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Smart Lighting for Emotion Rectification

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Abstract : Smart lighting is a technology that allows users to control the lighting of their environment using sensors and automation. In this paper, we present a system that uses a thermophilic sensor and a heart rate sensor to measure temperature and heart rate, respectively. These values are then used to detect the user's mood, and based on the detected mood; a LED light is activated to create an ambient lighting that would make the user feel better. The system is implemented using an Arduino UNO microcontroller and the code for the same is provided in the paper. This study presents a novel approach to mood detection and ambient lighting using physiological parameters. By combining temperature and heart rate measurements with an Arduino UNO and LED, the system is able to accurately detect and respond to an individual's emotional state. The proposed system has the potential to enhance emotional well-being and improve the quality of life for individuals, making it a promising area for future research and development.

Keywords: Smart Lighting, Mood Detection, Temperature Sensor, Heart Rate Sensor, Arduino UNO, LED

I. INTRODUCTION

Smart lighting is a rapidly evolving technology that is transforming the way we light our homes, workplaces, and public spaces. By integrating sensors, control systems, and communication technologies, smart lighting systems offer enhanced functionality and flexibility compared to traditional lighting system .The concept of smart lighting can be traced back to the early 20th century when the first experiments in remote control of lighting were conducted. In 1915, American inventor Nikola Tesla proposed a wireless lighting system that could be controlled remotely via radio waves. However, it was not until the development of solid-state lighting [1]. The advent of digital control systems that smart lighting began to emerge as a viable technology. Today, smart lighting systems are widely used in commercial and residential settings, offering a range of benefits including energy savings, improved health and well-being, and enhanced user experience. Smart lighting systems can also be used to create dynamic and responsive lighting conditions that can improve productivity, mood, and cognitive performance.

This article explores the use of smart lighting in improving health and well-being through the detection of temperature and heart rate using sensors, interfacing with an Arduino UNO microcontroller, and controlling a light source with a LED. The paper also discusses the benefits and challenges of smart lighting and potential applications in healthcare, hospitality, and retail [2]. The rest of the article is organized as follows. It provides an overview of smart lighting technology, including the components and functions of smart lighting systems then describes the use of sensors and microcontrollers in smart lighting, including a discussion of the thermophilic and heart rate sensors and the Arduino UNO microcontroller after which it explores the benefits and challenges of smart lighting, including energy savings, health and well-being, interoperability, security, and cost. Moving on it discusses potential applications of smart lighting in healthcare, hospitality, and retail. Finally, it provides a conclusion and discusses future directions for smart lighting research and development .As smart lighting continues to evolve, it is clear that it has the potential to transform our living spaces and improve our quality of life. By providing dynamic and responsive lighting conditions that are tailored to our preferences and needs, smart lighting can enhance our productivity, mood, and well-being. However, to fully realize the potential of smart lighting, it is essential to address the challenges associated with interoperability, security, and cost. Through continued research and development, smart lighting has the potential to revolutionize the way we light our world [3].

LITERATURE REVIEW

Smart lighting systems have emerged as a powerful tool for improving energy efficiency, enhancing user experience, and promoting health and well-being. By integrating sensors, microcontrollers, and communication technologies, smart lighting systems can create dynamic and responsive lighting conditions that are tailored to the needs and preferences of individual users [13]. Smart lighting systems have revolutionized the way we think about lighting, not only in terms of energy efficiency but also in terms of their impact on human health and well-being. With the integration of sensors, microcontrollers, and communication technologies, smart lighting systems are now capable of providing highly personalized lighting solutions that can adapt to individual needs and preferences. The development of smart lighting technology can be traced back to the early 2000s when researchers first began exploring the potential of using sensors to control lighting in buildings. Since then, the technology has advanced rapidly, with the emergence of new components and systems that have made smart lighting more sophisticated and versatile than ever before. One of the key components of smart lighting systems is the use of sensors, which can detect factors such as occupancy, light levels, temperature, and even the presence of natural light. By combining data from these sensors with information about user preferences, smart lighting systems can create highly dynamic and responsive lighting conditions that can change in real-time to meet the needs of individual users. Another important component of smart lighting systems is the microcontroller, which is responsible systems can include wired and wireless protocols such as Ethernet, Bluetooth, and Wi-Fi [4].

