International Journal of Smart Home
Vol. 9, No. 11, (2015), pp. 287-300
http://dx.doi.org/10.14257/ijsh.2015.9.11.28

The Smart Eye Frame Based On Internet of Things

Xin Zhenghua[1], Chen Guolong[1], Li Hong[1], Song Qixiang[1], Xiao Meng[2], Lu Biao[1*], Lu Hongmei[1], and Shi Yaqi[1]

1 School of Information Engineering, Suzhou University, 234000, Anhui, China
[2]CNBM International, Beijing, China
** The corresponding author, 1071460752@qq.com*

Abstract

Protecting the eyesight has become one of the most current concerns in China, especially for the adolescent group. This design is a tool of protecting the eyesight for preventing the myopia. It is based on the ultrasonic sensor, photosensitive resistance, Bluetooth, the voice module and the smart telephone. It discusses the hardware design and software control for the eye sight protection. It uses CC2530 MCU as the core chip. Its circuit is to achieve the low-cost, high-precision, minimized eye sight protection. It is simple to operate. It includes the strong anti-jamming capability. Now the smart eye frame is heavy because of the battery. But it can supply power by the charger in order to reduce the weight. The initial survey shows more than 50% of students and parents lack the basic science knowledge for caring the vision. Therefore the design of a vision protector to protect eyesight is particularly important. The design of the hardware includes the circuit of the transmitter and the receiver in the ultrasonic, the alarm circuit, the circuit of detecting the light intensity, and Bluetooth communication circuit. The market has no similar products.

Keywords*: the myopia; CC2530; the eye protection tool; the ultrasonic sensor; light intensity detection*

1.Introduction

1.1 The Reasons for the Incorrect Reading or Writing Position

Now the poor vision of young group has become the public health problem and the common concern at home and abroad. According to the initial statistics on the line, the myopia rate of the primary eyesight at China is 26.96%. The 53.43 percent of junior school students, 72.8 percent of high school students and the 77.95% college students are myopia. China has 300 million people suffering from myopia, accounting for about 30 percent of the world total myopia. At present, the myopia rate of students has been ranked second in the world. It is high to reach 34.6% in primary school. It is 71.29% in high school. The blindness number of juvenile due to myopia has reached 300 thousand. First, because the smart phones develop rapidly, the majority of parents will buy their children the mobile phones. The young always browse the web and find friends through the intelligent phones. All the free time they look at the phone. Because they lack the ability to manage themselves, too close distance between eyes and the phone and long time period for using the intelligent phone will damage the their vision. Second, the students spend long time on doing the heavy homework with the wrong posture. And they do not get timely warning from parents or teachers. They belong to the junior or high school

ISSN: 1975-4094 IJSH

groups. Third, the students in the university or other young people at work like to use the mobile phones when lying in bed. For the convenience, they always make the mobile phones close to the eyes.

It is necessary to cultivate good vision health habits. It is important to pay attention to self-care measures. First, the distance from the fingertips holding the pen in hand to the nib of the pen is 3.3 cm. Second, the chest is 6-7 cm away from the table. The books are about 33 cm from the eye. The correct posture is necessary for reading and writing. The readers do not read while walking, riding or lying down, especially in the environment of low light intensity. They should strengthen classroom lighting. The reader should ensure adequate lighting from the left front direction. The suitable light intensity range is from 100 to 200L (lux). It is equivalent to 40 watt incandescent or 8 watt fluorescent lamp. Too strong or too weak lighting can cause the eyes to be tired to adjust excessive strength.

The wireless Bluetooth technology can enable the user to control the conventional Polymerase Chain Reaction (PCR) process with a smart phone. The PCR machine is paired with a smart phone. The smart phone integrated a protocol that can control the PCR machine [1]. To overcome the files shared between two USB flash drives when the user is away from computer, two ways resolve transferring the data between two USB flash drives. One is Wireless Technology, the Wi-Fi technology or Bluetooth Technology which can send/receive File. Another is in-built USB slots to perform data transmission to other pen drives directly without the use of the computer system.[2]. To prevent the unaware attack, experts are encouraging to turn off unused network services. However, in their proposed method, many users cannot perform it properly. Therefore, in this paper, a context-aware based algorithm for prevention of Bluetooth device attack was designed so that users have better security options in any situation for digital signage[3]. Smart phones, as one of the most important platforms for personal communications and mobile computing, have evolved with various embedded devices, such as cameras, Wi-Fi transceivers, Bluetooth transceivers and sensors[4]. In this paper, the augmented reality English learning contents for the students to learn through the role and mission in the virtual space as the contents of new forms for the experiential learning through the augmented reality and TOLED (Transparent, Organic Light Emitting Diodes) system by using the vibrating Bluetooth maker cube for the multi maker configuration was designed and the system was designed to service it[5]. This system uses the CC2530 chip [6]. The study integrated IOT service platforms and developed an efficient target-oriented smart integrated multiple tracking system that looks up object location based on real time and guarantees the accuracy and reliability of logistics location and resource management by combining the function of multiple tracking system[7]. This paper focuses on some key issues such as how to connect to the target site via the communication interface, crawl pages and sub-pages, parse the desired content and store information in the SQlite database in developing wireless digital campus system based on Android[8][9]. This design applied the technology about Internet of things (Iot).

