Design and Realization of a Smart Bookmark

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***Abstract*—In view of the increasing myopia rate of teenagers, an intelligent bookmark based on a microprocessor is designed in order to prevent teenagers from myopia. The intelligent bookmark can help teenagers cultivate good reading habits, thereby reducing the myopia rate. The system is divided into a microprocessor module, a light intensity detection module, a display module, a sound-light alarm module and a key input module, each module coordinating with each other. Mainly using the single chip microcomputer as the control unit of the system and an illumination sensor to detect the ambient light intensity, through the analysis of the data of the ambient light intensity and the countdown of the preset time, the system completes the feedback of the reading ambient light intensity and the reading time and reminds readers whether the ambient light is suitable for reading and reading time to reduce the risk of the myopia.**

Keywords—smart bookmarks; MCU; sensors; myopia

I. INTRODUCTION

According to statistics, the myopia rate of teenagers is about 27% nowadays. The proportion in urban areas is twice than that in rural areas. On average, children spend nearly five hours a day doing close work, such as reading, writing, homework, computers, etc. and the time of the activity of medium distance activities (TV, musical instruments, etc.) is about 2.7 hours. More than 30% of the students will also attend cram schools outside the school. More than 50% of the students will read for 0-30 minutes uninterruptedly every day, and 18% even more than 60 minutes [1]. According to research, longer reading time and inappropriate light intensity environment are more likely to cause myopia [2].

It is urgent to solve this problem that the risk of high myopia because of inappropriate light intensity environmental reading and longer reading time. Traditional bookmarks can only record the page or do some short excerpts. After years of development, they have only made innovations in size and style and there is nearly no innovation in the essential function of bookmarks.

Microprocessors have the characteristics of high integration, small size, low power consumption and anti-interference. Intelligent products based on microprocessors have been rapidly developed and popularized. Microprocessors have been widely used in various electrical appliances, measurement and control equipment, electromechanical equipment and so on. Intelligent control and low cost make these devices more competitive. Under this background of the technology, an intelligent bookmark is designed based on microprocessors.

II. SYSTEM BLOCK DIAGRAM

The design of the intelligent bookmark is controlled by the microprocessor, and also including the light intensity detection module, display module, power module, key input module, alarm module, etc. The purpose is to achieve a reminder whether the environment light intensity is suitable for reading and an alarm function when the reading time is too long. The system block diagram is shown by Fig.1. The light intensity signal is collected and processed by the light intensity detection module, and then be sent to the MCU. The real-time environment light intensity data is compared with the preset light intensity signal which is the most suitable for reading by the MCU. The MCU outputs the result that the environment light is suit for reading and the result is indicated by LED. The reading time is set by key-press and the buzzer alerts when the reading time exceeds the preset time to preventing eye fatigue caused by reading too long. This design, compared with the traditional bookmark, has the intelligent function, can remind teenagers to overcome bad habits in the reading process, effectively prevent myopia.

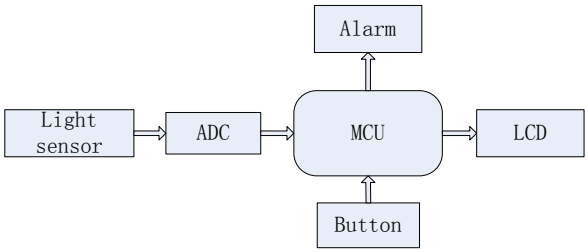

Fig.1. The design block diagram

III. DESIGN OF HARDWARE CIRCUIT

The hardware is mainly composed of MCU, light intensity detection module, display module, alarm module, key-press input module and so on.

A. Determination of MCU

Considering the technicality, practicability and exploitable ability, STC89C52 is selected as the control chip in the system. STC89C52 is a low-power, high-performance 8-bit microcontroller produced by STC (Hong Kong Standards and Testing Centre) [3]. It has 8K programmable Flash memory. STC89C52 uses the classic MCS-51 kernel, and many improvements have been made to make the chip have

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functions that the traditional 51 microcomputer does not have. It has 8-bit CPU and programmable Flash. STC89C52 provides a highly flexible and efficient solution for many embedded control applications. It has the following standard functions: 8k-byte Flash, 512-byte RAM, 32-bit I/O , watchdog timer, built-in 4KB EEPROM, MAX810 reset circuit, three 16-bit timers/counters, four external interrupts, a 7-vector 4-level interrupt structure, full-duplex serial port. The minimum system circuit diagram is shown by fig. 2.

