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Research Paper Subject

Microcontroller Driven RGB Led System For Tristimulus Surface Colorimetry

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ABSTRACT

This paper reports a Microcontroller based RGB LED system for tristimulus surface colorimetry. The intensities of Red, Green and Blue LED sources are adjusted and controlled by using microcontroller. Corresponding light intensity from a reflecting surface is detected using photo detector. The care has been taken to normalize the response for the spectral characteristics of the photo detector. The reflectance for the colored surface is measured as ratio of reflected intensity to the emitted intensity. After knowing the reflectance for the three stimulation sources, these values are input to a program to calculate chromaticity coordinates. These chromaticity coordinates serve as the measure of surface color. The system has been tested for measuring the surface color of different craft papers and the chromaticity coordinates of the surface are also reported under different illuminated conditions.

Keywords : Colorimetry, chromaticity diagram, microcontroller, photo detector

Introduction:

Colorimetry is a physical science that deals with objective and quantitative ways of describing color. Since the impression of color is something subjective what one person perceives as "light blue" may look "medium blue" to another it is not quite clear how to describe and identify different colors. Colorimetry tries to connect the notion of a standard color sample with the physical concept of light as a form of energy. [1]

It is thought that the retina of the human eye has three kinds of color sensors or cones with peak sensitivities for red, green and blue light. [2,4]. This tristimulus theory is attractive since it allows us to think of color as a positively weighted sum of the primary colors red, green and blue. It turns out that large number of colors can be reproduced by mixing red, green and blue color lights with proper proportions.

Trichromatic theory of Young and Helmoltz [2] gives very important additive process for the color formation using three light stimuli Red, Green and Blue based on the ability of human eye to respond the colors. Colorimetry is the technique used by which an unknown color is evaluated in terms of known colors. Colorimetric method find use in general laboratory work as well as in specialized applications like blood analysis, food detection of agriculture product, textile industries, paint industries etc. Identification of colors is possible by visual inspection. However the visual colorimetry is not used often because of poor resolution and less accuracy due to defective color perception of human eye. Photoelectric colorimetry is very accurate having good resolution and better sensitivity than visual colorimetry. This paper reports measurement of reflectance of colored surface with micro controller driven RGB LED's and by simulation to find chromaticity coordinates.

Experimental Setup:

The main aim of presented work is to control the intensities of the RGB LEDs in proper steps with proper selection of LEDs. FigFor this purpose, Microcontroller 89c51 is used. The block diagram is as shown in the figure 1(b), consists of Microcontroller (IC 89c51), three 8 bit DACs (IC 0808), quad opamp (LM 324) and RGB LEDs. Using assembly language program, the counter is set in desired steps, whose output is given to different ports to drive DACs. Three DACs are used to drive R, G and B LEDs. The DACs are interfaced to three different ports, Port 0, Port 1 and Port 2. The output current of DAC is then converted into voltage such that maximum 10V output is obtained. This output is given to drive LED with the current adjustment facility. The series resistor is made variable to control the current through LED. To select one of the three LEDs, the facility is provided using two switches S2 and S3. According to the truth table (shown in table 1), the required DAC will be selected. In the program the counter is set whose contents can be increased or decreased maximum in 10 steps. The step level can be changed according to the need of application to increase the accuracy and change in intensity of corresponding LED. Two switches S0 and S1 are used for increase and decrease the intensity counter respectively. Switch S0 is connected to interrupt INT0 used for increment the counter and Switch S1 is connected to interrupt INT1 used for decrement the counter. Thus using Microcontroller LED intensity can be increased or decreased in desired steps, and also proper LED can be selected.