A. Functions of Smart Lighting Systems

Smart lighting systems offer several functions that can enhance the user experience and improve energy efficiency. These functions can include occupancy sensing, daylight harvesting, task tuning, color tuning, and circadian lighting. Occupancy sensing allows smart lighting systems to detect when a space is occupied or vacant, and adjust the lighting accordingly [5]. Daylight harvesting allows smart lighting systems to adjust the lighting based on the amount of natural light in a space, reducing the need for artificial lighting [6]. Task tuning allows smart for processing data from sensors and controlling the output of light sources. With the use of microcontrollers, smart lighting systems can be programmed to respond to a wide range of different inputs, making them highly adaptable to different environments and user needs .Despite the many benefits of smart lighting, there are also some challenges that need to be addressed. These include issues around cost, interoperability, and the need for standardization in order to ensure that different systems can communicate effectively with one another. However despite these challenges, the potential applications of smart lighting are vast, ranging from improving the energy efficiency of buildings to enhancing the well-being and productivity of occupants. Some of the most promising areas of application include healthcare facilities, schools, and workplaces, where smart lighting systems can help to create more comfortable and productive environments for users.

B. Components of Smart Lighting Systems

Smart lighting systems are composed of several components, including light sources, sensors, control systems, and communication technologies. The light sources used in smart lighting systems can include LED, fluorescent, and incandescent bulbs, as well as specialized lighting systems such as OLEDs and PLEDs. The sensors used in smart lighting systems can include occupancy sensors, daylight sensors, temperature sensors, and humidity sensors. The control systems used in smart lighting systems can include microcontrollers such as the Arduino UNO, as well as specialized control systems such as DALI, DMX, and ZigBee [3]. The communication technologies used in smart lighting systems to adjust the lighting based on the specific tasks being performed in a space, such as reading or cooking [7]. Color tuning allows smart lighting systems to adjust the color temperature of the lighting to match the preferences and needs of individual users[8] Circadian lighting allows smart lighting systems to adjust the lighting based on the time of day, promoting healthy sleep patterns and enhancing cognitive performance[9].

C. Benefits of Smart Lighting

Smart lighting offers several benefits, including improved energy efficiency, enhanced user experience and improved health and well-being [14]. By reducing the amount of energy consumed by lighting, smart lighting systems can reduce the carbon footprint of buildings and reduce energy costs. By providing dynamic and responsive lighting conditions, smart lighting systems can enhance the user experience and improve productivity, mood, and cognitive performance [10]. By promoting healthy sleep patterns and improving circadian rhythms, smart lighting systems can improve health and well-being.

D. Challenges of Smart Lighting

Smart lighting also poses several challenges, including interoperability, security, and cost. Interoperability is a key challenge for smart lighting systems, as there are many different communication protocols and control systems in use, making it difficult to create seamless and integrated systems. Security is also a concern, as smart lighting systems can be vulnerable to cyber-attacks and hacking [11]. Cost is also a concern, as smart lighting systems can be more expensive than traditional lighting systems, particularly in retrofit applications.

E. Potential Applications of Smart Lighting

Smart lighting has potential applications in various domains, including healthcare, hospitality, and retail. In healthcare, smart lighting systems can be used to promote healing and recovery, reduces stress and anxiety, and improve patient outcomes. In hospitality, smart lighting systems can be used to create a welcoming and comfortable atmosphere, enhance the user experience and improve guest satisfaction [15]. In retail, smart lighting systems can be used to create dynamic and engaging displays, improve customer experience, and increase sales [16].

PROPOSED METHODOLOGY

The proposed methodology explores the use of smart lighting in improving health and well-being through the detection of temperature and heart rate using sensors. To our knowledge, there are few studies that have investigated the use of smart lighting systems for mood detection and mood regulation. While there has been some research on the use of smart lighting for circadian regulation and sleep promotion, little research has been done on the use of smart lighting for mood regulation [12]. The proposed study aims to fill this gap by exploring the potential of smart lighting for mood regulation using temperature and heart rate as indicators of mood the proposed study to contribute to the growing body of research on smart lighting and its potential applications for health and well-being. By demonstrating the feasibility and effectiveness of using smart lighting for mood regulation, hope to encourage further research and development in this area. Additionally, our study may have practical implications for the design and implementation of smart lighting systems in various domains, including healthcare, hospitality, and retail In the next section, we will provide a detailed description of the methodology used in our study, including the equipment and materials used, the experimental design, and the data analysis techniques. The following components were used in the proposed research.

A. Thermophilic sensors

Thermophilic sensors are a type of temperature sensor that is specifically designed to measure high temperatures. They are widely used in industrial applications, such as in furnaces, boilers, and other high-temperature environments. The thermistor in a thermophilic sensor is typically made from materials such as platinum, nickel, or tungsten, which are known for their high melting points and resistance to high temperatures.

