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Blue light Exposure Control System Using Sensor Modules

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Abstract

Recent impact of 4th industrial revolution is increasing usage of IoT technology along with smartphones and tablet PC. However blue light emitted from electronic devices such as smartphones and tablet PC causes detrimental change to human bodies. As the controversy over the harmfulness of blue light became known through the media and various communities, related markets were formed, and various blocking films, software, and vision protection monitors were released. In this paper focuses on utilizing IoT technology to protect human organizations from blue light. It presents anti-blue light system which prevents excessive exposure to blue light through Arduino module such as ultrasound, piezo buzzer and blue light measurement module.

Keywords: *Arduino, Blue Light Exposure, Microcontroller, Sensor Module*

1. INTRODUCTION

Recently smartphone distribution rate is increasing due to 4th industrial revolution and according to National Information Society Agency(NIA) statistics of 2018, 9 out of 10 citizens over age 3 owns a smartphone and 2 out of 10 smartphone users have dependency issues. Also according to statistics of Ministry of Science and ICT, 91.5% of population uses internet and due to continuous rise of internet access since 2000 utilization rate of tablet PC and desktop PC is projected to rise as well [1, 2].

Electronic devices such as smartphone, tablet PC and monitors create radio waves detrimental to our eye health where blue light among all can affect retina causing dry eye, decreased vison and damaged retina. Modern people's long exposure to electronic devices like monitor and smartphone can allow serious impact on human body from blue light [3].

Currently anti-blue light spectacles which are developed and being distributed is known as the most effective method that provides similar conclusion as applying blue light filters to every displays. However even without lens power, dizziness by prism effect is observed occasionally. This prevents people from purchasing anti-blue light spectacles.

In this paper, author presents safety alarm powered by ultrasound sensors and blue light measure module using Arduino to supplement blue light prevention method and further alert users about impact of excessive usage.

2. RELATED RESEARCH

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2.1 Blue Light

Visible ray is a ray with wavelength between 380 ~ 780 nm bandwidth that is detectable by eye. Depending on the wavelength of each visible ray, human eye detects varying color for example 440 nm to Violet, 460 nm to Blue, 507 nm to Blue-Green, 530 nm to Green, 590 nm to Yellow, 600 nm to Orange, 650 nm to Red. Among these rays around 460 nm is referred to as blue light. Normally related to blue light prevention, short wave visible ray around 380 ~ 500 nm bandwidth including Violet and Indigo is noted as blue light [4].

Figure 1. Blue Light / Blue Light Detector Example

2.2 Arduino

Arduino is a open source computing platform and software development environment based on simple microcontroller board intended to create digital devices and interactive object that can detect physical stimulus and control interactions. Microcontroller is a mini computer executing certain functions through single chip made out of microprocessor and input/output module. Arduino includes all development method and environment related to microcontroller. Arduino was initially composed on Atmel AVR microcontroller but is now providing various board for each purposes and libraries with numerous functions [5].

2.3 Ultrasound Sensor

Ultrasound is a sound with frequency above audible limits. Healthy adult can hear up to 20kHz noise, therefore frequencies over 20kHZ that are not audible are referred to as ultrasound. HC-SR04 ultrasound sensor is consisted of receiver and transmission compartment, and ultrasound transmitted from transmission compartment is reflected out of an object to be recognized by receiver compartment. The time between transmission and reception is measured to calculate the distance. HC-SR04 can measure 2~400 cm with 30 degrees measurement angle.

2.4 Piezo Buzzer

Piezo Buzzer is a device that vibrates air using piezo effect and thereby creating sound. Piezo derived from ‘Piezo effect’ indicates electricity generated by pressure. Speakers or buzzers are made using this effect.

2.5 Blue light Measurement Module (TOCON_BLUE7)

It is a Housing blue light radiation detector that according to 2006 instruction detects blue light with minimum radiation of 4.2μW/cm2 and maximum of 43mW/cm2. Spectrum sensibility is 390 ~ 515nm and used for blue light measurement centered around 445 nm peak wavelength [6].

2.6 Bluetooth

Bluetooth is a short distance wireless communication technology standard for connecting and exchanging information among portable devices. It is normally used for super short distances when low energy wireless connection is necessary. Bluetooth wireless system utilizes frequencies between 2400~ 2483.5MHz which is Industrial Scientific and Medical(ISM). ISM is bandwidth allocated for industrial, science and medical use which does not require approval therefore widely used for short connection between personal wireless device [7].

3. BLUE LIGHT EXCESSIVE EXPOSURE PREVENTION SYSTEM

3.1 System Architecture

In this paper, proposes buzzer alarm activated according to users and screen distance measurement using distance measurement ultrasound sensor based on Arduino Uno board, piezo buzzer for alarms and blue light measurement module for blue light measure and also smartphone alarm system triggered by blue tooth communication when exposed to blue light for certain time. Figure 2 shows the system structure implemented in this paper.

