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Colour Temperature based Light Ambience Control Application for Mood using Arduino

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Abstract

Normally, when a person moves from outdoor area having bright light to an indoor area with light of not similar brightness, it affects mood and also rhythmic activities within body. This paper presents the possibility of keeping the Mood consistent by implementing the Arduino based system to control the Colour Temperature of working space as that of ambient light. Here we have used high sensitivity, IR blocking RGB sensor to acquire ambient light. Colour Temperature thus obtained from RGB is sent through interfaced Arduino Nano controller. The range of 1000K to 10000K is considered for the study. These values are mapped for controlling pure white and warm white to glow LEDs similar to ambient light. General appearance of light is categorized in three forms viz. warm white, cool white and day light according to its varied Colour Temperature. The system was successfully implemented by varying Colour Temperature through different sources and mapped those values for glow of LEDs so as to maintain the light ambience. When the indoor light ambience becomes same as that of outdoor ambient light it helps to keep mood consistent.

Keywords: Arduino Nano, Mood, RGB Sensor

1. Introduction

As we know that human eyes can automatically adjust to different lights and CT (Colour Temperature) to sense the right colour but digital camera require adjustment to distinct lights for better colour reproduction. But in case a person enters suddenly within an area or room with varied light temperature than this may cause a drastic change in mood and it will also harm human eyes. Based on light therapy studies it is found that heart rate, circadian rhythm and mood are affected by different light wavelengths [1-2]. The reason behind this is that different light intensities stimulate the body to release varying hormones. Serotonin is released when high CT triggers and affects our energy level and mood. This is naturally occurring light from the sun during the day time referred to as blue light or a cool temperature. The short wavelengths in form of blue lights are the best to promote a positive environment and to increase productivity. Release of Melatonin causes relaxation and calmness with sleepy feelings because of low colour temperature [3]. Natural red light at the end of the day with low colour temperature is often called as warm light. To remain alert and active the right light colour at the right time of day is required which in turn helps to boost body's ability to calm down and relax when necessary. CT is considered as one of the most important parameter and if don't used in correct proportion results in ambience with colour different from the actual ones. The light spectrum that is radiated from a 'blackbody' is well described by CT to that of surface temperature. When attains one temperature it becomes red hot and when it is at higher temperature it is white hot. Likewise various blackbodies at distinct CT of white light contain uneven distribution of wavelength across the visible spectrum. Normally CT is a characteristic of visible light and is measured in Kelvin (K). More blue light or larger Kelvin value is observed when light having higher CT while smaller Kelvin value is observed when lower CT.

2. Literature Review

From the literature study we observed that many researchers in medical field have found the cause of Mood change due to change in CT. The mood is affected by Light in several forms: One is by direct modulation of the neurotransmitters like serotonin, a mood regulator, and other by training and stabilizing circadian rhythms, which addresses sleep disorders and desynchronisation of circadian rhythms [4, 5]. Study also reveals that the human pineal gland is also sensitive to shade of ambient light [6]. Researcher Plitnick and his team studied the impact of different visible spectrum wavelengths on measurements of mood transition at once, alertness, sleepiness etc. [7].

Table I, shows the CT values of various sources of illuminants. This reference is just to understand the colour temperature of the illuminants taken from different sources of light [8]. On heating blackbody radiate energy first in the infrared spectrum followed by visible spectrum in form of red, orange and bluish white at the end. Good example of blackbody radiators are Incandescent lights because due to heating of their filaments light is emitted.

Table 1. Blackbody Radiator Temperature for Various Illuminants

Colour Temperature (K)	Sources of Illuminants
1900	Flame of Candle
2000	Evening Sunlight
2800	60 W Tungsten bulb
2900	200 W Tungsten bulb
3300	Tungsten/halogen lamp
3780	Carbon arc lamp
5500	Skylight- Sunlight
6000	Xenon lamp
6500	Gloomy sky
10000	North sky light

As per the studies, intensifying emotions are because of brighter light, while steady emotions due to low light [2]. As shown in table 2, the CT and light appearance causes variance in ambience accordingly [9].

