Light Intensity Intelligent Control System Research and Design Based on Automobile Sun Visor of BH1750

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Abstract: This article investigates variable optical characteristics of Liquid Crystal Display (LCD). The main function of light intensity intelligent control system is to adjust the brightness of the LCD screen of automotive sun visors according to the light intensity of external environment. The working process starts sending a processed analog signal to single chip microcomputer by collecting data of environmental light through a sensor of BH1750, and then analyzes and computes through processing units, adjusts driving voltage and changes the brightness of LCD screen so that the drivers can fit the light intensity outside and drive safely.

Key Words: BH1750, LCD, Sun Visor

1. INTRODUCTION

Automobile sun visor is one of common devices in vehicles, which can prevent too weak or too strong light by expanding or folding itself. Due to the non-transparent visor, drivers' eye lights are blocked and their driving can be affected. Especially when driving at night or back light, drivers are explored at the light from strong sunlight and are very easy to get dazzled. Therefore, they do not see traffic clearly, it will cause the traffic accident and big loss of lives and property.

Light intensity intelligent control system based on automobile sun visor uses LCD screen instead of traditional sun visor. This system is to adjust the brightness of the LCD screen of automotive sun visors according to the light intensity of external environment [1]. Too high brightness of the screen will directly affect the service life of the LCD; while too low, it will affect the display. Nowadays, most of the light intensity collecting elements are photoelectric triodes or photocells, but due to the high complexity of the system design, this kind of system will increase the cost of the energy system and space, reduce its flexibility, and are easily interfered by invisible lights such as infrared. This system using the BH1750 light sensor with digital output better solves the disadvantages of the traditional metering system. It can be applied to a wide range of intensity of illumination detection to low the power consumption, and circuits are easy to design. When the system is in direct sunlight, it can keep dazzling light and large shadow sout of the driver's eyes to improve the driving comfort and safety.

2. SYSTEM HARDWARE DESIGN

2.1 Hardware Structure

Light intensity intelligent control system based on automobile sun visor is an open loop system, which possesses simple structure and the fixed structure order. The intensity of sunshine is needed to measure. Because the static error of BH1750 is small, the sun visor can change rapidly when encountered the overcast and insufficient sunshine situation happen. Therefore, it is friendly to the driver.

The main function of the system：

- Measure light intensity and send the value to theAT89C51 single-chip microcomputer by I2C;
- Through the MCU, calculate and output control signal. While using LED digital tube to display the size of the light intensity;
- Digital the control signal by PCF8591 and CD4053 and control the analog driving voltage signal of the LCD screen to realize the control of the LCD screen.

Light intensity intelligent control system based on automobile sun visor uses AT89C51 single-chip microcomputers as the CPU according to the characteristics of environment light intensity sensor BH1750[2]. The block diagram of light intensity measuring device based on BH1750FVI sensor is shown as Figure.1

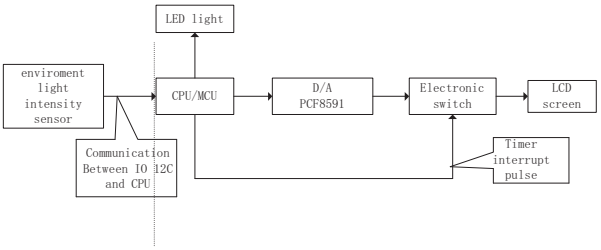

Fig1.Hardware structure

Light intensity intelligent control system based on automobile sun visor uses AT89C51 as the controlling core of the hardware. The main functions of AT89C51 control the output of the LED digital tube interface and the period of electronic switch control pulse. Collect the signal of light intensity by BH1750. Converting digital signals to analog signals, which can be used to control the LCD screen, by

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PCF8591. In the end, use the light of LEC to show the size of light density.

2.2 Control Circuit Hardware Design

Light intensity intelligent control system is based on AT89C51 single-chip microcomputer. System design not only uses the AT89C51 single-chip microcomputer resources, but also the external BH1750 control chip, LED digital tube and liquid crystal display. The reason for choosing LED digital tube is that the LED digital tube has excellent characteristics such as high display quality, digital PI, small size, low price and so on. It can reduce the cost of the whole system. It is easy to operate the system.

2.3 Principle of LCD brightness

According to different control modes, the liquid crystal display can be divided into active matrix LCD and passive matrix LCD. The use of more on the market is the active matrix type LCD, (TFT-LCD, which called thin film transistor LCD) [3]. The characteristic of TFT-LCD is that it has transistors in each pixel, more bright and colorful than the passive matrix. The characteristic of TFT-LCD is adapting the imaging principle of “back through”. When the light source is illuminated, the liquid crystal molecules are used to conduct the light rays. For the FET electrode is arranged between the upper and the lower clamping plates, the arrangement state of the liquid crystal molecules will be changed when the FET electrode is switched on, so that the purpose of light transmission and light shading can be realized.