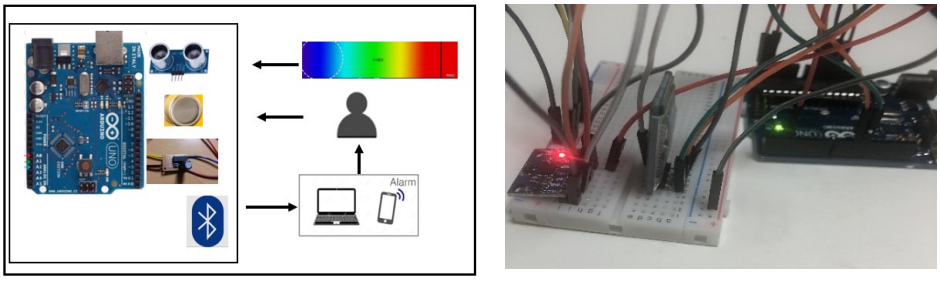

Figure 2. System Architecture & Implementation

3.2 Function of Each Configuration

Blue light sources from monitors, smartphones, televisions, etc. More specifically, blue visible light with wavelengths of 380 to 500 nm. It is often thought to be from the display of electronic devices, but blue light is literally blue light, and light scattered from the clear sky on a clear day is also blue light. The basic principle is that display panels basically mix red, green, blue, RGB, and light three primary color subpixel elements, and even if they are the same white, different white colors may appear depending on the mixing ratio of RGB.

The standard is a color temperature of 6500 K, and below this, colors appear mainly in long wavelengths such as red, and more than 6500 K, colors appear mainly in short wavelengths such as blue.

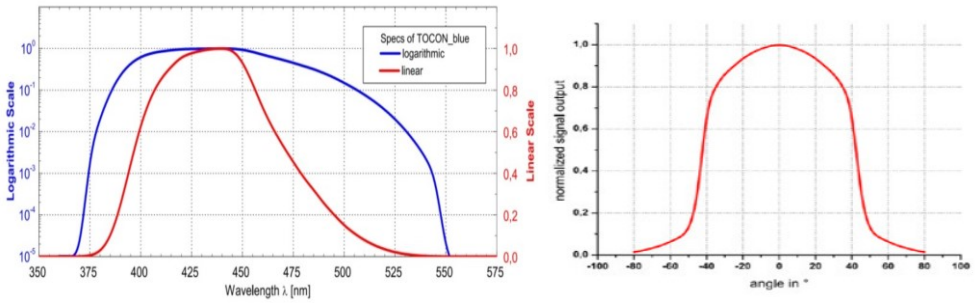

Figure 3. Blue Light Measurement & Measurement Angle

The blue light measurement module (TOCON_BLUE7) applied in this paper, it is possible to measure wavelengths between 390 nm and 515 nm, the peak wavelength is 445 nm.2.5 .... 5VDC power is used, and the output value depends on the power used. The Figure 3 is a graph showing the sensitivity of the sensor according to each wavelength. And it is a graph of the sensitivity of the product according to the measurement angle. Control algorithms that alarm user through piezo buzzer when monitor gets close with the user is as Figure 3. The degree of exposure of blue light varies by measurement angle. It shows the highest value at 0°, and it can be seen that it appears smaller toward the side.

```
#include "pitches.h"

void setup() {
  pinMode(trig, OUTPUT);
  pinMode(echo, INPUT);
  Serial.begin(9600);
}

void loop() {
  digitalWrite(trig, HIGH);
  delayMicroseconds(10);
  digitalWrite(trig, LOW);

  int duration = pluseIn(echo, HIGH);.

  int dis = duration / 29 / 2;

  if(dis<30)
    sound();
  else
    noTone(SOUND);
}
```

Figure 4. Distance Measurement Alarm Algorithms

Ultrasound sensor is able to detect between 2cm and 400cm. Under the algorithm, ultrasound sensor transmits 10us width pulse and converts pulse that returned into cm unit. If converted pulse is shorter than 30cm, piezo buzzer is programmed to alert.

```
#include <SoftWareSerial.h>

SoftWareSerial bluetooth(19, 18);

void setup() {
  Serial.begin(9600);
  bluetooth.begin(9600);
}

void loop() {
  if(bluetooth.available()) {
    char c = (char)bluetooth.read();
    Serial.print(c);
  }
  if(Serial.available() {
    char c = (char)Serial.read();
    bluetooth.write(c);
  }
}
```

Figure 5. Bluetooth Communication Algorithms

Figure 5 is a blue tooth communication algorithm using blue tooth module. During persistent smartphone use or monitor operation, blue light sensor keeps track of blue light exposure time and sends blue tooth alarm to user device for notification after certain cumulative time.

4. CONCLUSION

The relationship between blue light and health has not yet been clearly concluded, but in light of Korea's lighting and display environment, blue light blocking or appropriate filtering is necessary. This is because the color temperature of natural light is 5400-5800K, while the color temperature of smartphones, monitors, and LEDs, which are mainly used by Koreans, goes up and down 7,000-8000K, which is much higher than this, so there is a gap. At such a high color temperature, the color of things looks distorted, and the indoor atmosphere gives a cold feeling, which hinders comfortable rest, sleep, and reading.

This paper is proposing distance alarm and blue light exposure blue tooth alarm system powered by Arduino Uno board, ultrasound sensor, blue light measurement module and blue tooth module.

Smartphone being a necessity in modern society and with advance in IT, PC product will be widely used also leaving users more prone to blue light exposure. With products fused with blue light exposure system, users could use electronics in a much more safety and suitable manner in consistent with eye health.

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