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Research Article

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Detection system for optic characteristics of automobile glasses

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ABSTRACT

With the development of the domestic and foreign automobile scale, automobile glass type and quantity increased strongly. Optic characteristic of automobile glass is one of the important technical requirements of automobile glass, as a result, the detection of optic characteristics of automobile glass is very necessary. An on-line automatic detection system for automobile glass transmission and reflectivity was proposed. This system was mainly based on the different reflection, absorption and transmission principle when light propagates in different medium, and combined with modern photoelectric detection and digital signal process technology, achieved on-line automatic detection for automobile glass transmission and reflectivity. By simulation verification, this system can detect transmission and reflectivity for automobile glass on-line, moreover, it has high reliability, high precision, high cost performance and easy expansion.

Key words: Photoelectric detection, on-line, automobile glass, transmission, reflectivity

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INTRODUCTION

Glass is the indispensable material in car, its quality has serious effect on person's life and property safety. Nowadays, automobile glasses are mainly laminated glass and tempered glass, they have excellent impact strength[1], mechanical behavior and thermal shock resistance[2]. With the increase of glass production industry, the quality of the automobile glass detection is more and more important. In quality testing indexes, the optic characteristic is an important feature, and it is the main parameter of the national quality inspection. The optic characteristic includes visible light transmittance, reflectivity, optical distortion, and color identification[3]. In this article, transmittance and reflectivity detection were mainly researched.

The traditional off-line detection method utilizes spectrophotometer to detect automobile glass[4], and carries on sampling detection for finished product. As a result, lots of manpower and material resources are wasted, and real time monitoring on production cannot be achieved, moreover, batch productions may be unqualified[5]. Later, automatic off-line detection and on-line detection were proposed, but those methods have respective shortcomings[6]. On the base of above mentioned, an on-line detection system was proposed.

EXPERIMENTAL SECTION

On-line automatic detection was based on different reflection, absorption and transmission principle when light propagates in different medium[7], and combined with modern photoelectric detection and digital signal process technology, achieved on-line automatic detection for transmission and reflectivity of automobile glass. The system chart was shown in figure 1.

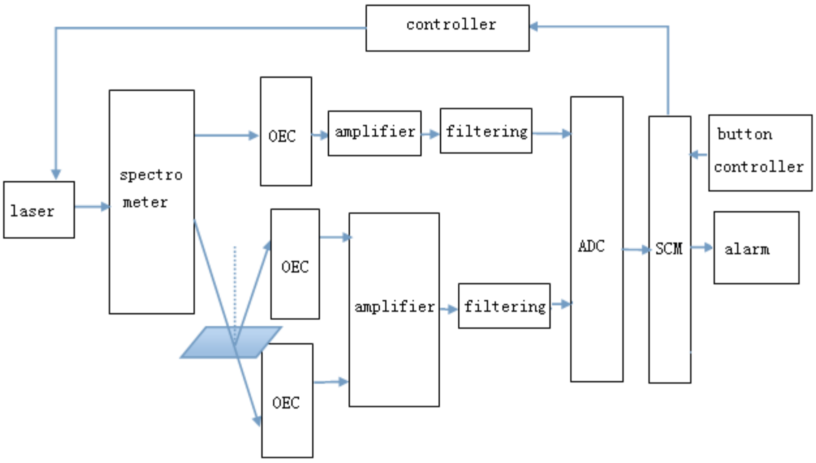

Fig.1: Diagram of on-line automatic detection system

The signal process utilized pulse amplitude modulation, and combined digital signal process and single chip microcomputer technology. As a result, this system had strong anti-jamming, and could adjust its own parameters to ensure the system operate on-line regularly. The system utilized 1 kHz pulse laser as light resource. First the pulse laser passed through the spectrometer, output two beams of light, one was reference ray, the other passed through the measured glass, then transmitted light and reflected light emerged. Second, the silicon photodiode photoelectric were utilized to receive reference ray, transmitted light and reflected light so as to achieve photoelectric conversion. Third, the electrical signal were amplified, filtered, and converted to digital signal, then input in single chip microcomputer. Finally, the results were displayed on digital tube. The system included hardware and software design.

Hardware Design

The hardware included light resource, photoelectric conversion(OEC), amplifier, filtering circuit, ADC, single chip microcomputer (SCM), display and alarm module. The main modules were shown as following.