Block Diagram of Microcontroller based LED Driver:

Fig : 1(a) experimental setup

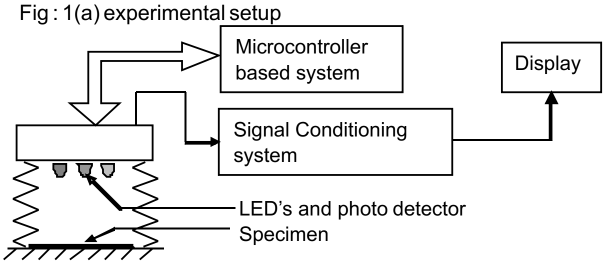


Fig 1(b) Block diagram of microcontroller based LED drivers

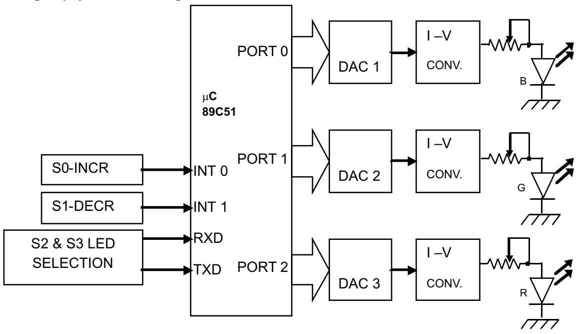


Fig 1(c) Block diagram of signal condition unit

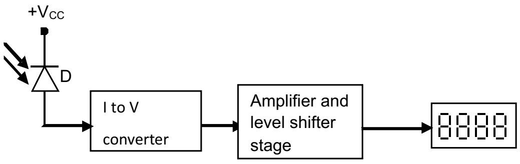


Table 1: Truth table for LED Selection:

S2	S3	LED Selection
0	0	RED
0	1	GREEN
1	0	BLUE
1	1	---

The position of RGB LEDs is fixed at the vertex of the triangle. At the center of the triangle photo detector is mounted at position such that light from LEDs will not fall on the photo detector directly. The light is made to fall on the target surface from suitable distance. The reflected light is then detected with photo detector. Mirror is used as a target surface for initial adjustment. The detected reflected light gave different readings for different LED sources for the same target surface hence spectral response of detector is required to be adjusted to get same detected output for all LEDs.

Photo detector Spectral response Normalization:

Since the photo detector gives different spectral response to different wavelengths, it has to be normalized. For normalization purpose, first perfectly reflecting mirror is taken as the target surface. It is illuminated by different colored LEDs separately and then reflected light is detected. For different colored LEDs, the detected output found different. So, by properly adjusting the intensities of LEDs, the final reflected light from the mirror is detected and it is made equal for all the colors using potentiometer after I to V converter. Thus the spectral response of detector is normalized.

By applying constant normalized intensities of LED to the target surface, the reflected light is detected using photo detector. The target surface is replaced by different colored craft paper and detected output is measured.

Theoretical Background:

The three CIE standard weights can be calculated by using following equations.

$$X = \sum_{380}^{780} R(\lambda)E(\lambda)\bar{x}d\lambda \quad Y = \sum_{380}^{780} R(\lambda)E(\lambda)\bar{y}d\lambda$$

$$Z = \sum_{380}^{780} R(\lambda)E(\lambda)\bar{z}d\lambda \qquad (1)$$

Where R (λ) is surface reflectance and E (λ) is light source distribution.

The weights X, Y, and Z define a color in the CIE space.

X+Y+Z=1

The result is a 2D space known as the CIE chromaticity diagram. The co-ordinates in this space are usually called x & y and they are derived from XYZ using the following equations:

$$x = \frac{X}{X+Y+Z} \quad y = \frac{Y}{X+Y+Z} \quad z = \frac{Z}{X+Y+Z} \qquad (2)$$

$$x + y + z = 1 \quad i.e. z = 1 - x - y \qquad (3)$$

Procedure:

Place perfectly reflecting mirror as a specimen and set the potentiometers P1, P2 and P3 so that LEDs will give light radiation of required intensities to get equal reflected output reading to compensate for the variations in the sources as well as detector's spectral response.

Measure outputs for different individual intensity settings and store them as mirror readings. Replace mirror by specimen and note the reflected readings. Take ratios of the specimen reading and the corresponding mirror reading, which will be used as reflectivity of the surface for the corresponding source wavelengths. Obtain R () using interpolation/extrapolation. Find chromaticity coordinates x, y of the specimen surface using above equations (1), (2) and (3).

Plot them on chromaticity diagram and quantify the surface color. The flow chart of the presented work is as shown the fig (2).