2.4 Design of BH1750 light sensor

BH1750FVI is a kind of digital light intensity sensor, which the light sources not needed to distinguish. From Japan RHOM Corporation R&D products, BH1750FVI is an integrated circuit with two wires serial bus interface, which can monitor the external environment, at any time, according to different light intensity.BH1750FVI has with high resolution, which reached 1 ~ 65535 LX, so that wide range of light intensity changes can be monitored and collected[4][5].

I2C bus by PHILIPS Company R & D, which has two wire serial bus, mainly is used to connect the micro controller and its peripheral equipment. There are three types of signal for I2C bus when transmitting data start signal, end signal and response signal.

The communication protocol between BH1750 and main controller is standard I2C communication protocol. Main controller sends a variety of control commands and read the measurement data to the BH1750 by using I2C interface [4]. From figure 2 we can be easily seen that the photo diode (PD) has high precision, which likes human eyes. The PD detecting light, then use of integrated operational amplifier conversionPD current to PD voltage, 16 bit digital data acquisition by the analog to digital converter, the digital data is processing and storage by logical and IC interface. Then, through the corresponding instruction operation the internal storage data of light can be read [6]. OSC is an internal oscillator, it is mainly to provide internal logic clock, light data transmit through the standard I2C bus, the whole process is simple and easy to operate.

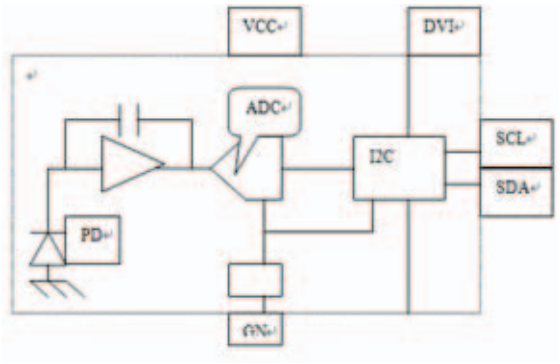

Fig2. Structure of BH1750FVI

2.5 Hardware Design of LED,PCF8591 and CD4053

LED digital tube receives the signals from the CPU and display the size of light intensity, then through the PCF8591 and CD4053 conversion the control digital signal to the driving voltage analog signal which control the LCD screen [7]. Hardware structure is shown as figure 3 and figure 4.

CD4053 is a kind of typical digital control analog switch. There are binary control input A and INH input B, which have low conduction impedance and the role of cut-off leakage current. The Figure 5 is the logic diagram for the CD4053 [8]. From the truth table (Table 1), we can see that when the control input is high, the "0" channel is selected, on the other hand, the "1" channel is selected. When the INH input = "1", all of the channels are cutoff.

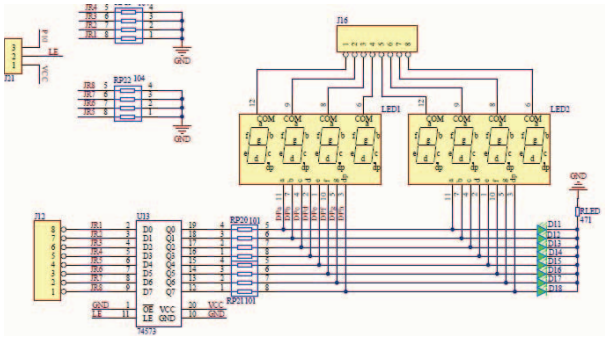

Fig3. Design of Dynamic LED digital tube

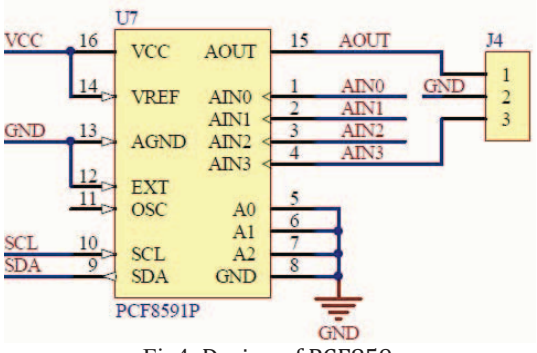

Fig4. Design of PCF859

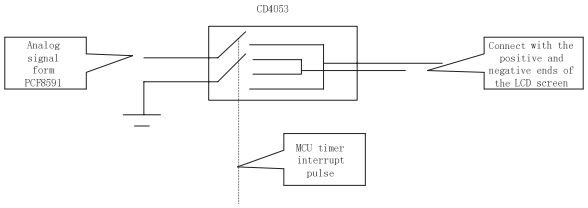

Fig5. Hardware design of CD4053

Table 1 CD4053

CD4053				
INPUT STATES				"ON"CHANNELS
INHIBIT	C	B	A	CD4053
0	0	0	0	cx,bx,ax
0	0	0	1	cx,bx,ay
0	0	1	0	cx,by,ax
0	0	1	1	cx,by,ay
0	1	0	0	cy,bx,ax
0	1	0	1	cy,bx,ay
0	1	1	0	cy,by,ax
0	1	1	1	cy,by,ay
1	*	*	*	NONE

3. SYSTEM SOFTWARE DESIGN

3.1. Main Program Design

The total flow chart of light intensity intelligent control system based on automobile sun visor is shown in figure 6. The system collects external environment light density by the BH1750, and converts the signal to a digital signal through the I2C bus to the single-chip microcomputer AT89C51, AT89C51 read the measuring data through a series of calculations, display the light intensity with the LED screen, and control the brightness of LCD.