1. Filtering circuit module

In this system, active band-pass filtering circuit were utilized to guarantee noise-signal ratio, the circuit was shown in figure 2. This filter has characteristics such as high input impedance, low output impedance, good isolation from input to output and adjustable band-pass coefficient. Supposing $C_3 = C_4 = C$, the important parameters could be calculated as followings.

Center frequency

$$f_0 = \frac{1}{2\pi C}\sqrt{\frac{1}{R_5}(\frac{1}{R_1}+\frac{1}{R_2})} \tag{1}$$

Gain at center frequency

$$K_{f0} = -\frac{R_5}{2R_1} \tag{2}$$

The equivalent quality factor

$$Q = \frac{1}{2}\sqrt{R_5(\frac{1}{R_1}+\frac{1}{R_2})} \tag{3}$$

The 3dB bandwidth

$$B_{3dB} = \frac{f_0}{Q} = \frac{1}{\pi R_5 C} \tag{4}$$

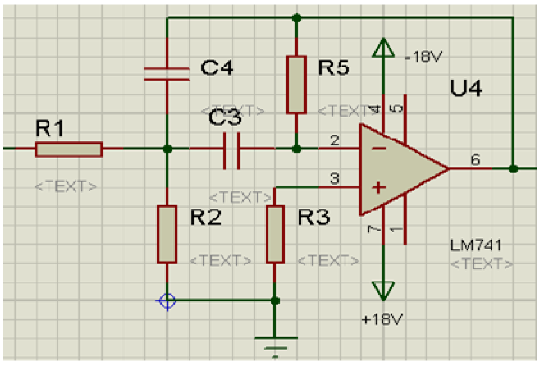

Fig.2: The circuit of filtering

2. ADC and SCM module

When electrical signal were amplified and filtered, three stable voltage signals were output. In order to process the signals by SCM, the three initial voltage signals should be converted to digital signals. In this system, ADC0808 was utilized to achieve AD conversion. The circuit was shown in figure 3.

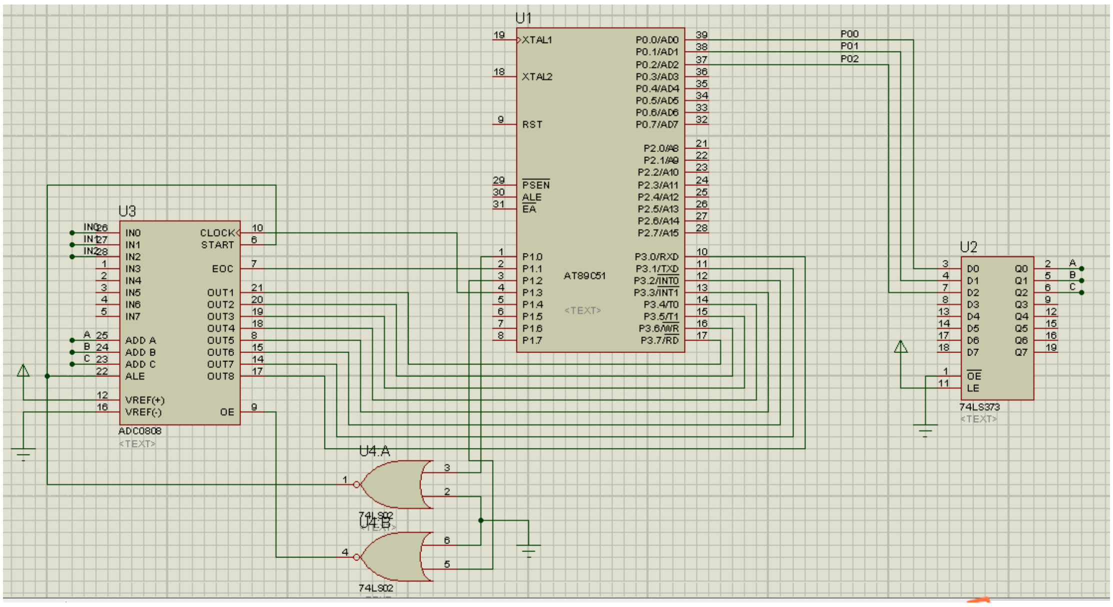

Fig.3: ADC circuit of detection system

In figure 3, reference ray voltage signal input IN0, transmission light voltage signal input IN1, and reflected light voltage signal input IN2. The three voltage signals were converted to digital signals.

