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Design of a New Flat Body Mechanical Cleaning Device Based on Electrical Signal and Sensor Technology

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Abstract: With the progress of science and technology and social development, especially influenced by the accelerated pace of life and increased work pressure, people want to be relieved from the tedious daily household cleaning affairs, therefore, automated cleaning technology has been developed rapidly and more and more automated cleaning devices are designed and put into application. The purpose of this paper is to design a device that can automatically monitor the cleaning condition of a flat surface and provide a mechanical device for automatic cleaning by using the rapid information collection capability of sensors and the powerful data processing capability of MCU chips. At the same time, the software programming and algorithm level, the algorithm is designed to cooperate with the hardware device, so that the automatic device can complete the task of cleaning the surface of the flat body efficiently and quickly.

1. Introduction

With the rapid development of sensor technology and MCU chips, more and more automated cleaning technologies or semi-automated cleaning technologies with human-computer interaction are proposed and put into application in field scenarios [1]. We have designed an automated cleaning device for small and medium-sized flat bodies based on electrical signal and sensor technology by studying the literature and referring to some mechanical cleaning devices put into production on the market, through the integration of cost-effective, high-performance sensors and electronic information technology applications.

The design aims to combine the ability of sensors to collect information quickly with the powerful data processing capability of MCU to design a device that can automatically monitor the cleaning information of a flat body and provide a mechanical device for automatic cleaning. At the software programming and algorithm level, a fusion processing algorithm capable of handling multi-sensor information is designed with reference to market design examples and hardware manuals, enabling the MCU to extract effective information from the complex sensor feedback, make decisions based on optimal policy rules, and determine the start and end of cleaning.

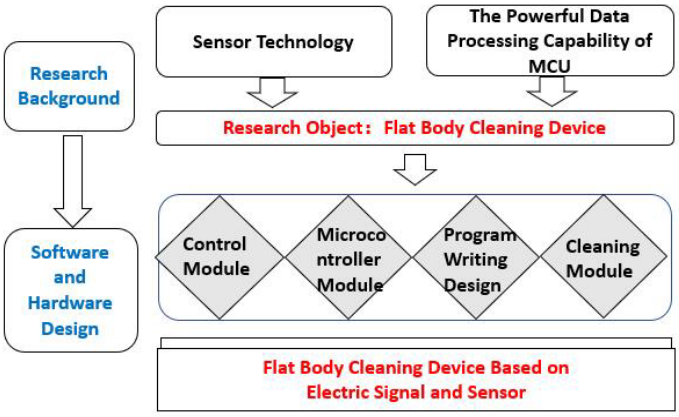

Figure 1: Design Ideas

2. Model Overview

The cleaning device consists of two main modules: the cleaning implementation module and the control monitoring module. The project uses an STM32 microcontroller, which is the core of the whole device and the control center, playing an important role in connecting and controlling the two modules. The control and monitoring module is equipped with sensors that can identify large particles of dust, water droplets and other foreign objects on the surface of the flat body and transmit an electrical signal to the STM32 microcontroller, which executes a pre-written source program to control the mechanical device of the cleaning and realization module to achieve a detailed cleaning function on the surface of the flat body [2].

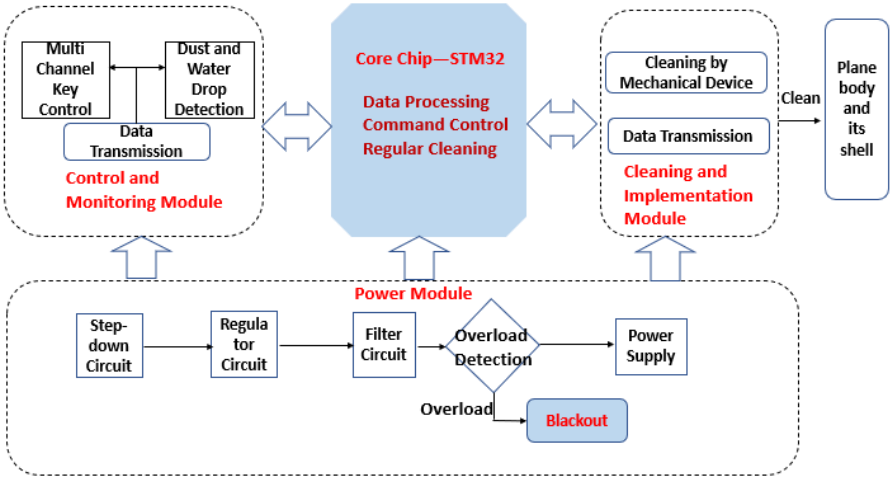

Figure 2: Composition of Cleaning Device

3. Design Details of the Module

3.1 Power Modules

The power supply module supplies power to the entire cleaning device. The power supply circuit can be powered by a rechargeable lithium battery or by a limited power adapter connected to a power supply outlet. The power supply circuit consists of a step-down circuit, a voltage regulator, a filter circuit, and a fuse. The buck, regulator and filter circuits are used to obtain the 3.3V voltage required

by the microcontroller, while the added fuse will blow in case of overload and the emergency cutoff is used to protect the device from burning out [3].