1.2 The Purpose and Significance of the Design

This project is designed to protect eyesight for the issue of juvenile myopia using the technology based on the internet of things. It includes the following features. The short distance from the book can lead to the alarm to remind the user. When the user works in too dark ambient or high light intensity, it reminds users to turn on the lights. This design implements the above functions. It can effectively protect the eyesight of adolescent.

The following section is the implements of the system. Then the intelligent eye frame product is presented. The conclusion section has summed up the system. At last, there are acknowledgments and references.

2. The Design Ideas of the Eye Frame

The program of the CC2530 microcontroller generates a 40HZ signal. And after amplification the signal is output by the ultrasonic transmitter. The signal to the ultrasonic receiver will send to the microcontroller via the amplifier. Then the timer is turned off to calculate the time t. The formula can output distance. If the distance is less than the set distance by comparing, then the Bluetooth module is triggered to send the message to the intelligent phone. The light intensity detection module uses the photo resistor and AD converter to distinguish too bright rank or too dark rank. Then the abnormal signal will send to the intelligent phone and alarm.

2.1 The Various Components of the System

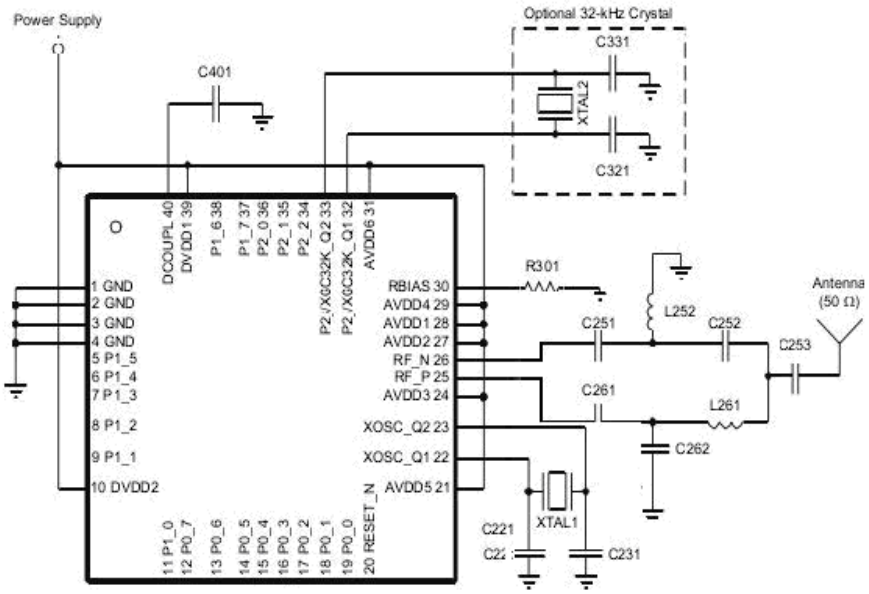


Figure 1. The Pins of the CC2530

In the Figure 1, the pin AVDDn (n on behalf of 1, 2, 3, 4) connects the analog power that ranges from 2V to 3.6V. The port similar to the P0_0 is the digital I/O. XOSC_Q1 22 is an analog I/O 32-MHz crystal pin 1 or the external clock input pin.

The Ultrasonic module uses the type HC-SR04 shown in the Figure 2. This module can achieve 2cm ~ 400cm non-contact distance measurement. The accuracy is up to 3mm. The module includes an ultrasonic transmitter, receiver and the control circuit. The project is to send the collected data from the CC2530 to the receiving end realtimely such as the phone, the wrist strap and so on. And if the tested value is out of the pre-set range, the CC2530 will call the alert program to give voice prompts.