Table 2. Ranges of Colour Temperature and their Ambience

Colour Temperature (K)	Light Appearance	Mood Ambience
2000-3000	Warm White	Cosy, Calm, inviting, intimate
3100-4500	Cool White	Bright vibrant
4600-6500	Day Light	Crisp, invigorating

The incident light direction and ambience can alter room atmosphere and affect the way people feel in their room. Warm colour often evokes feelings of gladness, confidence and energy while cool colour express sadness though it is usually calm and soothing.

Considering light therapy idea, we attempt to design a system which keeps the person’s space as illuminated as the ambient light to keep the mood consistent. To govern the mood balance we tried to maintain CT of the space and ambient CT equal. The system is made to adapt the incoming light from the outside of the working area or premises. If a person enters the area with different CT it will not affect drastic change. Once the human eye and mood can adapt the light we can change the rate of light Kelvin gradually as per requirement.

3. Materials and Methods

The system consists of hardware and software. The microcontroller and RGB sensor are part of hardware while controlling action and mapping the values according to CT are based on programming through software.

3.1. Arduino Nano

The microcontroller used is Arduino Nano. It has property of portability, flexibility and compatibility. It is breadboard friendly Microcontroller board based on ATmega328p with flash memory of 32KB as modeled in Arduino Nano V3.x form. It has an operating 5V capability but the input voltage can vary from 7 to 12V, having digital pins 14, analog pins 8, reset pins 2 & Power pins 6. Multiple functions are assigned to each of these

Digital & Analog pins. When interfaced with sensors they act as input while driving some load they act as an output. Based on crystal oscillator of frequency 16 MHz and analog pins of 10 bits resolution measures the value from 0 to 5V. It comes with mini USB support. Tiny size makes this device an ideal choice for this application.

3.2. TCS34725 RGB Sensor

It is a Colour Sensor bsed on optical techniques. It has property of detecting colour in its peripheral environment. The digital return of Red, Green, and Blue (RGB) value is provided. IR blocking filter included makes it an ideal colour sensor for varied lighting conditions. It also include high sensitivity and wide dynamic range. Four ultra-bright LEDs substitutes external light sources. Because of its compact size and accurate light temperature control, its dynamic range provides very fast changes. Inbuilt SMD components are power efficient.

3.3. Software

The following are steps to run Arduino Nano.

- First step is to download the Arduino software (Integrated Development Environment). This enables run Windows Installer and follow the pop up instructions.
- Connect Arduino Nano board to a computer. Here finding of proper Arduino driver by Windows automatically. After installing Nano board is ready to use.
- Launch the Arduino application.
- Selection of appropriate board. - select Tools > Board > Arduino Nano / Atmega328.
- Selection of proper serial port is must, for that go to Tools than select Serial Port. The port number COM3 or higher is selected. To check out, first remove Arduino board and re-open the menu. If the the entry disappears it confirms. Reconnect the board and select that serial port.
- Next step is to upload the program to Nano board.

On clicking the “Upload” button wait for a few seconds. Observe the flashing of RX and TX LEDs on board. On successful uploading the message appears as “Done uploading” on status bar. Pin 13 LED on the board start to blink after few seconds of upload. This makes Arduino ready to use.

3.4. Hardware Integration

With 12V dc supply, this circuit uses two SMD LEDs as shown in Fig.1, D5 and D6. Opto-couplers V01 and V02 are at the input section for the safety purpose. Arduino, PWM pin 5 is attached for warm white temperature and pin 6 is for pure white temperature for respective glow. We use RGB Colour Sensor - TCS34725 with IR filter to sense the ambient light and with four White LEDs inbuilt. A4 and A5 are analog input pins through which sensor input is acquired. As ambient light falls on the RGB sensor it activates and sends the signal to the Arduino Nano. It fetches the colour temperature data through the sensor from ambient light. These CT values range in 1000K to 10000K are recorded as 0 to 1023 values through Arduino Nano. Later these values are mapped as warm white and pure white brightness levels ranging from 255 to 0 and 0 to 255 respectively for LEDs. This way the combination of warm white and pure white LEDs are governed by Arduino Nano controller for the luminance of LEDs to keep the space illuminated in coordination with the ambient light.

