Annals of the Academy of Romanian Scientists
Series on Physics and Chemistry Sciences
ISSN 2559-1061 Volume 2, Number 1/2017

COLOURS IN LIGHTING SYSTEMS

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Abstract. *Starting from idea to have reduced energy consumption, the project has been developed by using LED technology (Light Emitting Diode). Further on, the paper aims to develop a lighting system with color temperature control, and respectively lighting level control The purpose of this study is creating a prototype for one indoor and outdoor industrial lighting system, and also implementing characteristics useful for medical applications.*

Keywords: RGB LED, LabVIEW, Cypress, Philips

1. Introduction

"For humans, light not only means receiving visual information, it also has non-visual effects. In the cause of evolution, regular alternation of the day and night had become the basic impulse, which controls biological processes in the human organism. It's a biological clock, which activates the body during the day and reduces its activity at night."[1]. Therefore, light plays an important role in human life and especially in its daily comfort. Since the development of cities and the construction of specially-designed spaces, such as: hospitals, schools, houses, etc., light also had to be adapted and dedicated to their needs. Hence, light characteristics in terms of intensity and the resultant of the combination between natural and artificial light have become major concerns on the specially-designed habitat [4]. Lighting spaces by maintaining approximately constant characteristics within the entire working or reference surface has always been a challenge. From the point of view of light intensity within an indoor space where also natural light comes in, within most of the cases, sensors were used to adapt darker areas to those that had better lighting. According to "Intelligent Lighting System Using Wireless Sensor Networks", in terms of color temperature, this was not possible by using ordinary artificial light sources (incandescent light bulb, neon lamp, etc.) [6].

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If we monitor the factor, color temperature, we notice that adapting to natural light is not necessarily important, but probably how this factor influences our perception on the surrounding environment and, last but not least, how it influences the mental state of the human being.

In the research “The effect of sunlight on post- operative analgesic medication usage” [8] is clearly described how the influence of the sun can improve the capabilities of the body of faster heal.

More than that according to “Color, Harmony, Comfort” [2] the effects of colors have are in direct connection with the physiological and psychological of human state (see Table I).

Table 1. Physiological and Psychological Effects of Colours

Colour	*Physiological Effects*	*Psychological Effects*	*Psychological Explanation And Affective Resonance*
Red	Increases blood pressure. Increases muscle tone. Activates breathing. Calorific effect.	Very warm, vivid and dynamic colour. General stimulant: irritating, provocative, stimulates to action especially at psychomotor level. Intellectual stimulant. Disquieting. Sensation of closeness in space. Activism, mobilization, associative affluence, closeness.	“Will power” Active, Eccentric, Offensive-Aggressive, Autonomous, Locomotive, Competitive, Operative, Desire, Dominance.
Orange	Accelerates heart rate. Maintains blood pressure. Helps gastric secretion and digestion.	Optimism, joy. Very warm colour, emotional stimulant, strong sensation of closeness. Sociable colour. More active than yellow. Sensation of wellbeing and optimism. In excess and covering large surfaces it may seem gushy and irritating.	“Will power” Active, Eccentric, Offensive-Aggressive, Autonomous, Locomotive, Competitive, Operative, Desire, Dominance.
Yellow	Stimulates the optic nerve. Influences the normal functioning of the circulatory system.	Warmth, intimacy, satisfaction, admiration, refreshing. Warm and dynamic colour. The most joyful colour. Stimulates sight. Calming effect in psychoneuroses. Sensation of closeness in space. Stimulates and maintains vigilance, increases attention focusing and mobilization capacity. Increases communication.	“Spontaneity” Eccentric, Active, Projective, Heteronomic, Effusive, Aspirational, Investigative, Variability, Expectancy, Originality, Joy.
Green	Decreases blood pressure. Dilates capillaries.	Tranquillity, good mood, relaxation, medication, balance, contemplation. Cold, nice, easeful, relaxing and calming colour. Sensation of freshness. Helps calm nerves. Sensation of distance in space. Conveys security and introspection.	“Will elasticity” Focusing, Passive, Defensive, Autonomous, Restrained, Possessive, Lasting, Persistency, Boldness, Abstinence, Self-assessment.