The system uses the I/O port TRIG to trigger the ultrasonic to start measuring. It gives at least 10μs high-level signal. The module sends eight 40 khz square wave, and detects whether a signal returns automatically. If a signal has returned, then the IO port ECHO outputs a high level. The duration of the high level is the ultrasonic starts launching until

it returns.

The tested distance = (he duration of the high level * speed of sound (340M / S)) / 2;

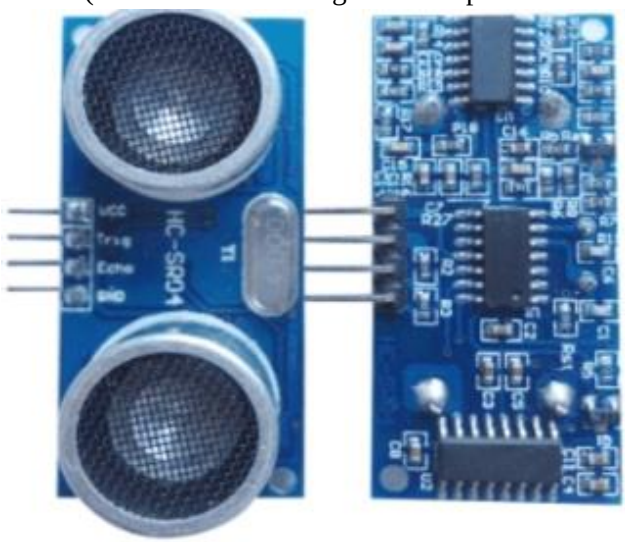


Figure 2. The Physical Map of the Ultrasonic Sensor

In the Figure 2, there are four pins, VCC, GND, TRIG and ECHO. The VCC pin provides 5V power supply. The GND pin is connected to the ground. The TRIG pin triggers the control signal to input. The ECHO pin receives the echo signal.

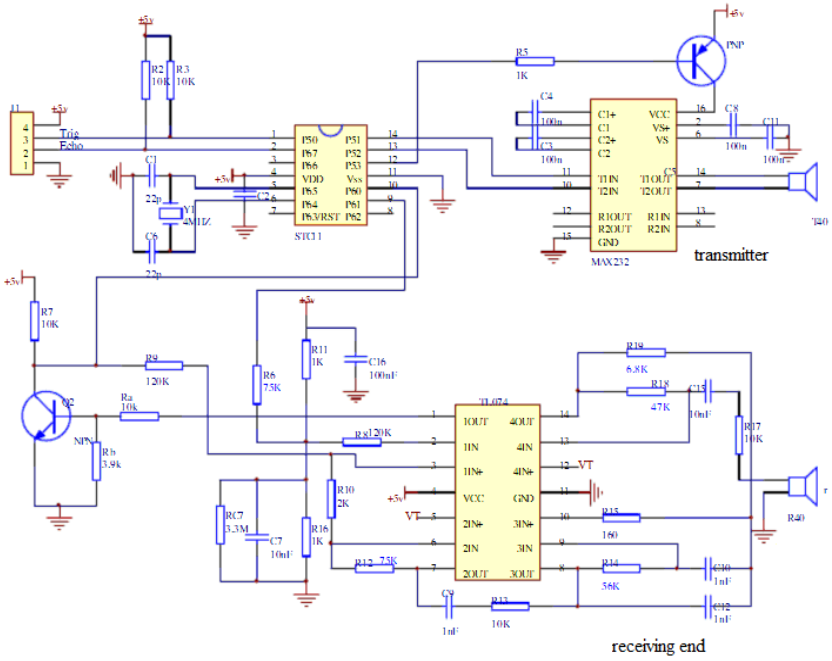


Figure 3. The Circuit of the Ultrasonic Module

In the project, the P0_5 of the CC2530 chip is connected to the TRIG pin of the HC_SR04 ultrasonic sensor. The P0_6 pin is connecting with the ECHO pin in the HC_SR04 chip. When the ultrasonic sensor encounters the obstacle, the TRIG pin gets a rising edge to trigger transmitting the ultrasonic. The ECHO pin will return the information. Then the calculated distance is compared with the preset distance which is set by the program.

The detection circuit of the light intensity is mainly consisted of the photosensitive

resistance, AD0809 chip and 74LS74 chips.