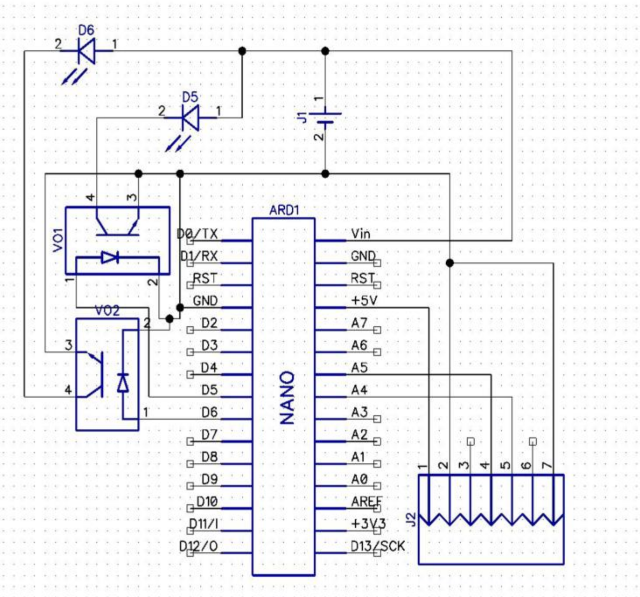

Fig. 1. Connection diagram of Arduino Nano with RGB Sensor

3.5. Flow Sequence

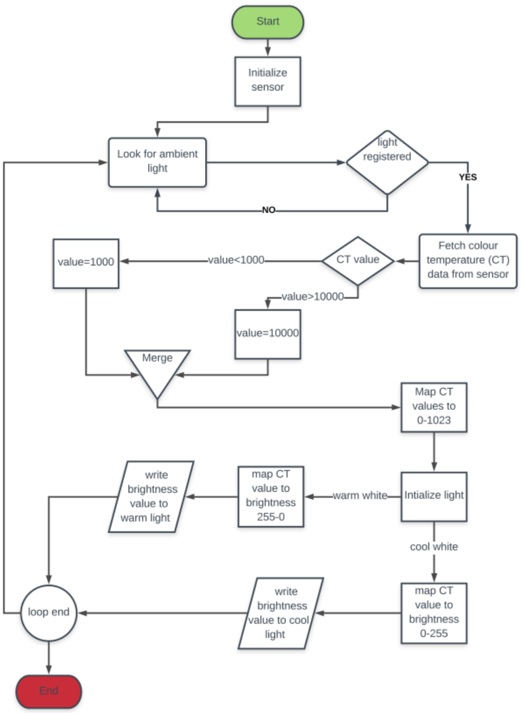

Fig. 2. Flow of RGB Sensing and controlling process

As shown in flow diagram in Fig. 2, at the initiation controller checks for interface connectivity and initialize sensors. It looks for ambient light which measures CT values. The range set for CT is from 1000K to 10000K Arduino records it in the range of 0 to 1023. These values are then mapped to control the brightness levels of LED from 0 to 255 as cool white and 255 to 0 as warm white. Loop continues till the ambient lights colour temperature changes. This is the way in which RGB sensed ambient light CT values can be used to control brightness levels of LEDs similar to ambient light.

4. Experimental Setup

The Fig. 3. shows setup which is used to perform the brightness level control based on Colour temperature variation.