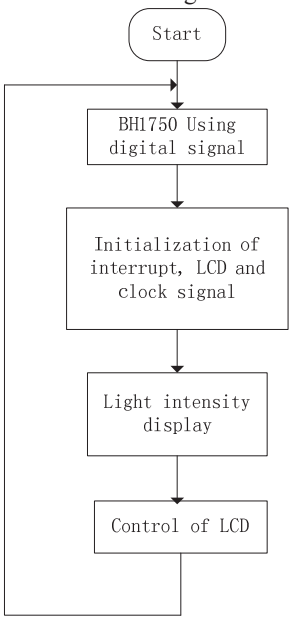

Fig6. Total Flow of System

3.2. LED Display Program Design

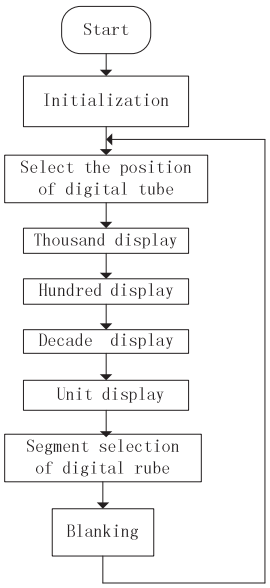

Fig7. LED Display subroutine design

4. EXPERIMENT

4.1. System Debugging

The system debugging is running the hardware and software. The system testing is according to the expected goal and function design of LCD screen. Before debugging, test the BH1750 [9] [10]. Download the initialization procedure to the original chip, then debug digital display screen. Set BH1750 under different light intensity and observe whether the digital tube screen displays the corresponding information. If displayed, then the program can be set up SCM operation control, and the display work is made. Finally, debug the PCF8591. Through the debugging of the above, if the digital tube can display the corresponding light intensity, the BH1750 chip can be the controlled by the program correctly. The main work for debugging is to make the BH1750 chip, LED digital tube and the program in single chip microcomputer suitable [11]. Compare the functions that are necessary to achieve and the expectations, modify the procedures accordingly, then check if the displayed figure is corresponding with the light intensity and if there's any delay or mistake. After several modifications, this design will achieve the expected functions i.e., demonstration with the power on. After that, cut off the power of the system. So repeatedly, it will complete the comprehensive debugging.

4.2. Experimental Results

After the hardware and software design, a sample of light intensity intelligent control system based on automobile sun visor is completed in the figure 8. Proper driving voltages with the corresponding to the light intensity show on the table after multiple tests, which is the brightness value of the screen. As per the figure 9, according to the results of the experiment, LCD driving voltage should be improved to maintain a better contrast when the light

intensity outside becomes stronger, vice versa. However, the decreased amplitude should get smaller. As the external light intensity decreases to a certain extent, driving voltage increases and the whole change trend is similar to the quadratic function curve.

Fig.8 Experiment prototype

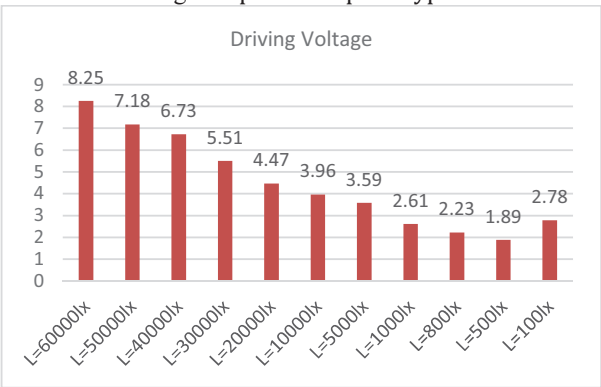

Fig.9 Experiment date

In addition, from the experiment, the whole control system reacts very quickly, almost synchronously with change of light intensity. It shows the advantage of fast and stable of the single chip digital processing system. Also, it possesses benefit of driver's safe driving.

5. Summary

Based on variable optical characteristics of LCD, design of the intelligent control system of a car visor is completed. This design is based on BH1750 measurements of light intensity outside and implements adjustment of the driving voltage of LCD. Due to BH1750 light sensor measurement accuracy, high precision, IIC bus interface is simple and easy to realize. Besides, this system automatically adjust the brightness properly. After experimental verification, it achieved an expected desire according to the sensitive reaction speed, high controlling. By changing the brightness of the LCD screens, the driver's eye that is suitable for outside the strength of the light, and it can ensure their safe driving.

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