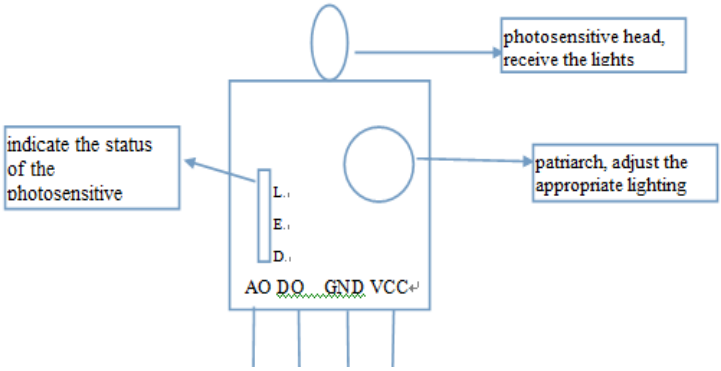


Figure 4. The Schematic of the Photosensitive Module

The value of the photosensitive resistor changes with the strength of incident light (visible). In the dark environment, the resistance is up to 10MΩ. In the 100LX light, its resistance is just in the range from a few hundred Ω to several thousand Ω. The light sensitive degree of the resistance is almost as same as the eyes. The eyes can see the light range from 0.4μm to 0.76μm.

The photosensitive module is connecting with the P20 port of the CC2530 chip. This port can input or output the data. If the P20 port is set to be the input mode, then the level is pulled. And the photosensitive module is waiting the high level to trigger.

```
void LightInit()
{
P2SEL &= ~0X01; //set P20 as the general IO port
P2DIR &= ~0X01; // use P20 port as the input mode
P2INP &= ~0x01; //open P20 to pull up resistor
}
```

In the Figure 4, there are four pins in the photosensitive module. They are AO, DO, GND, VCC. The AO and DO pins mainly complete the A / D conversion. When the module receives the external light intensity, the light-sensitive resistor makes the appropriate changes according to the light strength. And the signals of the current passing through the photosensitive module changes with the resistance. And these two pins convert the analog electrical signals into the digital signals. The GND and VCC pins take charge of the power supply. Its internal circuit is shown as the following Figure 5.

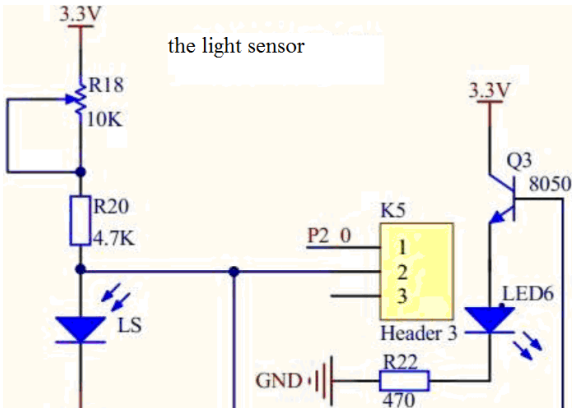


Figure 5. The Circuit of the Light Sensor

The data from the AO and DO pins is sent to the CC2530 MCU. Then the microcontroller determines whether the light is fit to read or write and tells the information to the intelligent phone through the Bluetooth module. The Bluetooth module supports the wireless communication in the short range. The communication distance is divided into one hundred meters and two hundred meters two classes. The Bluetooth uses the IEEE 802.15 standard and works in the band of the 2.4GHz. The bandwidth is up to 3Mb/s. The mobile phones, PDA, the wireless headsets, the new laptops and other related peripherals can transmit or receive wireless information through the Bluetooth. In this project, the CC2530 MCU transforms the instruction into text message to the intelligent phone with the help of the Bluetooth technology.

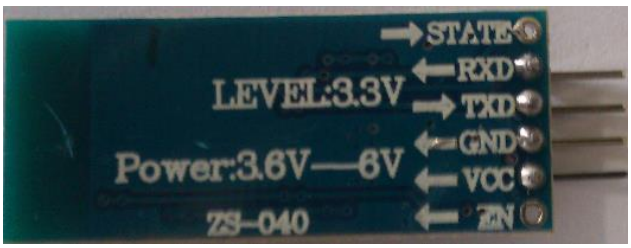


Figure 6. The Bluetooth Module

In the voice module, the correct link of the VCC and GND pins can provide the voltage of 3.7V through the Dupont cable. One end of the Dupont line is connected with the P_E port. The other end is linking with the P0_4 port of the CC2530. When the tested distance from the ultrasonic sensor is less than 30cm, the program sets the voice module to work. There are codes to complete this function.

```
if(distance<30)
{
    VOICE=1;
    VOICE=0;
}
```