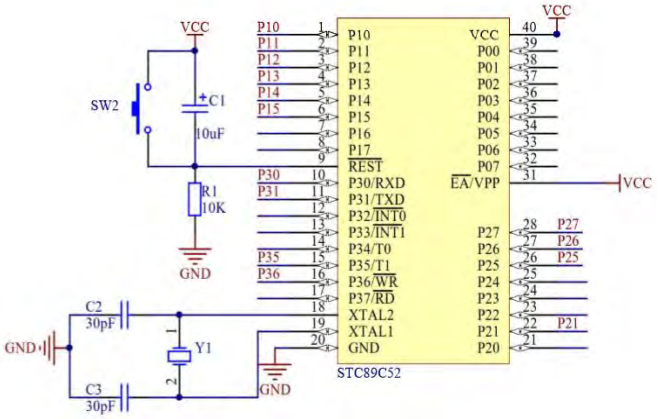

Fig.2. The minimum system circuit diagram

B. *Light Intensity Detection Module*

BH1750 is an digital Ambient Light Sensor IC for I2C bus interface [4]. This IC is the most suitable to obtain the ambient light data. It is possible to detect wide range at High resolution.(1 - 65535 lx). The block diagram is show by Fig.3. PD is a photo diode with approximately human eye response. AMP is an integration-OPAMP for converting from PD current to Voltage.ADC is AD converter for obtainment Digital 16bit data. Logic + I2C Interface is the ambient Light Calculation and I2C BUS Interface. It is including below register. Data Register → This is for registration of Ambient Light Data. Initial Value is "0000_0000_0000_0000". Measurement Time Register → This is for registration of measurement time. Initial Value is "0100_0101". OSC is the internal Oscillator (typ. 320kHz). It is CLK for internal logic.

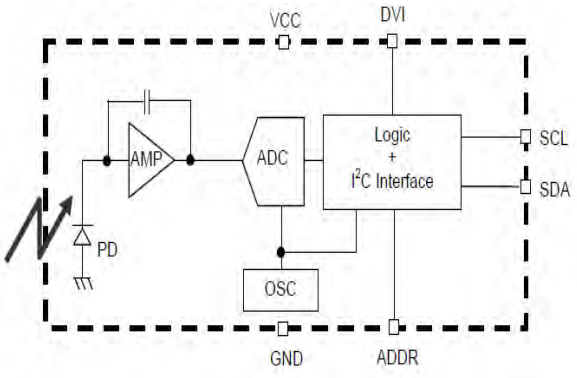

Fig.3. The block diagram of BH1750

The connection diagram of BH1750 and MCU is shown by fig.4. The BH1750 module will communicate with MCU by I2C bus, Pin SCL and SDA in BH1750 will be connected with pin P3.6 and P3.5 in STC89C52. In the I2C bus specification, when the I2C bus is idle, both pin SCL and pin SDA are high level, because the output of the device connected to the bus must be open collector or drain, there is a wired-and, so as long as there is a device at a certain time output low level, the bus will be pulled to low level. Therefore, the external pull-up resistors are needed and can ensure signals more stable.

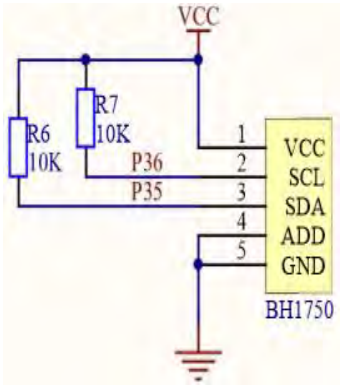

Fig.4. Diagram of BH1750 and MCU

C. *The Display Module*

LCD1602 is chosen as LCD display in this system. Its power is 5V. It has backlight and can display two lines. There are 16 characters per line and cannot display Chinese characters. It has 128 ASCII characters. Its connection diagram with MCU is shown by Fig.5.

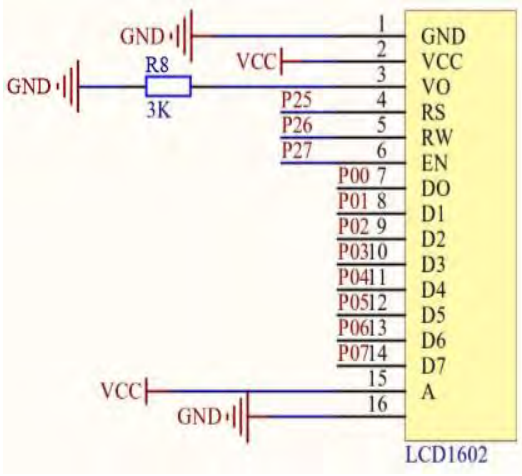

Fig.5. Diagram of LCD1602 and MCU

D. *The Alarm Module*

The sound-light alarm module includes three LEDs (One is red, one is green and the other is yellow) and a buzzer alarm circuit. In the light alarm circuit, different color LED shows different range of illumination intensity. The red LED is light on when the illumination intensity is higher than 500 lux. The yellow LED is light on when illumination intensity is lower than 300 lux. The green LED is light on when illumination intensity is between 300 and 500 lux(suitable intensity of

illumination for reading). The buzzer alarm when the timer reaches the preset time.

E. Key Input Module

In this design, the key input module adopts independent keys. The independent keys are simple not only in hardware but in software. The connection diagram is shown by Fig.6. K1 is used for the setting key for the timing, the K2 and K3 keys are the adjusting key for controlling the timing, the K2 is used to increase the timing, and the K3 is used to reduce the timing.

