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ENVIRONMENTAL-SMART LIGHTS

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RESUMEN

El observar una pantalla de computadora por largos períodos de tiempo demanda un esfuerzo en los ojos. Esto puede producir fatiga ocular. Al estar en un lugar oscuro los ojos tendrán que adaptarse constantemente a un entorno de colores muy cambiante. Con la luz trasera en un monitor se suaviza la distribución de la iluminación sobre el plano en el que se fija la visión. Al producir cambios menos bruscos en la intensidad de la luz se fuerza menos la vista. El cansancio se puede reducir entre 60 y 90%. En este trabajo se muestra un sistema de luz ambiental inteligente capaz de reproducirse en el fondo del monitor, los colores que aparecen en el borde de una pantalla. Con este proyecto no solo se pretende ayudar a la decoración de cierto lugar sino también a disminuir la fatiga visual al pasar mucho tiempo frente a un monitor.
Palabras Clave: *Ambilight*, LED Strip Lights, *Prismatik*.

ABSTRACT

Looking at a computer screen for lengthy periods of time produces strain on the eyes. This can cause eye fatigue. Being in a dark place, the eyes will have to constantly adapt to an environment of highly changing colors. With the rear light on the monitor, the distribution of lighting on the plane in which the vision is fixed is softened. By producing less sudden changes in the intensity of the light, the view is less strained. Tiredness can be reduced between 60 and 90%. This work shows an intelligent ambient light system capable of reproducing the colors that appear on the edge of a screen in the background of the monitor. This project is not only intended to help decorate a certain place but also to reduce visual fatigue when spending a long time in front of a monitor.
Keywords: *Ambilight*, LED Strip Lights, *Prismatik*.

1. INTRODUCTION

In recent years, the use of screens has been growing due to the entry into the market of smartphones and other electronic devices. In turn, digital entertainment in the form of movies, series or video games is increasing[1]

In the last five years, the Mexican Internet user population increased by 72%, according to INEGI, 22 million people have joined the Internet [2].

Internet users reached 84.1 million in 2020, the year the Covid-19 pandemic began, which is equivalent to 72% of the population, according to data released by the National Institute of Statistics and Geography [3].

The National Survey on Availability and Use of Information Technologies in Homes (ENDUTIH) 2020 revealed an increase of 1.9% points compared to 2019, where 70.1% of those over the age of six used the internet, that is, 80.6 million people [3].

According to the Federal Institute of Telecommunications (IFT) through the National Survey of Audiovisual Contents (ENCCA) 2019, in Mexico, people consume an average of 2.5 hours of open TV and 3 hours in internet video platforms daily [4].

In addition, it must be distinguished that looking at a screen (computer, tablet or intelligent phone) is different from reading printed pages and usually requires the eyes to work more. The family of eye and vision problems that arise from excessive screen use are known as Computer Visual Syndrome (CVS) which is a multifactorial syndrome that affects not only the eye, but also the musculoskeletal system, the circadian rhythms, the behavioral and sleep patterns, the social lifestyle, the occupational performances and the public health [5].

Glare and reflections, low contrast, and poor definition make text hard to read. The way you interact with computer monitors and digital “pages” is different than when you read and write on paper. All this extra load can cause eye problems or aggravate existing ones.

Watching TV with the light off or using a computer without any point of light in the room, can damage your eyesight.

Eye and vision problems that arise or worsen with computer use include [6]:

a) Blurred vision
b) Dry and irritated eyes
c) Eye strain
d) Headaches

The eye is an organ that adapts to the light it receives and has two mechanisms that constantly work to be able to see the world around it correctly.

One of the mechanisms is the retina. It is the most sensitive part of the eye, that is why it is not visible, but is inside it, protected by the iris and the pupil. In the retina are millions of light

receptors, dynamic and adaptable to the conditions of life. If you are normally in environments with a lot of light, the cells will lower the sensitivity to prevent excess light from being harmful. In dimly lit environments, cells will strive to increase sensitivity. For this reason, when you spend some time in the dark, you are able to perceive visual stimuli that were previously invisible (in the first seconds of exposure to the dark). Once this is explained, it is easier to understand why it is bad to watch television or the computer with the light off [7].