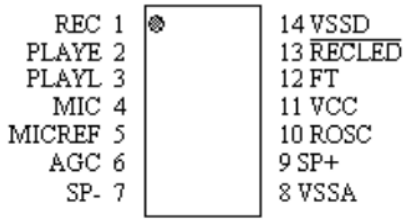


Figure 7. The Voice Module

The program sets the P0_5 pin of the CC2530 to connect the TRIG pin of the HC_SR04. The CC2530 sends the high level to the ultrasound module. The module receives the reflected ultrasonic waves and it sends the signal to the CC2530's P0_6 pin by its ECHO pin. This project combined the photo resistor module, AD, and the CC2530. When the light intensity is higher than a set threshold, the CC2530 MCU will give a tip. When the light intensity is below the set threshold, the CC2530 MCU also gives a tip.

In the Bluetooth module, the TXD is the sending end. And it connects the RXD of another Bluetooth device in the communication. The P0_2 and P0_3 pins of the CC2530 connect the Bluetooth module.

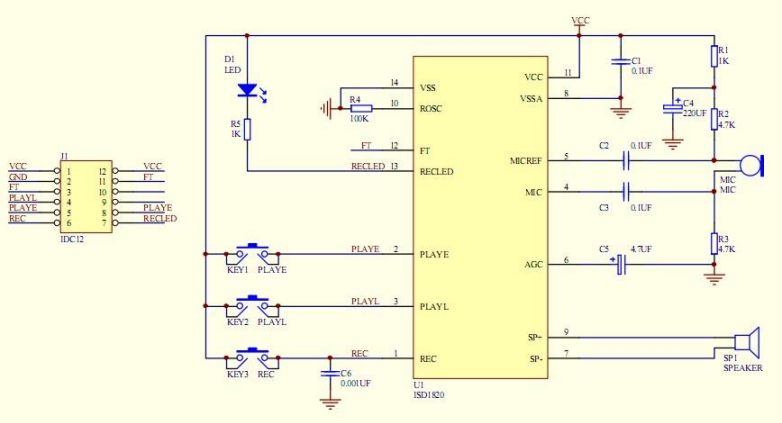


Figure 8. The Circuit of the Voice Module

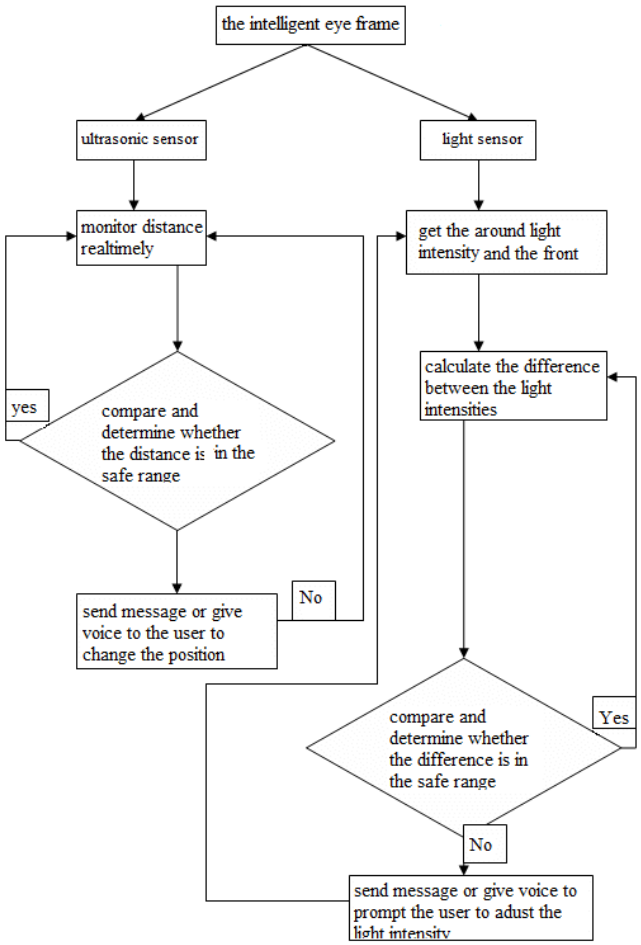


Figure 9. The Program Flow Chart

```
#define TRIG P0_5
#define ECHO P0_6
void SysClkSet32M(void);
```

```
void Delay_10us(void);
void Delayms(uint xms);
void Init_GPIO(void);
void Init_T1(void);
void Init_Key1(void);
void SysClkSet32M()
{
      CLKCONCMD &= ~0x40;
      while(CLKCONSTA & 0x40);
      CLKCONCMD &= ~0x47;
}
void Delay_10us()
{
    uchar i;
    for(i=0;i<9;i++)
    asm("NOP");
}
void Delayms(uint xms)
{
   uint i,j;
   for(i=xms;i>0;i--)
     for(j=587;j>0;j--);
}
void Init_GPIO(void)
{
   P0DIR |= 0x20;
   P0DIR &= ~0x40;
}
void Init_T1(void)
{
   T1CTL = 0x05;
   T1STAT= 0x21;
   T1CNTL=0x0000;
   T1CNTH=0x0000;
}
void Init_Key1(void)
{
   P0IEN |= 0X40;
   PICTL &= ~0X01;
   IEN1 |= 0X20;
   P0IFG = 0x40;
   EA = 1;
}
#pragma vector = P0INT_VECTOR          __interrupt void P0_ISR(void)