Blue	Decreases blood pressure. Decreases muscle tone. Slows down breathing and heart rate.	Very cold, relaxing and calming colour. Induces calmness and relaxation. Helps find focus and inner peace. In excess it leads to depression. Seriousness, tendency to evoke, spaciousness, indulgence, peace, yearning, nostalgia. Stimulates development of inhibition and action rhythm slow down processes. Sensation of distance, timelessness and meditation.	Deep experiences and feelings. Concentric, Passive, Sensitive, Perceptive, Unifier, Peace, Satisfaction, Tenderness, Love, Affection.

A very common situation which particularly photographers and videographers face is poor lighting conditions.

They use various methods to bring additional light to the frame they want to capture.

In most cases, the problem is solved by filling the frame with the help of an artificial light source, often having a single colour temperature.

But the critical moment occurs when the artificial light source is highly different than the natural one, in terms of colour temperature.

This scenario appears when photographers capture a sunset (colour temperature of 9000 Kelvin degrees) in the background, the subject being in front.

As illustrated in Fig. 1, the most handy solution is artificial light, with a colour temperature around 3000 (K), originating from incandescent light sources.

This solves the problem of light level, but from an artistic point of view, the combination of light temperatures lighting the subject does not always reflect the photographer's vision on the captured frame.

This project intends to solve the challenge, by creating a simple and easy to control system, adaptable to any environment (indoor or outdoor) and to any person, more or less experienced.

2. Experiments

2.1. Preliminary tests

Preliminary tests on creating a LED lighting system with adjustable frequency feature were carried out using a circuit of three LEDs (embedded in a RGB LED), manually controlled in the current.

The analysis of the issued radiation was carried out with a Spectrum Analyzer with Optical Fiber (FO), AVANTES AvaSpec-2048-type, controlled from a computer, by means of an USB, AvaSoft 8.0 software and/or an application developed in LabVIEW.

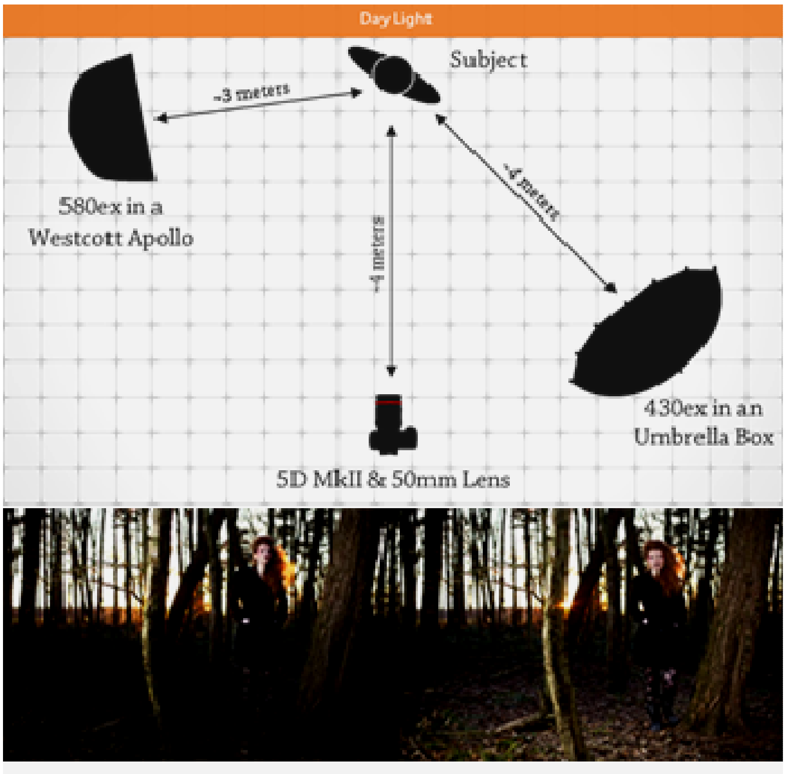

Fig. 1 illustrates a photo frame example.

Fig. 2 illustrates the software interface of AvaSoft 8.0 and the overlapping of the three spectra from the RGB LED.