This module was constituted with 74LS373, AT89C51 and ADC0808, two 74LS02 achieved to start conversion and receive data respectively, the output digital signals were processed by AT89C51, then 74LS373 achieved options to output for ADC0808 conversion channel.

The CLOCK signal of ADC0808 was provided by P1.3 of AT89C51 SCM. When P1.0 of AT89C51 was available, ADC would be started, digital signals would be outputted to AT89C51, at this time, if P1.2 and OE were available, AT89C51 began to receive digital signals.

Software Design

The system achieved the following functions. 1. On-line detection for transmission and reflectivity of automobile glass; 2. Display transmission or reflectivity alone by pushing button. 3. Alarming when detection results exceed fixed range. 4. Selection on light path. 5. Display results repeatedly. To achieve these functions, main thought of software design was shown as followings.

First, achieve switch on system by detecting button, push the button to achieve on-line automatic detection for transmission and reflectivity of automobile glass. Second, according to the definition of transmission and reflectivity achieve results display. Finally, achieve alarming when detection results exceed standard. The flow chart of main program was shown in figure 4.

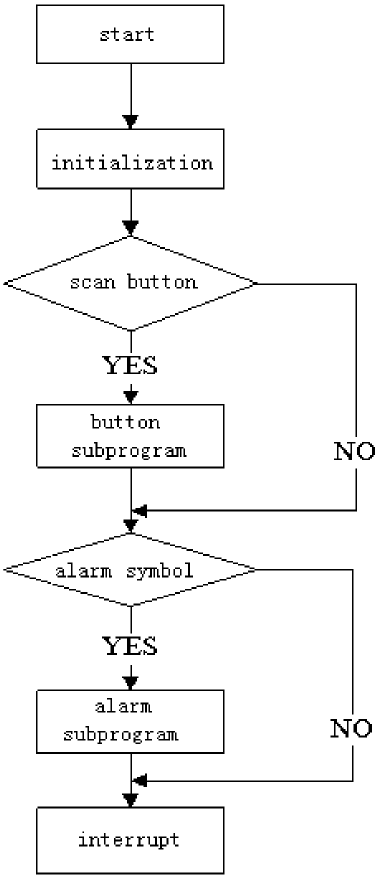

Fig. 4: The flow chart of main program

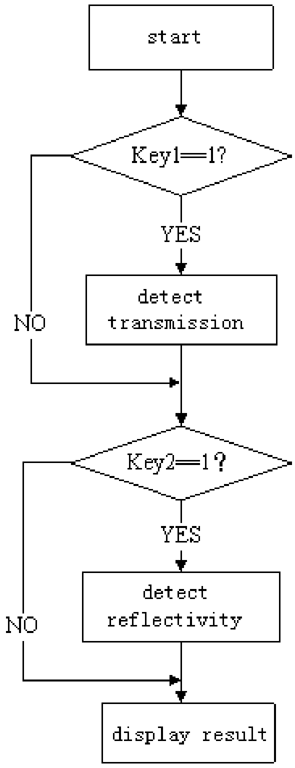

Fig.5: The flow chart of button scanning subprogram

Button scanning subprogram mainly achieves to scan high or low level of buttons, and achieve executive function of each button. This subprogram mainly includes the detection for transmission and reflectivity, and switch display for detection results. The flow chart of button scanning subprogram was shown in figure 5.

Alarming subprogram was expansion module, the function was achieving alarming when detected automobile glass exceed standard, in this system, mainly transmission T < 70 %.
The flow chart of alarming subprogram was shown as figure 6.

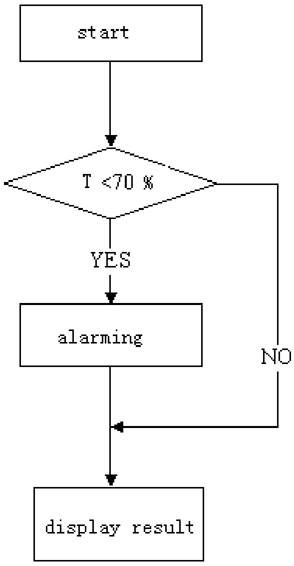

Fig. 6: The flow chart of alarming subprogram

RESULTS AND DISCUSSION

In order to ensure the practicability of designed detection system, the simulation was carried on by Proteus, the simulation result of transmission and reflectivity detection was shown in figure 7 and 8.