Another mechanism is the iris. It is the one that gives color to the eyes, which apart from fulfilling this task is also a diaphragm that opens and closes depending on the light that enters it. It can be seen in the black dot in the center of the eye, the pupil. The smaller it is, the more closed the diaphragm is: a sign that there is a lot of light in the environment, and it does not need to be more open. The opposite happens when light is very dim [7].

The eyes are placed in a contradiction and on effort, an intense light stimulus is received from a small part of the visual field (the screen), while the rest of the field, the vast majority, is completely dark. This makes the eye want to adapt the iris and light receptors to the intense lighting of the screen and, in turn, to the extremely poor lighting of the environment. The brain understands that it is in a dark environment, even though it is concentrating its eyes on a very bright point, so it sends the order to increase photosensitivity, the diaphragm opens and that is when the eye fatigues [7].

Viewing screens in the dark will not cause permanent damage or visual loss, but it will weaken the mechanisms of the eyes, causing eyestrain, tiredness and even symptoms such as headaches, tearing and blurred vision. As is known, television affects vision temporarily, causing eye fatigue, especially if you are in a dark place, since your eyes will have to constantly adapt to the colors. The pupils continually dilate and contract to adapt to the environment lighting, if it is very changeable, visual fatigue occurs [9].

The way to avoid this is as easy as turning on a small light that provides indirect illumination, which will go unnoticed, but it will be enough so that the peripheral field of vision is slightly illuminated, and the eye is not overloaded.

With the rear light, the distribution of lighting on the plane in which the vision is fixed is softened, by producing less abrupt changes in the intensity of the light, the view is less strained. Depending on the content, fatigue can be reduced by 60-90% [10].

Another advantage of this system is the quality of the vision, since it helps to better perceive the black scales, especially at night, since these lights can only be used on low light occasions, this will help not only to set the mood room, but to better the images quality . The light coming out from behind the TV does not match the image, a problem that usually occurs with common room lamps.

The research of [11] defines ambient light as “is a general light that is previously present in the scene, before any supplementary light is added, illuminating a particular area and thus providing a satisfactory intensity of brightness without glare”. Display backlighting is a promising technology that provides a solution to eyestrain caused by watching TV in a dark environment.

Philips® conducted a study with several people who were introduced to the benefits of Ambilight, many refused to believe that it would change anything [12].

Ambilight devices have a little-known technology, which consists of adapting the ambient light around a monitor based on the image emitted by the screen. The device provides a solution for users seeking greater immersion while using computers for recreational purposes, such as watching movies or playing video games. In turn, Ambilight devices help reduce eye fatigue created by the extreme contrast between the screen and the background of the computer.

The Ambilight system can aid in this because extending the lights from the screen to around the screen produces light all around, which will make it so that not only the eye focuses light on a small section of the view. Health by having ambient light improves by not forcing the eye to the abrupt change in light, in addition, we can have a decorative and entertaining setting that will envelop the viewer in the content of the screen [13].

On the other hand, in the research [14] it is mentioned that nowadays, imaging systems can be equipped with immersive enhancements such as 3D and Ambilight. In this experiment, a state-of-the-art 3D technology demonstrator was used, and pixelated LED-based technology and Ambilight were built. The aim of the experiment was to investigate the concepts of naturalness, visual experience, and presence in relation to image quality, depth and Ambilight. The results show a significantly higher viewing experience for a setup with 3D and Ambilight compared to a setup without 3D and without Ambilight. The presence of the concept considers the level of video quality, but to a lesser extent than naturalness and viewing and experience. On the other hand, depth enhancements and Ambilight have a greater effect on presence rates than naturalness or visual experience. Depth and dynamics Ambilight provide more sensory input to the viewer resulting in a greater sense of presence.

In the present work, an investigation will be shown in which, based on a microcontroller system, an intelligent ambient light system capable of reproducing the colors that appear on the edge of a screen is developed in the background of the monitor. This project is not only intended to help decorate a certain place but also to reduce human visual fatigue when the person is spending

a long time in front of a monitor. The system also have a couple of buttons to turn the strip on and off manually.