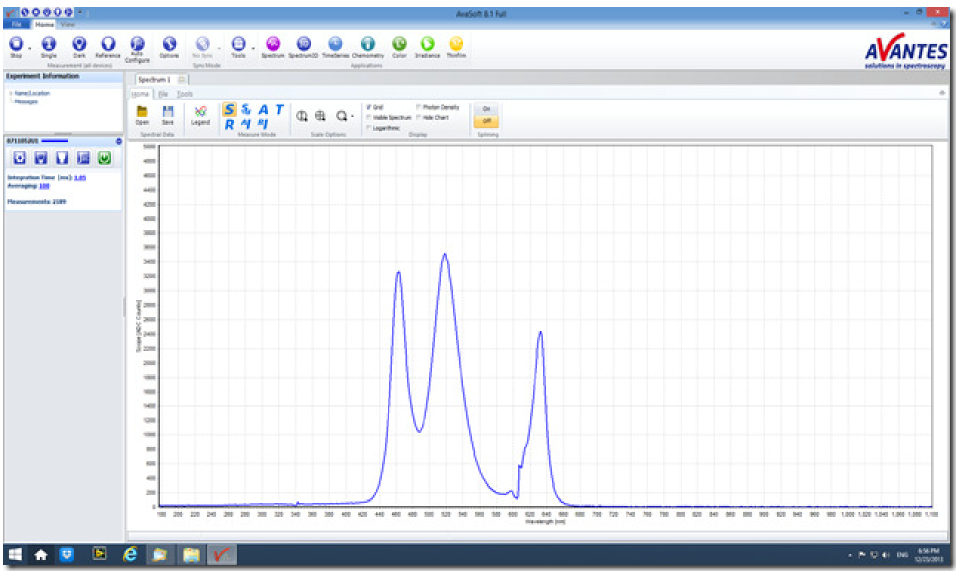

Fig. 2. Overlapping of the three spectra RGB LED.

For preliminary tests, the control of a current with constant LEDs was carried out by using three voltage channels supplied by the Digilent Explorer board (Power Supplies), easy to control in the Digilent WaveForms software (Fig. 3).

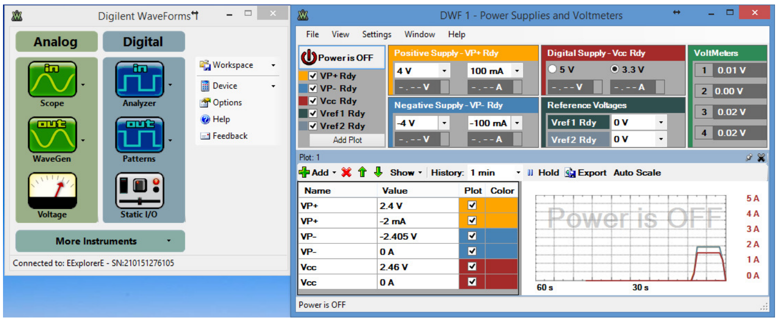

Fig. 3. Power Supplies control with Digilent WaveForms software.

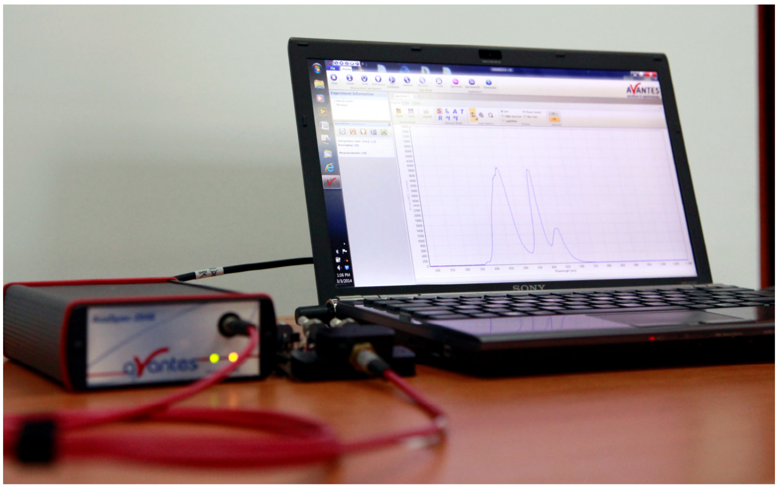

Fig. 4. Preliminary tests with RGB LED and AvaSpec-2048 spectrometer.

2.2. **First prototype**

After such preliminary tests, a projector comprising of 9 blue LEDs, 4 red LEDs, 4 green LEDs and 4 white LEDs as built.

The adequate choice was made by measuring relative light intensities – which imposed selecting the number of LEDs and their relative position in the experimental projector.

For this new system, the tests for various current intensities were retaken by various LEDs and the resultant frequency characteristic was investigated with the mentioned AvaSpec-2048 spectrometer.

Fig. 5 shows this experimental arrangement. The projector uses a Fresnel lens with zoom ×3 in the focal point where the 21 LEDs are positioned.