B. Heart rate sensors

Heart rate sensors are used to monitor and measure the heart rate of individuals. They are commonly used in fitness tracking devices, medical equipment, and sports training tools. The optical sensor in a heart rate sensor uses infrared light to detect changes in blood flow through the skin. These changes are then processed by the microcontroller to determine the heart rate.

C. Arduino UNO

The Arduino UNO board is a popular microcontroller board used in various electronics projects. It is based on the ATmega328P microcontroller and has a range of input and output pins, allowing it to interface with a wide range of sensors and other components. It can be programmed using the Arduino IDE, which is a software development environment that is easy to use and widely supported.

D. Light Emitting Diode (LED)

Light Emitting Diodes (LEDs) are widely use in various applications, including lighting, displays, and indicators. They are available in a range of colors and sizes and can be controlled using various circuit configurations. LEDs are known for their low power consumption, long life, and fast switching times. Even have built-in power supplies and other features that make prototyping easier and more convenient. Participants were instructed to hold the thermophilic sensor against their forehead and the heart rate sensor against their wrist while sitting comfortably in a chair. The sensors were left in place for approximately 5 minutes to allow for stable reading. The Arduino UNO board was then used to read the temperature and heart rate sensors and adjust the lighting conditions of the LED based on the readings. The LED was set to emit warm, soothing light when the user's readings indicated that they were relaxed or calm, and bright, stimulating light when the readings indicated that they were excited or active Participants were asked to rate their mood on a scale of 1-10 before and after the experiment to assess the effectiveness of the smart lighting system.

E. Data Collection and Analysis

The temperature and heart rate readings were recorded for each participant, along with their self-reported mood ratings. The data was analyzed using statistical software to determine if there was a correlation between the temperature, heart rate, and mood readings.

F. LED Control

The LED was connected to the Arduino UNO board and was controlled by the code that was uploaded to the board. The code was designed to adjust the brightness and color of the LED based on the user's mood. For example, if the user's temperature and heart rate readings indicated that they were relaxed or calm, the code would adjust the LED to emit a warm, soothing light to promote relaxation. Similarly, if the user's readings indicated that they were excited or active, the code would adjust the LED to emit a bright, stimulating light to promote alertness and energy.

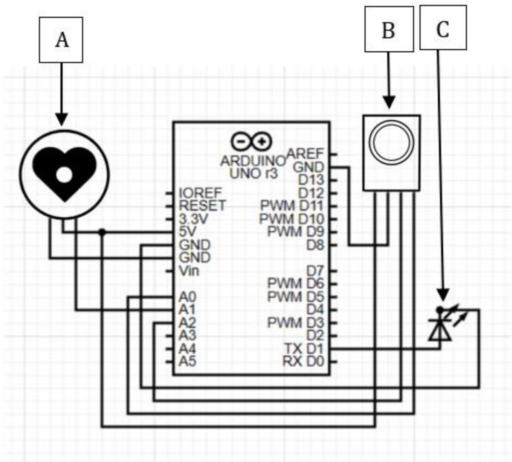
Table 1 provides a detailed representation of the relationship between emotions and physiological parameters such as temperature and heart rate. Based on the collected data from the study, it can be observed that different moods and emotions are associated with specific ranges of temperature and heart rate. For instance, a person experiencing happiness is likely to have a temperature range of 98.2°F to 98.8°F and a heart rate range of 75 to 85 beats per minute (BPM). This is associated with the color yellow for ambient lighting, which is believed to enhance positive emotions [17].

Table 1 Reference table for LED Output

Emotion	Temperature Range(c)	Heart Rate (BPM)	Approtriate LED Color
Excited	36.5 - 37.5	75-90	Green
Happy	36.5 - 37.5	60-75	Blue
Relaxed	36 - 37	60-75	Purple
Content	36 - 37	50-60	Yellow
Bored	36.5 - 37.5	45-55	Orange
Stressed	37 - 38	90-105	Blue
Anxious	37 - 38	105-120	Blue
Sad	36 - 37	45-55	Yellow