Ambient light is a dynamic lighting system that extends the screen by reflecting the content to the wall behind it, this in addition to making the user have a better viewing experience and less eye fatigue.

The main problem in the development of the project was to recognize the individual colors projected on the edge of the television, as well as to turn on that particular pattern of colors of the LED strip on the rear section of the monitor that corresponds.

A system was made that contains an Arduino one, and a strip of LED lights, which will receive signals from the Arduino and turn on automatically when seeing the colors on the screen.

It is particularly important to consider that not any RGB LED is viable, this is because most commercial led strips can only change the entire strip to one color and not put a LED of each color.

2. Ambilight

When it refers to lighting technology, it refers to the technique of lighting with artificial light for open or closed spaces, for recreational, work, or artistic purposes.

Ambilight is a backlight system produced by Philips® for its line of plasma, LCD, OLED and OLED+ flat-panel TVs. The Ambilight is used to extend, by means of LED lights arranged on the sides of the television, the colors of the image, achieving a more immersive effect.

Ambilight is the result of an in-depth study conducted on the way people watch television at home. Among consumers who evaluated Ambilight, more than 70% found that the lighting around the TV contributed to a more relaxing experience and improved picture parameters such as contrast, depth, and vividness of colors. The use of color for the Ambilight function makes an even bigger difference. The SMTPE (Society of Television and Motion Picture Engineers) also recommends backlit displays to maximize TV performance.

Ambilight is a technology designed to enhance the viewing experience and can be used with any type of television signal. Whatever the signal source, Ambilight technology analyzes incoming signals and produces the right ambient sidelight for the content being displayed on the screen.

In 2013, the Philips company transferred Ambilight technology to computer monitors under the name Ambiglow, with the Gioco 278G4 3D model, winner of that year's IF Design Award, being the brand's first monitor to display this technology.

All Ambilight systems share the same functionality. A processor must process the video signal that appears on the screen and send that information to the microcontroller. The microcontroller modifies the intensity and color of the LEDs, thus achieving the Ambilight effect. Although there are many ways to do this process, since obtaining the video signal is complicated in some cases, which makes device compatibility difficult [15].

3. METHODOLOGY & MATERIALS

Activities are divided into two parts; the part inside the computer, which includes code in the Arduino IDE and the Prismatik® application; and the one outside the computer, physically at the back of the monitor screen.

The led strips are accommodated on the back of the screen, then they are connected to the Arduino and this to the computer to be able to load the program.

3.1 LED Strip Lights

WS2812B LED lights, it is a digitally addressable LED strip, in which there are 60 RGB LEDs per meter, the color of each red, green, blue LED and its brightness can be adjusted individually (Figure 1). The 256-level brightness and 24-bit color display achieves 16777216 colors in full color. It can be programmed by Arduino, Raspberry Pi, Fadecandy and T1000S, K1000C controllers. It can also be controlled by SP103E SP105E SP108E SP110E Preprogrammed Controllers, SP106E SP107E Music Controllers and SP501E Smart WiFi Controllers [16].

Fig. 1 LED lights WS2812B.

3.2 Hardware Connection

In Figure 2 it is possible to see the connection used for physical assembly. This consists of a 5V source as well as an Arduino, the WS2812b LED strip, a 330Ω resistor which will serve to protect the circuit and finally a computer screen on which the LED strip will go.

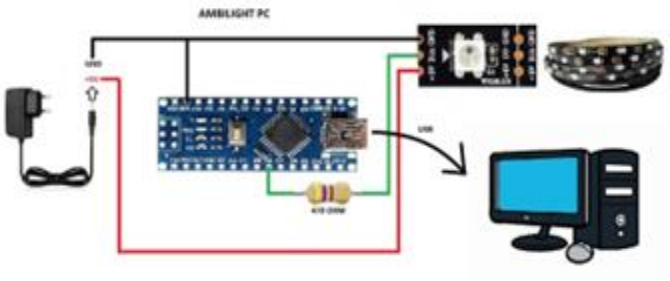

Fig. 2 Project Diagram.

3.3 Software

The Prismatik® program mentioned in the Methods Section is installed and configured, it has different options, its logo is shown in Figure 3.

Fig. 3 Prismatik logo.