 {
   //Init_Key1();
   Init_T1();
   while(ECHO);
```



```
        L=T1CNTL;
        H=T1CNTH;
        s=256*H;
        distance=((s+L)*340)/30000.0;
        T1CNTL=0x0000;
        T1CNTH=0x0000;
        P0IFG = 0;
        P0IF = 0;
      }
    void main(void)
    {
          SysClkSet32M();
          Init_GPIO();
          Init_Key1();
          while(1)
          {
            TRIG =0;
            Delay_10us();
            TRIG =1;
            Delayms(1000);
          };
}
```

3. The Related System Results

The micro-ultrasonic module is mounted on the eye box to collect the distance from the eye to the book or the screen. The appearance of the intelligent eye frame is shown as in the Figure 10. If the distance is less than a pre-set value, it sends a high signal. The light sensor is located on the sides of the eye box to get the light intensity around the people. If the tested value of the light intensity is out of the pre-set range, the CC2530 micro controller will send the high-level signal. And then the Bluetooth module sends the signals to the phone. This triggers the software in the phone to run. The warning tips people to watch the target farther. Or it tells people the light too strong or too weak in the smart telephone shown as in the Figure 11.

Figure 10. The Appearance of the Product

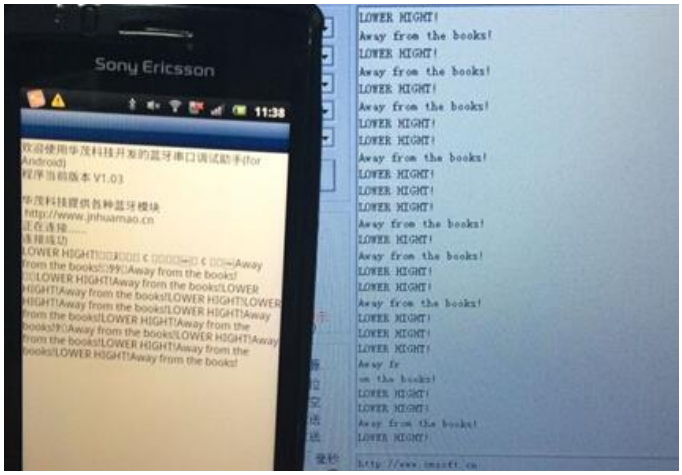


Figure 11. the Smart Phone Showing the System Result

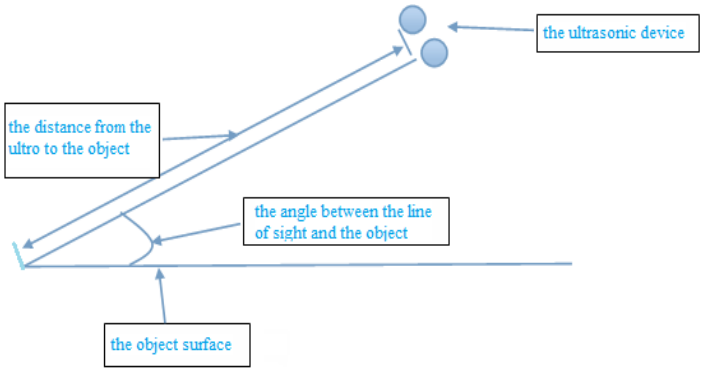


Figure 12. The Schematic of the Operating Smart Eye Frame

Under the premise of the same distance, the distance from the glasses or the eyes to the same object is variable with the different angles.