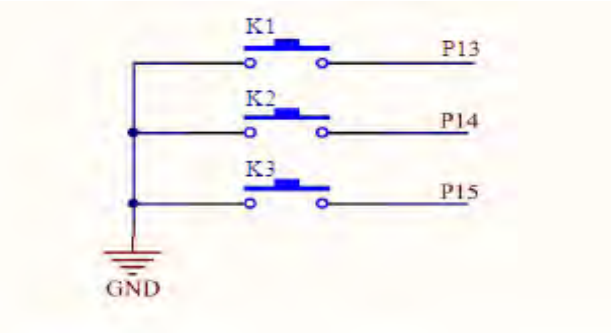

Fig.6. Diagram of key-press and MCU

IV. SOFTWARE DESIGN

The software flow chart of this smart bookmark is showed by fig.7. The software design uses C language on the Keil development platform. The program of this system mainly consists of the digital signal acquisition from the sensor, judgment and analysis, output alarm and the liquid crystal display program.

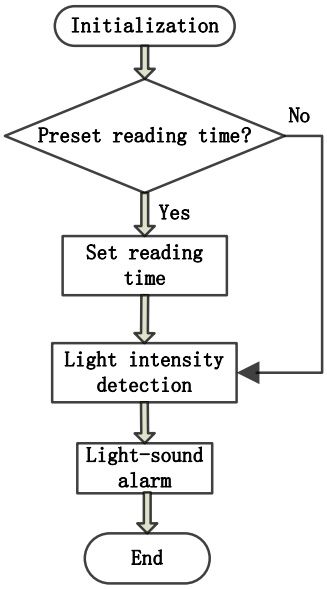

Fig.7. The software flow chart

A. Information Interaction between light sensor BH1750 and MCU STC89C52

Measurement procedure of BH1750 is shown in Fig.8 [4]. Write measurement command and Read measurement result are done by I2C Bus interface. Completely refer the formally specification of I2C Bus interface, and the formally timing chart is shown in Fig.9.

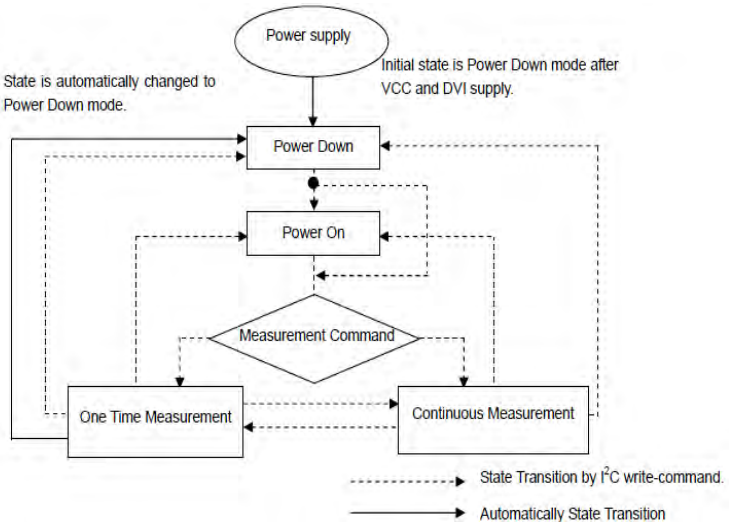

Fig. 8. Measurement procedure of BH1750

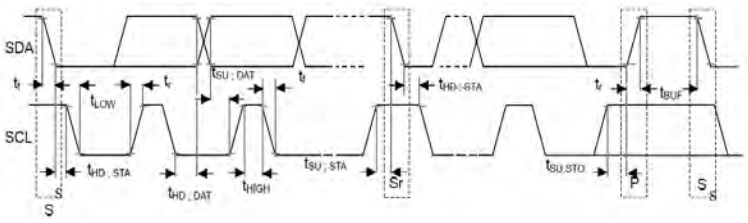

Fig. 9. I2C Bus Interface Timing chart

The program that MCU sends a byte data to the bus can be referred to as follows:

```
void BH1750_SendByte(BYTE dat)
{
  BYTE i;
  for(i=0; i<8; i++)
  {
    dat<<=1;
    SDA=CY;
    SCL=1;
    Delay5us();
    SCL=0;
    Delay5us;
  }
 BH1750_RecvACK();
 }
```

The program that MUC receives byte data from the bus can be referred to as follows:

```
BYTE BH1750_RecvByte()
{
  BYTE i;
  BYTE dat=0;
```

```
    SDA=1;
    for(i=0; i<8; i++)
    {
      dat<<=1;
      SCL=1;
      Delay5us();
      dat |=SDA;
      SCL=0;
      Delay5us();
    }
    return dat;
}
```

V. CONCLUSIONS

Finally we make the wise bookmark according the hardware and software design scheme. The testing result meets the anticipated design targets and all the functions have been completed. Where the design needs improvement is the wise bookmark need to be further miniaturized.

ACKNOWLEDGMENT

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