Prismatik® software is a desktop capture software to send the information to LED lights, capable of managing various profiles and configuring the number of lights that will be used to generate the brightness [17]. Once configured, there is no need to open the application on the computer (Figure 4).

Fig. 4 Prismatik software.

3.4 Libraries

To build the smart LED lighting system, the *FastLED* library must be installed in the Arduino programming IDE to have the appropriate control code for the WS2812 LED strip. It uses the *Adalight* protocol and is compatible with Boblight, Prismatik, etc. With the generated code, it is loaded into the Arduino UNO, after which the Prismatik application is opened to configure the amount of LED lights on each side of the screen [18].

4. RESULTS

Figure 5 shows the physically assembled circuit, there is a connection on a test board where the light cables are together with cables with the Arduino UNO signal, as well as the use of a 330Ω resistor as indicated in the diagram from the supplier of the LED strip (Figure 2).

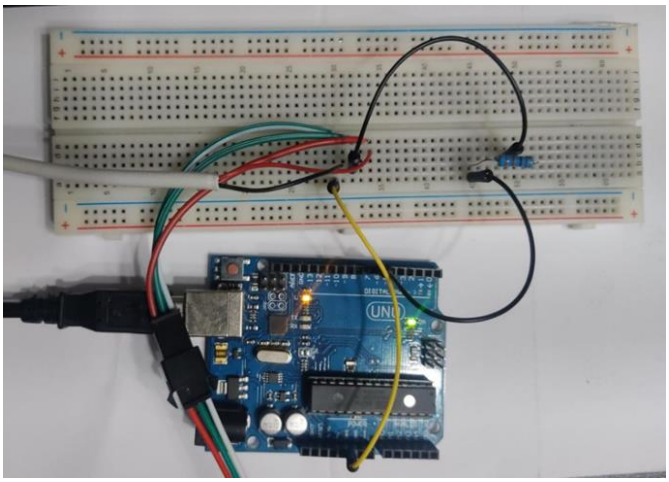

Fig. 5 Arduino Connection.

The LED lights come with adhesive to facilitate their placement; they were installed behind a 17" screen of a laptop (Figure 6).

Fig. 6 LED strip on laptop.

It is imperative that the same number of LEDs are placed on both the right and left sides since it is important for the program to have the lights centered.

Figure 7 shows the Prismatik® software configuration interface.

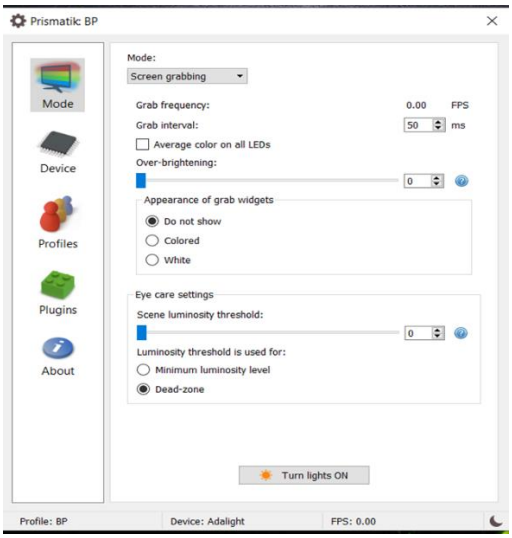

Fig. 7 Prismatik program interface.

When configuring the Prismatik® application, the LEDs can be arranged in any way that is convenient. The LED strip has a specific order in the arrangement of the LEDs, so they have to be put in that order when they are attached to the back of the screen. It is also possible to configure the size of the boxes that detect the screen colors to show the ambient light from behind (Figure 8).

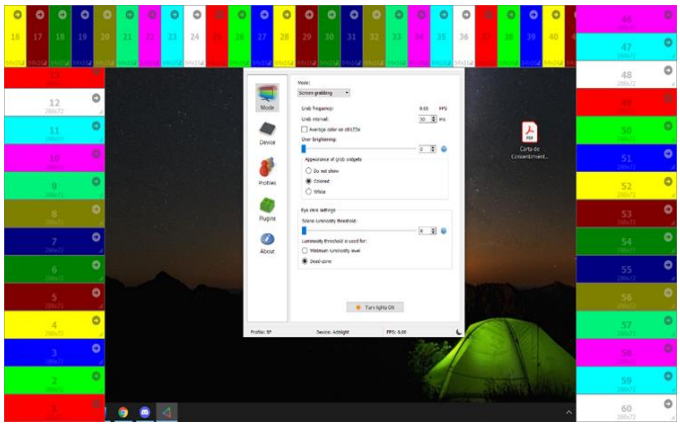

Fig. 8 LED strip configuration in the App.