Table 1. The Measured Distance for the Fixed Distance at Different Angles

distance/cm *angle*	10	20	30	40	50
10 degree	12.14	18.35	27.78	37.10	45.23
20 degree	11.23	20.65	30.80	40.23	50.54
30 degree	11.15	20.78	30.82	40.31	50.66
40 degree	11.24	20.43	30.22	40.29	50.34
50 degree	11.26	20.97	30.56	40.38	50.76
60 degree	11.28	20.34	30.77	40.32	50.27
70 degree	11.33	20.78	30.26	40.34	5056
80 degree	11.46	20.67	30.11	40.43	50.54
90 degree	11.05	20.68	30.03	40.65	50.43

Under the premise that the angle between the ultrasonic sensor and the plane which the object belongs to is invariant, every set of data is calculated from the average of the 1000 times experiments. The following table shows there is the error in the tested distance.

Table 2. The Measured Distances at Different Angles and in Different Distances

distance/cm angle/degree	10	15	20	30	45	60	70	80	90
20	16.33	17.22	20.73	20.25	20.11	20.53	20.64	20.57	20.16

The above experiments have been done repeatedly. The result shown in the above table illustrates the when the angle is smaller than 15 degree, the error is greater. When the angle is more than 15 degree, the error is acceptable.

3.1 The Problems Existing in this Product

The test has proved that the system hardware design is reasonable, real time, effective to play the role of eye protection. After assembling and debugging the hardware, it has achieved all the functions. But it has the limitations. The analysis is as follows.

(1) The error is caused by the temperature of the environment

The ambient temperature Influences the measured data from the sensors. And there is no temperature compensation module in this design. Because the design is primarily used as a tool of the protective vision. It reminds the users to protect eyes. There is no need to have high accuracy in daily life. This design does not use temperature compensation module design.

(2) The different surface media of different obstructions materials causes the error.

Because the results of the measurements for objects with rough surface are worse than obstacles with the smooth surface. The rough surface of the obstacles will cause the transmitted signals to be scattered. Then the echo will be weakened. This will lead to measurement errors.

(3) Influence of the induced angle of the ultrasonic sensor

Two ultrasonic probes, the launch probe and the receiving probe, are formed a geometry angle with the tested obstacle. The trial and data shows about 15° angle is the best. There is some angle between the reflected wave and the probe. When the angle is too large, it will result in the large measurement error. Even it will not receive the echo signals. Especially when the eye is near to the obstacle, the error becomes clear. But this error can be reduced as much as possible. The method is using the probes of strong emission capability and the little scattering. Or the system uses multiple probes.

4. Conclusion

This paper describes the principle of the system components, circuit and the design for every module. And the program achieves the desired functionality. In fact, the myopic is one step away from the blind. This system has been developed to prevent the myopia. When the distance between the user and the mobile phone or the desktop is within 30 cm and the external light is not suitable when reading or writing, the system will prompt the user to be away from the phone by the voice or the message. It keeps the users' eyes

healthy in the correct posture.

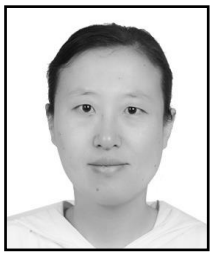
Acknowledgments

This paper are sponsored by the key project from the Ministry of Education, the research for the model theory and its application (205074), Anhui Province Soft Science Project Research on the high-reliability key techniques for the system services of the cloud computing(1502052053), University science research project of Anhui Province (KJ2012A263), National Students' Innovation and Entrepreneurship Training Program, wireless sensor data processing based on cloud computing, (201410379005), Anhui University Innovation and Entrepreneurship Training Program, Establishing the cloud service model based on the granular computing (AH201410379040)," Zigbee-based GPS positioning system "(AH201410379043)," Smart water rescue robot fish global strategy "(AH201410379044)," The design and Implementation of the sensor data based on CC2530 to publish on the web "(AH201410379046)," The energy-saving screen software system design to protect eyes based on android"(AH201410379047), and Anhui Province Natural Science Research Major Project, Research on P2P multi-channel video encoding key technologies (KJ2014ZD31), Anhui Province Natural Science Research Key Project, Research on vegetable supply chain tractability Platform Based on the quality and safety (KJ2014A247). Anhui Province College Humanities and Social Sciences Key Research Base - Culture University Research Center, the tender: Research on Campus Culture Construction Evaluation System (SK2014A116), Suzhou University outstanding young teachers support program (2014XQNRL007) and The plant alarm system based on linux (2015HX023) .