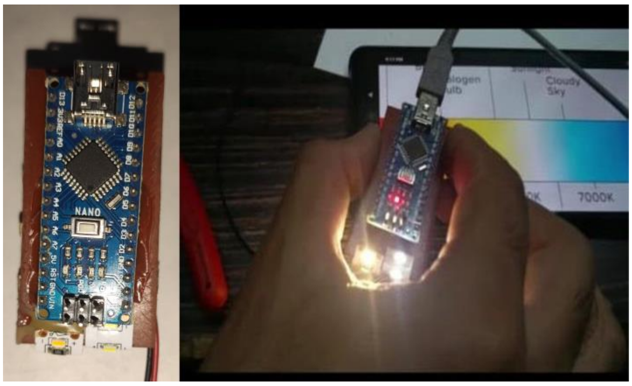

Fig. 3. Arduino Nano circuit connection and Status of the circuit ON with brightness level

5. Results and Discussion

Standard illuminant sources are used to check the sensing ability of RGB sensor and accordingly Light appearance as an output of LED. Table 3 shows the pure white and warm white values corresponding to colour temperature. This is the result of sensed CT and mapped through controller for balancing the combination of pure white and warm white values to set LED brightness. To determine the condition, mapped values for PW (Pure White) and WW (Warm White) are calculated considering the range of 1000 to 10000 with following equation:

$$PW = \frac{(CT - 1000) * 255}{9000} \quad (1)$$

$$WW = 255 - PW \quad (2)$$

It is observed that the light appearance due to this constructed system is in accordance with values that are mentioned in table 2, of blackbody radiator temperature for various illuminants. The representative picture of Light appearance is shown in Fig. 4. This shows the difference of appearance in accordance with CT values within a picture. Thus these lights have their own characteristics which affect mood, heart rate and circadian rhythm. Thus with this system we are able to control the CT of room space with the ambient light which in turn can facilitate the Mood consistency for happier life and efficient working ability.

Fig. 4. Visual representation of CT variations

Table 3. Output Appearance of Light through Mapped Values Corresponding CT

Input to Sensor (Source)	Colour Temperature (K)	Mapped Value PW	Mapped Value WW	LED Light Appearance
Candle Light	1900	26	229	Warm White
Halogen Lamp	3300	66	189	Cool White
CFL	5000	114	141	Day Light
Sun Light	5500	128	127	Day Light

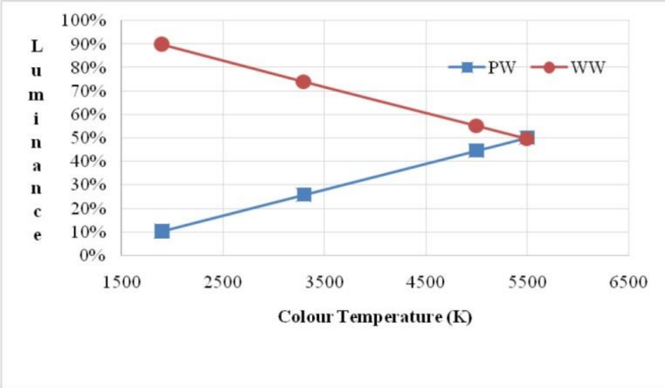

Fig. 5. Colour Temperature (K) vs Luminance (in %).

The graph in Fig.5 shows correlation between CT and percent luminance. An increase in colour temperature increases PW values from about 10.2 % luminance towards 50.2 % while WW decreases proportionately from 89.8 % to 49.8% of luminance. This is the way in which balance is established between two white lights (PW and WW) to fulfill the input variations generated corresponding to CT.

6. Conclusion

Light can affect mood in several ways. As we understand that lower the CT in Kelvin the warmer colour of the light and conversely, higher the CT in Kelvin cool colour of the light. Our objective was to keep the colour temperature of the room space in accordance with current light temperature as at the outdoors. This was successfully implemented and achieved by varying CT through different input light sources. Correspondingly different CT values were mapped for PW and WW combination of LEDs. This is in turn maintaining the brightness level of light ambience of indoor space. This system is easy to install and effective for Mood consistency..

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