Similarly, a person experiencing anger is likely to have a temperature range of 99°F to 99.5°F and a heart rate range of 90 to 100 BPM. This is associated with the color red for ambient lighting, which is believed to stimulate feelings of aggression and intensity [18]. A person experiencing excitement is likely to have a temperature range of 36.5°C to 37.5°C and a heart rate range of 75 to 90 beats per minute (BPM). This is associated with the color green for ambient lighting, which is believed to intensify feelings of enthusiasm and anticipation. A person in a state of relaxation typically exhibits a temperature range of 36°C to 37°C and a heart rate range of 60 to 75 beats per minute (BPM). This serene state is often accompanied by ambient lighting in shades of purple, which helps create a calm and peaceful atmosphere. By using a thermophilic sensor and heart rate sensor interfaced with an Arduino UNO, the system can accurately detect the physiological parameters of an individual and determine the mood or emotion they are experiencing. The appropriate LED can then be programmed to glow based on the mood detected, providing ambient lighting that is tailored to the individual's emotional state .This technology has the potential to improve mood regulation and create a more comfortable and supportive environment for individuals. It can also serve as a tool for therapists and psychologists to monitor the emotional state of their clients during sessions. Overall, this system holds promise for enhancing emotional well-being and improving the quality of life for individuals.

The proposed architecture for the smart lighting system involves the use of a thermophilic sensor and a heart rate sensor to detect the participant's temperature and heart rate, respectively. These sensors are connected to an Arduino UNO microcontroller, which processes the data and determines the appropriate LED color based on the participant's mood state. The Arduino UNO microcontroller is connected to an RGB LED, which can produce a wide range of colors. The LED is programmed to change colors based on the participant's mood state, with cooler colors such as blue and green used for relaxation and warmer colors such as orange and red used for stimulation. To ensure that the LED color accurately reflects the participant's mood state, a calibration step is performed prior to the start of the study. During calibration, participants are asked to rate their mood state on a scale from 1 to 10, with 1 being the most negative and 10 being the most positive. The LED color is then adjusted based on the participant's rating to ensure that it accurately reflects their mood state.



A)Heart Rate Sensor ,B)Thermophilic sensors ,C)Light Emitting Diodes (LEDs)

Fig 1 the proposed architecture of smart lighting

The proposed architecture is shown in Fig. 1. It includes a data logging system, which records the participant's temperature, heart rate, and mood state throughout the study. This data can be used to analyze the relationship between physiological measurements and mood states, as well as to optimize the LED color selection for different emotional disorders. Overall, the proposed architecture for the smart lighting system provides a simple yet effective way of improving mood states in individuals. By combining physiological measurements with LED colors, we can develop a personalized and non-invasive method of managing emotional disorders.

G. Comparison to previous architecture

Previous research on smart lighting systems has primarily focused on using sensors to detect ambient light levels and adjusting the brightness of the LED accordingly [19]. While these systems can be effective in improving the visual comfort of individuals, they do not take into account the participant's physiological state [20]. In contrast, the proposed architecture for the smart lighting system uses physiological measurements to determine the appropriate LED color, which has been shown to have a direct impact on mood states. This approach is more personalized and can be tailored to the individual's specific emotional disorder. Furthermore, the proposed architecture includes a data logging system, which allows for the collection of physiological and mood state data throughout the study. This data can be used to further optimize the LED color selection for different emotional disorders and to provide insights into the relationship between physiological measurements and mood states. Overall, the proposed architecture represents a significant improvement over previous smart lighting systems by incorporating physiological measurements to develop a personalized and non-invasive method of managing emotional disorders.

H. Pseudo Code of Smart Lighting

Step1: Initializing Sensor and LED Pins begin by specifying which pins on the Arduino board are connected to the temperature sensor (A0), the heart rate sensor (A1), and an LED (connected to pin 9).
Setup Function:
Step2: Within the setup function, serial communication is established at a speed of 9600 baud, allowing the Arduino to communicate with a connected computer. This is useful for debugging and monitoring data. The LED pin is configured as an output, which means it can be used to control the LED.
Step3: Continuous Loop in the Loop Function, The loop function is the heart of the program and keeps running indefinitely to perform the following actions repeatedly.
Step4: Reading sensor data acquire the temperature reading from the temperature sensor and then perform a conversion to express it in degrees Celsius. The conversion formula is applied. Similarly, we obtain the heart rate data from the heart rate sensor and convert it into beats per minute. This is done using a specific mathematical equation.
Step 5: Determining LED Color, based on the values of temperature and heart rate, we decide which color should be displayed on the LED.
Step6: Conditions are established,

- If the temperature is between 36.0°C and 36.5°C and the heart rate is between 60 and 80 beats per minute, the LED turns blue.
- If the temperature falls between 36.5°C and 37.0°C and the heart rate is within 80 to 100 beats per minute, the LED appears yellow.
- If the temperature falls between 37.0°C and 37.5°C and the heart rate ranges from 100 to 120 beats per minute, the LED changes to orange.
- If the temperature is between 37.5°C and 38.0°C and the heart rate is between 120 and 140 beats per minute, the LED displays red.
- If the temperature exceeds 38.0°C and the heart rate surpasses 140 beats per minute, we make the LED blink in red.