References

[1] K. J. Dae, C. Y. Park, J. Yeon, K. Y. Seop, H. J. “Development of PCR controller and smart-phone application based on bluetooth communication”, International Journal of Multimedia and Ubiquitous Engineering, vol. 8, no. 5, **(2013)**.
[2] N. K. Reddy, B. Venktram and N. Sireesha, “An efficient data transmission by using modern USB flash drive”, International Journal of Multimedia and Ubiquitous Engineering, vol. 9, no. 10, **(2014)**.
[3] J. S. Mo, C. Y. Sam, S. J. Hun, B. Uyeol and K. S. Soo, “Design of context-aware based information prevention for digital signage”, International Journal of Multimedia and Ubiquitous Engineering, vol. 8, no. 3, **(2013)**.
[4] D. X. Hao, L. H. Ning and W. H. Wai, “SPTF: Smart photo-tagging framework on smart phones”, International Journal of Multimedia and Ubiquitous Engineering, vol. 9, no. 9, **(2014)**.
[5] K. D. Hyun and K. S. Soo, “Design of smart learning system based on AR-APM”, International Journal of Multimedia and Ubiquitous Engineering, vol. 9, no. 6, **(2014)**.
[6] Z. H. Xin, G. L. Chen, X. W. Li and L. Y. Hu, “Research On the ZigBee Network and Equipment Design Based on the CC2530”, Sensors & Transducers, vol. 158, no. 11, **(2013)**.
[7] K. J. Su, H. J. Lee and O. R. Duck, “Smart integrated multiple tracking system development for IOT based target-oriented logistics location and resource service”, International Journal of Smart Home, vol. 9, no. 5, **(2015)**.
[8] M. Li, Z. Yu, L. Kuo, L. Shen, Q. Jie, H. Z. Yu and J. Wang, “Development and research of digital campus system based on android”, International Journal of Smart Home, vol. 8, no. 4, **(2014)**.
[9] J. S. Song, Z. G. Xin and W. Ding, “Research on android intelligent phones controlling the car to run”, TELKOMNIKA, vol. 11, no. 12, **(2013)**.
[10] Z. H. Xin, H. Li and L. Y. Hu, “The Research on CC2530 Nodes Communicating with Each Other Based on Wireless”, TELKOMNIKA, vol. 11, no. 1, **(2013)**.
[11] Z. J. Gang, W. C. Dong, D. Liu, H. Z. Hua, B. Liang, “The design for the smart home alarm system Based on the wireless sensor network technology”, Journal of Shenyang Jianzhu University (Natural Science), vol. 24, no. 2, **(2008)**.

Authors



Xin Zhenghua, he is a lecture in the Department of Information Engineering, Suzhou University. Her research interests are things of internet, cloud computing and robotics. And she is also a researcher at Intelligent Information Processing Lab, Suzhou University, China. She has published about 20 articles indexed by the EI or SCI.

Guolong Chen, he is the professor, party secretary of Suzhou University in Anhui province. He got the doctor degree from Beijing Normal University, the postdoctoral from the institute of Software in China. His scientific interest includes the digital computer, cloud computing. He has chaired or participated in nearly 10 national and provincial scientific research projects. A number of articles have been indexed by SCI and the American Mathematical Reviews.

Hong LI, he is the professor. He got the doctor degree from China University of Mining and Technology, Xuzhou in Jiangsu province. His scientific interest is the intelligent computing, algorithm design and analysis, data mining. His magnum opus are as follows.[1] Further Study on Granulating Thinking. Journal of Suzhou university. 2013.28(5). [2] Research on four-element model of granular computing. Computer Engineering and Applications. Computer Engineering and Applications. 2013.49(4). [3] Formal Method of Granular Synthesis Based on Category Theory. Computer Engineering. 2011.37(14).

Qixiang Song, Current position, grades: professor, Dean of School of Information and Engineering, Suzhou University, Anhui Province University studies: bachelor degree from Anhui University ;Scientific interest: physics, cloud computing Publications (number or main): 15 Experience: A number of articles has been indexed by SCI.