To use the intelligent LED light system, the *"FastLED"* library must be installed in the Arduino development environment (IDE), this to have adequate communication with the Arduino. Having the code with the library, it is loaded into the Arduino UNO. After this, within the Prismatik® application, the number of led lights on each side of the screen is configured, to create the desired lighting effect.

With the Prismatik® wizard, select the LED strip (Adaligth) connected to the Arduino, see figure 9.

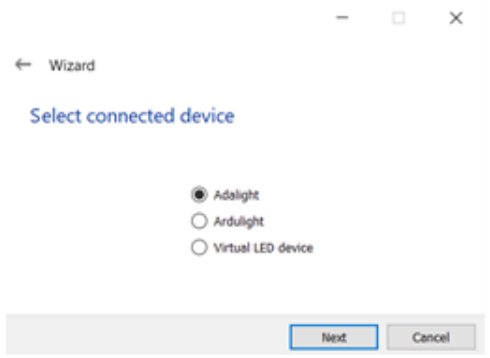

Fig. 9 Strip light wizard selection.

Figure 10 shows the wizard to define the port in which the Arduino is connected to the computer.

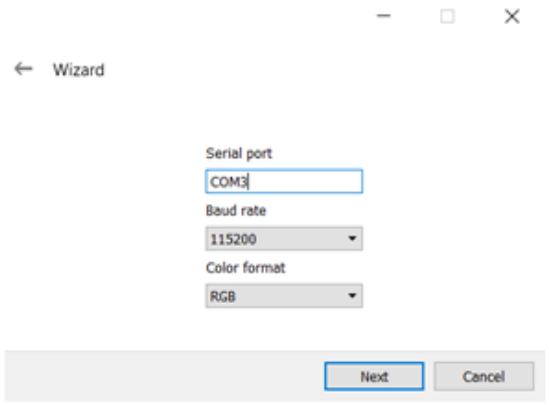

Fig. 10 Serial port wizard selection.

Once the physical circuit is connected, the colors are obtained using Prismatik®, the serial communication between the computer and the LED strips is carried out using Arduino®, then the LEDs of the strip light up (Figure 11).

Fig. 11 LED strip on the back.

Figures 12 and 13 show the aesthetic and comfortable effect that was pursued in this project.

Fig. 12 System operating, front.

Fig. 13 Operating system, front, another view.

5. CONCLUSIONS

It can be concluded that the stated objective was achieved. The Ambilight® system turned out to be more than an attractive and visually pleasing system, in the area where it is installed, it also benefits the reduction of SIV, which, as seen, has increased in recent years due to the increase in screen exposure time. The created system is helpful, both for health and aesthetic improvement in any area behind a TV or monitor. It was possible to develop a prototype that involves an Arduino.

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Bibliography

[1]. Research.com (2023, Apr 6). Mobile vs Desktop Usage Statistics for 2023. Recovered on May 28, 2023 of: https://research.com/software/mobile-vs-desktop-usage

[2]. Forbes (2021). La población Mexicana usuario de internet aumento 72% en 2020. Recovered on May 19, 2023, of: https://www.forbes.com.mx/la-poblacion-mexicana-usuaria-de-internet-aumento-72-en-2020/

[3]. IFT (2020). En México hay 84.1 millones de usuarios de internet y 88.2 millones de usuarios de teléfonos celulares: ENDUTIH 2020. (Comunicado de Prensa) 22 de junio. Instituto Federal de Telecomunicaciones. Recovered on May 19, 2023, of: https://www.ift.org.mx/comunicacion-y-medios/comunicados-ift/es/en-mexico-hay-841-millones-de-usuarios-de-internet-y-882-millones-de-usuarios-de-telefonos-celulares