3.2 Microcontroller Module

The microcontroller module is the core of the whole cleaning device, and its input port needs to be connected to the control monitoring module to receive the return signals from the control monitoring module, and then to process and analyze the data of these signals, and then to judge whether the cleaning device starts working. When cleaning is required, the microcontroller will execute the on-board code to control the cleaning implementation module connected to its input and output ports to control the module's mechanical device to achieve the cleaning function. The circuitry of the STM32 microcontroller-based module consists of a reset circuit, a linear regulated LDO circuit, a BOOT jumper circuit, an LED light circuit, a Bluetooth serial port circuit, an MCU circuit, a USB interface circuit, a crystal oscillator circuit and a power supply circuit.

3.3 Control and Monitoring Module

The core technology of the control and monitoring module is the sensor technology, where the sensors on the module continuously monitor the information on the surface of the plane and report the information to the MCU for processing. There are many types of sensors on the market that can monitor the environmental cleaning, and the selection needs to take into account both the stability and anti-interference of the sensors to ensure the cleaning quality of the device, and the size and power consumption of the sensors to ensure the cleaning efficiency of the device [4].

To meet the above requirements our control monitoring module consists of two parts.

- Key circuit module: this module can trigger the device in three different ways by key control, meanwhile the key control has the advantages of simple operation, light quality, small size and occupies less IO port resources of the microcontroller.
- Sensor monitoring circuit, we use the water drop sensor for signal acquisition, its principle and design are as follows: sensor information acquisition circuit consists of ADC0832 chip, filter circuit, power supply circuit and voltage regulator circuit. ADC0832 chip is used for cleaning information data acquisition. The module equipped with this sensor can identify large particles of dust, water droplets and other foreign objects on the surface of the plane body, and at the same time send out the collected information. The water droplet detection circuit diagram is shown in Figure 4, where J1 is the droplet receiving module [5].

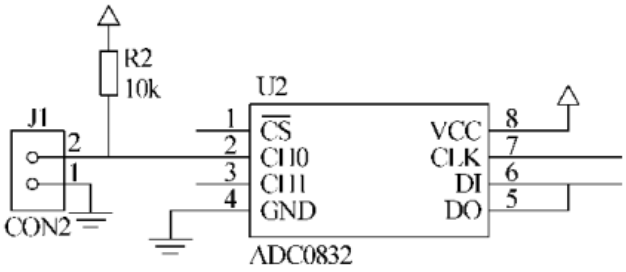

Figure 3: Droplet Receiver Module

4. Industrial Control Algorithm

The design of the software is based on the completed hardware circuit and modules. Firstly, the MUC will always determine whether the key is pressed or not. If the button is pressed, an interrupt is triggered and the MCU responds quickly once to achieve a real-time response. The MCU will control

the control monitoring module and continuously receive the sensor data from the IO port, and then the program will decode the data to determine whether to start the control cleaning module, and also to indirectly control the speed of cleaning the mechanical part by controlling the control cleaning module. If the button is not pressed then the procedure of manual cleaning is executed, the cleaning personnel are required to input the signal of manual cleaning from other buttons, when the button of manual cleaning is pressed, the microcontroller triggers an interrupt and the cleaning realization module starts to operate. The time of manual cleaning is regulated by the internal timing counter of the microcontroller. Through a well-designed industrial control algorithm the device can also perform the timed cleaning function, which can be achieved by controlling the internal timer of the microcontroller in accordance with the pre-set time interval [6].

5. Conclusion

Comprehensive analysis of the above, in today's highly developed electronic information technology and sensor technology, the development prospects of automated mechanical cleaning devices are both considerable, sustainable, and will be infinitely expanded. Automated cleaning of planar bodies is a broad application scenario of current automation technology applications, and with the highly developed technology in the field of sensors, embedded fields will have a larger research space and market. In today's technology is constantly updated and improved, not only has its development inevitable, but also can bring more convenience to people.

Acknowledgements

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