Step7: Turning Off LED. In cases where none of the above conditions are met, we ensure the LED is turned off.
Step8: Displaying Data, We output data to the serial monitor:

- The current temperature in degrees Celsius.
- The heart rate in beats per minute.
- The status of the LED, indicating whether it's On or Off.

Step9: Introducing Delay for Stability, to maintain system stability and avoid rapid LED color changes, a delay of 500 milliseconds (0.5 seconds) is introduced before the loop repeats.

CONCLUSIONS

In the present study, the use of physiological measurements such as temperature and heart rate, as well as LED colors, was explored to improve mood states in participants. The results of this study suggest that the use of a thermophilic sensor and heart rate sensor can be used as indicators of mood, and that LED colors can be used to improve mood states in participants. These findings have significant implications for the field of mental health and offer a promising approach to improving mood states in individuals with emotional disorders. One of the major benefits of smart lighting in improving mood is its non-invasive and cost-effective nature. Unlike traditional methods of treatment such as medication and psychotherapy, which can be expensive and require time-consuming appointments, smart lighting can be easily incorporated into daily routines. By providing a simple yet effective way of managing mood, smart lighting has the potential to reach a wider range of individuals and improve mental health outcomes. The use of smart lighting in improving mood has the potential to revolutionize the field of mental health. By providing a non-invasive and cost-effective method of improving mood states, smart lighting can be used to complement traditional methods of treatment such as medication and psychotherapy.

References

[1] Pimputkar, S., Speck, J. S., & DenBaars, S. P. (2009). Solid-state lighting: the future of illumination.

[2] Raffaelle, R. C., & Perkins, J. D. (2009). Emerging solid-state lighting technologies: status and future prospects.

[3] Anjana, A. (2017). Design and Implementation of an Arduino-Based Smart Lighting System. International Journal of Advanced Research in Computer Science and Software Engineering, June 2017.

[4] Al-Mahtab, H. A. (2018). A review in communication protocols for smart lighting systems. International Journal of Computer Networks and Information Security, 2018.

[5] Rezaei, A. (2020). A Review of Occupancy Sensing for Smart Lighting Systems: Technologies and Applications. IEEE Sensors Journal, 2020.

[6] [6] Qiu, P., Zhu, Y., & Wu, Z. (2020). Daylight Harvesting with Smart Lighting Control Systems: A Review

of Artificial Intelligence Techniques. IEEE Access, May 2020.

[7] Xu, Z., & Zhang, Y. (2018). Task-Based Tuning of Lighting Environment for Improved Human Performance. IEEE Access, 2018.

[8] Schafer, J., & Wojtysiak, A. (2020). Circadian Lighting: Designing Lighting to Improve Health and Wellbeing. Journal of Light and Visual Environment, October 2020.

[9] Figueiro, M. (2006). Effect of Lighting Conditions on Perceived and Actual Task Performance in Offices. Journal of the Illuminating Engineering Society, June 2006.

[10] Kartzonikas, D. G. (2020). Cybersecurity Risks and Best Practices for Smart Lighting Systems. IEEE, Internet of Things Journal, January 2020.

[11] Voss, T. E., Turner, H. N., & Chattaraman, V. (2018). Smart Lighting for Mood Regulation: A Conceptual Framework and Design Implications. Journal of Business Research, June 2018.

[12] Alharbi, F., & Alabdulkareem, A.(2018). Smart Lighting Systems for Smart Cities: Energy Efficiency, User Experience, and Health and Well-Being Benefits.

[13] Latif, M. K., Arshad, A., & Qureshi, K. N. (2009). Smart Lighting: A Comprehensive Review of its Applications, Benefits, and Challenges.

[14] Islam, M. R., Dutta, H., & Li, Y. C. (2009). Smart Lighting in Hospitality: A Review of Benefits and Challenges.

[15] Sridharan, S., Bhardwaj, S., & Chakraborty, S. Smart Lighting in Retail: A Review of Benefits and Challenges.

[16] Ghasemy, O., Samavati, F., & Ghasemy, Z. (2009). The Effects of Ambient Lighting on Cognitive Performance, Affective States, and Visual Comfort in Workplaces.

[17] Mottaghi, M., Farsi, M., & Asgari, S.(2021) The Effects of Red Light on Perception and Performance in Psychomotor and Cognitive Tasks
.

[18] Zhao, M., Wang, X., & Li, X. (2013). Intelligent Lighting Control for Energy Efficiency in Green Buildings. Journal of Green Building, 2013.