[4]. IFT (2022). En México se consumen 2.5 horas y 3 horas en Plataformas. Instituto Federal de Telecomunicaciones. Recovered on May 19, 2023, of: https://www.ift.org.mx/comunicacion-y-medios/comunicados-ift/es/en-mexico-se-consumen-25-horas-de-tv-abierta-y-3-horas-en-plataformas-de-video-en-internet-al-dia

[5]. M. Iqbal, A. Soliman, O. Ibrahim & A. Gad (2023). Analysis of the Outcomes of the Screen-Time Reduction in computer Vision Syndrome: A Cohort Comparative Study, clinical Ophthalmology, 123-134. DOI:10.2147/OPTH.S399044

[6]. Coopervision. (2023). Visión en la computadora: un nuevo problema para una nueva era. Recovered on May 19, 2023, of: https://coopervision.com.mx/eye-health-and-vision/computer-vision

[7]. J. Garrity (2022, Sept). Structure and Function of the Eyes. MSD Manual. Retrieved on May 28, 2023 of: https://www.msdmanuals.com/home/eye-disorders/biology-of-the-eyes/structure-and-function-of-the-eyes

[8]. BCNbaixavisio. (2015). Ver la televisión a oscuras perjudica la vista. Recovered on May 19, 2023, of: https://www.bcnbaixavisio.com/2015/05/06/ver-la-tele-a-oscuras-perjudica-tu-vista/

[9]. C. Blehm, S. Vishnu, A. Khattak, S. Mitra & R.W. Yee (2005). Computer Vision Syndrome: A review. Survey of Ophthalmology, Vol. 50. Num. 3. Elsevier. DOI:10.1016/j.survophthal.2005.05.008

[10]. ConSalud.es (2023,28,05). La tecnología Ambilight de las televisiones Philips reduce el estrés visual entre un 60% y un 90%. Recovered on May 28, 2023 of: https://www.consalud.es/tecnologia/la-tecnologia-ambilight-de-las-televisiones-philips-reduce-el-estres-visual-entre-un-60-y-un-90_8549_102.html

[11]. A.S. Mali, B.N. Dhanush, M. Shashank, M.S. Saujanya & M.R. Kounte. (2018). Design and Development of Dynamic Lighting System Using Ambient Lighting Technology. International Journal of Advanced Research in Science and Engineering (IJARSE). Vol. 7, Issue 7. April 2018. India. ISSN:2319-8354.

[12]. E. Rodríguez (2021, May 14). Tecnología Ambilight y alternativas: guía de compra de sistemas LED para crear una iluminación ambiente en la parte trasera de la TV . Xataka. Recovered on May 19, 2023, of: https://www.xataka.com/seleccion/tecnologia-ambilight-alternativas-guia-compra-sistemas-led-para-crear-iluminacion-ambiente-parte-trasera-tv

[13]. A. Olea Barril. (2019). Estudio de viabilidad de una empresa dedicada a la fabricación y comercialización de sistemas Ambilight. Tesis Maestría. Universitat Politécnica de Catalunya. Recovered on May 19, 2023, of: https://upcommons.upc.edu/bitstream/handle/2117/173307/TFM_Alvaro_Olea_Barril.pdf?sequence=1&isAllowed=y

[14]. P. Seuntiens, I. Vogels & A. Van Keersop. (2007). Visual experience of 3D-TV with pixelated ambilight. Proceedings of Presence, 2007.

[15]. E. Diederiks, H. Hoonhout. (2007). Radical Innovation and End-User Involvement: The Ambilight Case Knowledge, Technology & Policy (2007) 20(1) 31-38. DOI: 10.1007/s12130-007-9002-z

[16]. WS2812. (2023). Recovered on May 19, 2023, of: https://cdn-shop.adafruit.com/datasheets/WS2812.pdf

[17]. *Giyhub.com (2014).* Lightpack project with Prismatik flavour. Recovered on May 19, 2023, of: https://github.com/psieg/Lightpack

[18]. D. García & M. Kriegsman (2013). Fast, easy LED library for Arduino. Recovered on May 19, 2023, of: https://fastled.io