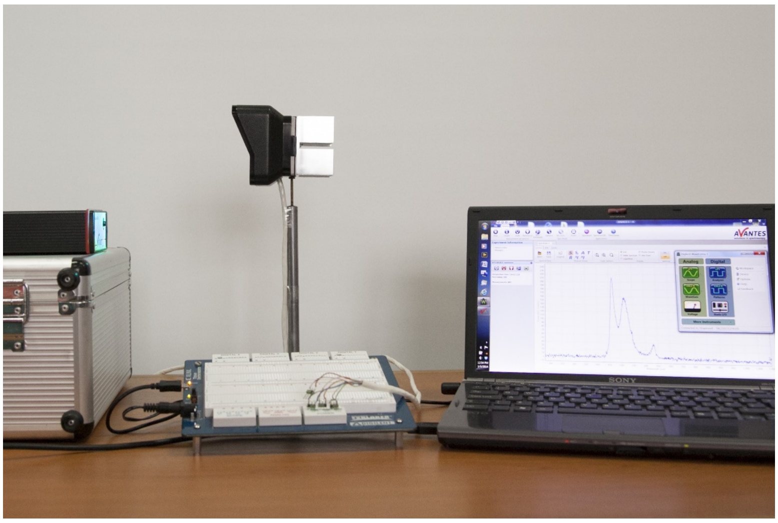

Fig. 5. Prototype - overview

The LEDs were positioned on an experimental board fitted with a correctly-sized thermal heat sink.

In order to estimate the spectrum of a particular LED combination with light emission at various frequencies (shown in Fig.6) one LabVIEW application was developed for spectrometer control and spectra recording.

Fig. 6. Light combination.

Later on we can pass from manual control to automatic control by developing a means of control and automatic fixation of the current by various LEDs. The resulting spectrum shall be recorded in a database that will be used later on for the LabVIEW simulation of the final spectrum.

These operations have been carried out by using as control means the Digilent Explorer system and the corresponding WaveForms software. The results have been used in the LabVIEW simulation.

Fig. 7 illustrates LabVIEW control of the AvaSpec-2048 spectrometer and the spectrum corresponding to a certain excitation current for the LED, included in the LabVIEW simulation.

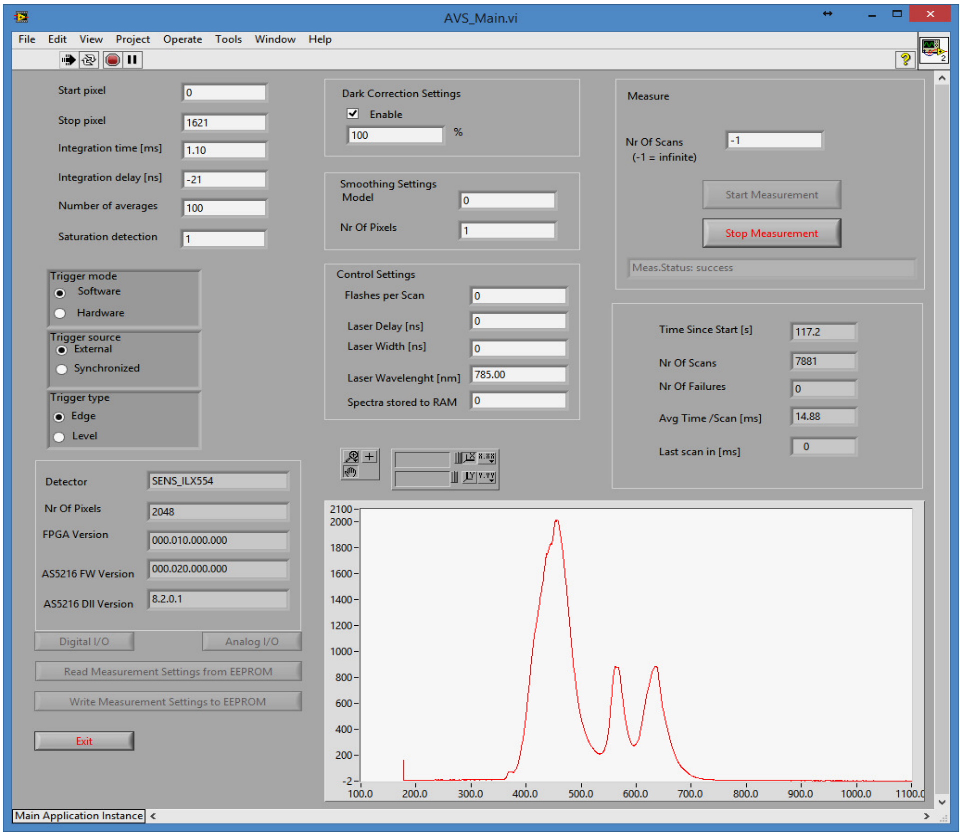

Fig. 7. LabVIEW.