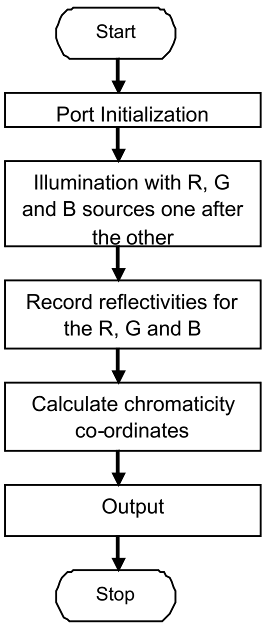
Results and Discussion:

The developed instrument was used to obtain Chromaticity co-ordinates of different colored craft papers. The reflectance data recorded with different LED sources is given in table 2.

Table 2: Reflectance for LED source

Obs No.	Reflecting surface	Reflectance for LED Source		
		R	G	B
1.	Mirror	1	1	1
2.	Red Craft paper	0.148	0.060	0.028
3.	Green Craft paper	0.034	0.056	0.040
4.	Blue Craft paper	0.038	0.082	0.086

Fig.2 Flow chart



These observed values were used for obtaining R () over the visible range. Further, by assuming a perfect white light illumination i.e. I ()=1. The chromaticity co-ordinates were calculated using a program written in C++. This program uses the CIE standard chromaticity functions and compute the chromaticity co-ordinates using equations (1) to (3).

Table 3: Chromaticity co-ordinates under red, green and blue illuminations

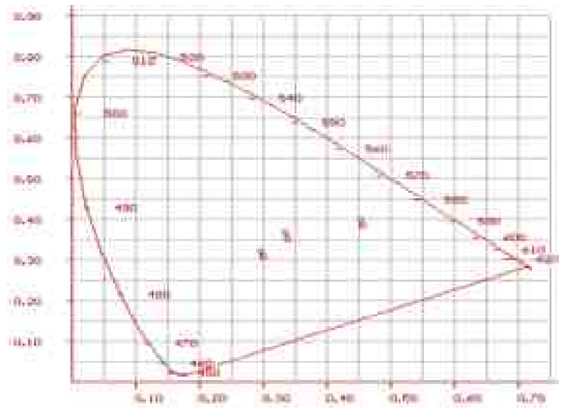
Surface Color	Chromaticity Co – ordinates for illuminant							
	White		Blue		Green		Red	
	x	y	X	y	x	y	x	y
Blue	0.296441	0.381214	0.147531	0.046703	0.24770	0.732838	0.705874	0.294926
Green	0.33553	0.36586	0.146483	0.048627	0.248849	0.732046	0.706345	0.293655
Red	0.452121	0.398854	0.144726	0.051851	0.25260	0.729080	0.707874	0.292126

Table (3) shows the chromaticity co-ordinates obtained for the craft papers under observation. Mapping these on the chromaticity diagram, as shown in fig. 3 indicates that the paper has a specific color but has substantial amount of whitish component. This is confirmed further by studying the chromaticity co-ordinates under red, green and blue illuminations. The observations show that though there is a slight difference in actual co-ordinates as per the original paper color, the final observed color strongly depends on the illumination source. Thus utility of the instrument is proven.

It is expected that, this microcontroller-based instrument will be suitable for surface color measurements, irrespective of surface texture and illumination level.

Fig. 3 Chromaticity diagram

Blue, Green & Red paper is illuminated with white source



REFERENCES

Kirk Othmer, “Encyclopedia of Chemical Technology”, Volume 5, 2nd edn, Interscience Publishers, 1964, Color and Constitution of Organic Dyes, pp763-765, Colorimetry and Fluorometry pp788-795, Color Measurement pp 809-811. | S.P. Bali, “Color Television Theory & Practice”, Tata Mc Graw-Hill Publication, 1994, ch.1, pp1-12. | “Mc Graw-Hill Encyclopedia of Science and Technology”, Volume 4, 7th edn, Mc Graw-Hill, 1992, Colorimetry, pp 158-159. | “Improved Matrix Method for Tristimulus Colorimetry of Displays”, Paper presented at AIC Color' 97, Kyoto, May 26th30th, 1997 by Yoshihiro Ohno and Jonathan E. Hardis. | S.T. Henderson and A. M. Marsden, “Lamps and Lighting, A Manual of Lamps and Lighting”, Edward Arnold Publishers, 1975, chapter 3 and 4, pp 45-87.

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