle slot.

The transmission device of the convection window rotating core is shown in Figure 5. The connection between the rotary gear and the rotary core of the convection window adopts spline connection in order to improve the assembly convenience. The motor gear is designed as a pinion to reduce the torque required to drive the motor.

2.4. software design
This program is programmed by C language. In the control of the program, we can choose the automatic mode and manual mode in two ways to achieve control of the window, in the automatic mode, the system will automatically detect the environmental temperature, the detection is completed by sensor the signal is transmitted to the microcontroller, in order to control the windows open or closed; in the manual mode. We can realize the remote control of the window through the infrared...
remote control. The two mode switches by infrared remote control button. Process control diagram as shown in Figure 6, all modules of the program must be coordinated, accurate judgment, in order to achieve the overall control of the automatic window.[4]

![Fig.6 Process Control Diagram](image)

3. Experimental Results
After the system is powered, the initialization of each component is completed first. After initialization, the system starts the Bluetooth serial communication module to ensure the Bluetooth module and the Bluetooth control terminal of the mobile phone to complete the matching. The microcontroller realizes the communication with the Bluetooth module through the serial port communication. The microcontroller receives the instructions received by the Bluetooth module and then outputs the control instructions to the relay switch, so as to realize the control of the convection window switch. If the Bluetooth function is turned off, the convection window can be automatically opened and closed by the temperature sensor.

When the convection window rotates in the position shown in Fig. 5, the air inside and outside the car is connected. Due to the thermal convection, the high temperature gas in the vehicle can be exchanged with the outside gas to achieve the cooling effect. When the rotating core around the axis of rotation of 90 degrees, the part without holes in the core is in the upper part and the air inside and outside the car is not connected, this will play a role in the winter and autumn heat preservation. The rotation of the rotating core is automatically driven and rotated by the temperature detecting device and the driving device according to the indoor temperature without manual operation.

When the convection window is opened and closed, the driving motor drives the motor gear to rotate, and the motor gear drives the rotary gear to rotate, so as to drive the rotation of the rotary core to realize the opening and closing of the convection window. Due to the different size and shape of the car, there is no design of the size of the convection window and the structural parameters of the gear. In the following research, the relative general parameters of convection window should be designed for different types and sizes of vehicles.

4. Conclusion
In this paper, we designed a temperature adjusting system based on the principle of air convection. We can choose the automatic mode or manual mode to achieve control of a convection window. In the automatic mode, the system will automatically detect the environmental temperature, through the sensor to complete the detection, and the signal is transmitted to the microcontroller to control the window open or close, in manual mode, the remote control of the window can be realized by Bluetooth. Therefore, the system has important practical significance to effectively regulate temperature, prolong battery life, and improve the safety and comfort of traffic vehicles.

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References

[1] He wen Jiao, Wang Huazhang. Intelligent window stepper motor control system design based on [J]. micro motor, 2015,43 (06): 83-86.
[2] Li Quanmin. Intelligent control of car sunroof based on embedded system [J]. modern computer (Professional Edition), 2017, (27): 77-79+84.
[3] Chen Jiting, Zhao Kang, Ho Haobo. MCU rainproof and dustproof intelligent window control system design based on [J]. industrial control computer, 2017,30 (03): 115+117.
[4] Yuan Jun, Feng Yufei, Wang Haoran, Yang Qisheng. The intelligent breathing window system based on the Internet of things [J]. information communication, 2017, (07): 101-104.