2.3. **Control**

From the point of view of control a system was created using PSoC (Programmable System-on-Chip) from Cypress. This system has been conceived using the development module CY3268 PowerPSoC Started Kit (Fig. 8).

Fig. 8. General view of Cypress PsoC.

Being a system implemented on one single chip, Cypress offers PsoC Designer, an environment for implementing the interconnect diagram and the programming code. In this case, we have interconnected each of the 4 LEDs with CapSense sensors, available on CY3268 PowerPSoC Started Kit, and we used CapSense sensors for intensity control (Fig. 9 - Interconnect Diagram). From the point of view of the programming code, we have created an algorithm that gradually controls the intensity of each led thus creating a controlled dimming. We have set the increase level to 10% at each phase, by touching the dimming CapSense sensors above mentioned. Thus, by touching the CapSense sensors afferent to the led we want to control once, the LED is selected and by touching the dimming sensor several times we increase the led intensity (the highest level reached is when touching the dimming sensor the 10th time, and then the led resumes its cycle starting with first one). This way of controlling the 4 LEDs offered us a much better picture on the combinations of spectra which may be obtained by colour variation and intensities. In our future developments we intend to use PSoC technology from Cypress to create a control system, using also other LEDs scales [5].

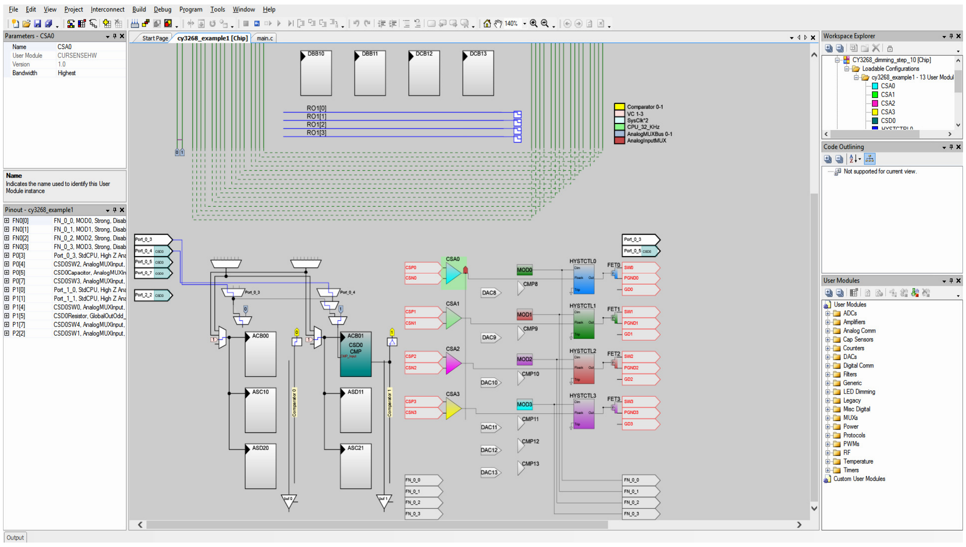

Fig. 9. Interconnect Diagram.

2.4. **Future tests**

In our next experiments the LEDs scale LUXEON will be used, more precisely LUXEON Z Red, LUXEON Z Green, LUXEON Z Blue, LUXEON Z Lime, LUXEON Z Amber, LUXEON Z 5000 (K), LUXEON Z 2700 (K), LUXEON Z 3000 (K), LUXEON Z 6500 (K).

Conclusions

The system has passed the preliminary tests using four categories of LEDs (R, Y, B and white).

The frequency feature for various LEDs at various lightings (according to the current going through the LEDs) may be purchased in the developed LabVIEW application and may be used for the simulation of certain frequency features required by the type of application for which we develop the lamp (homes, health care premises, photography, museums, etc. lighting).

Upon examining the literature in the field and the features of various categories of LEDs we have selected for future development the LUXEON Z category of LEDs from Philips.

Acknowledgment

We thank Philips for supporting the development by offering the necessary LUXEON Z LEDs to the Creativity Lab.

We thank Steinel Romania for their support and documentation.

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