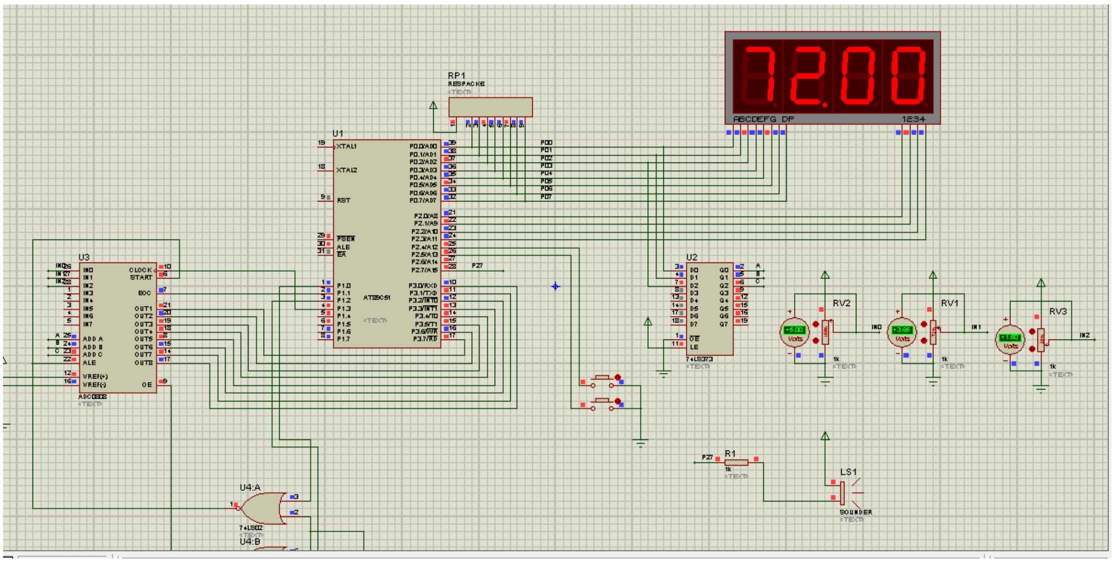

Fig.7: The simulation result of transmission detection

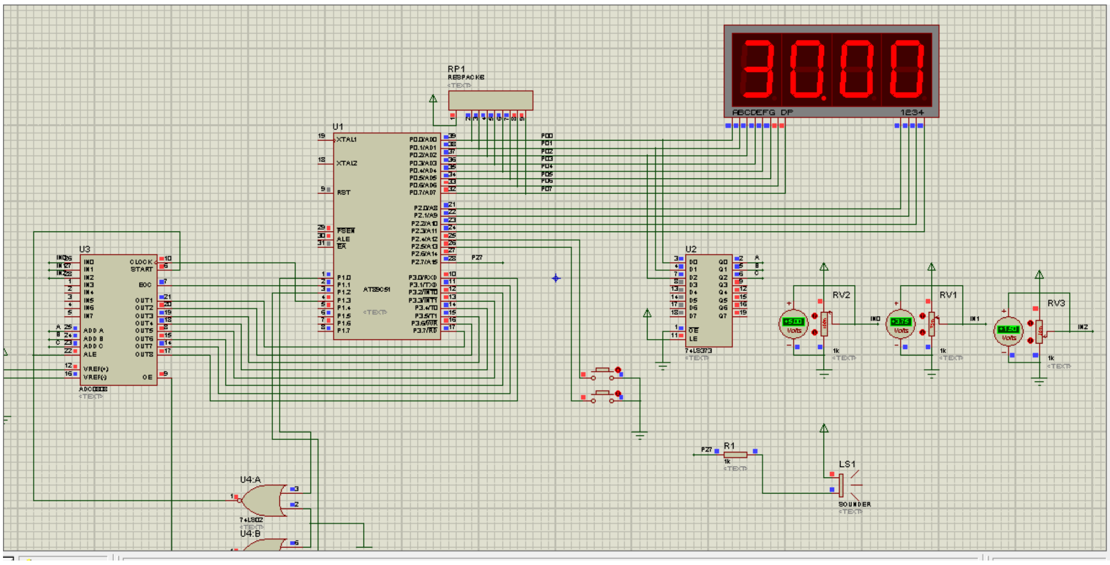

Fig.8: The simulation result of reflectivity detection

CONCLUSION

This article elaborated the on-line automatic detection system for transmission and reflectivity of automobile glass. From the simulation results, this system can be utilized to detect transmission and reflectivity of automobile glass, and it can alarm when transmission less than 70%.

Acknowledgments
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