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Study of Light Radiation Intensity and Emissivity

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ABSTRACT: This article examines the intensity and emissivity of light radiation. Natural light varies throughout the day, directly affecting the human body. The paper analyzes the impact of light's color temperature and intensity on human health, mood, and productivity. It also explores methods to mimic the rhythm of natural light using artificial lighting systems. Practical examples are provided on utilizing the BH1750 light sensor and Arduino platform to determine light levels. The results enable effective monitoring and management of light intensity.

KEYWORDS: light intensity, emissivity, BH1750 sensor, Arduino platform, artificial lighting, circadian rhythm, human health.

I. INTRODUCTION

Light significantly impacts human life, as it provides about 90% of environmental information through vision. The intensity and emissivity of light play a critical role in scientific research and practical applications. Properly calibrated lighting conditions can enhance productivity and overall well-being, while poor lighting may lead to health issues such as eye strain and circadian rhythm disturbances.

This study addresses the measurement of light radiation intensity and emissivity using innovative devices. By employing the BH1750 light sensor and the Arduino platform, the research explores the simulation of natural light rhythms through artificial lighting systems. The findings aim to contribute to improving human health, mood, and productivity by aligning artificial lighting with natural light pattern

II. METHODOLOGIY

In nature, natural light changes throughout the day, and we have not paid much attention to it for a long time. However, the amount of light perceived by our eyes directly affects us. During the dark hours of the day, the human body actively produces the sleep hormone melatonin. At light levels above 300 lux, the production of the happiness hormone cortisol increases. The increase in cortisol production occurs as the light rises to 1000 lux, after which the hormone stabilizes.

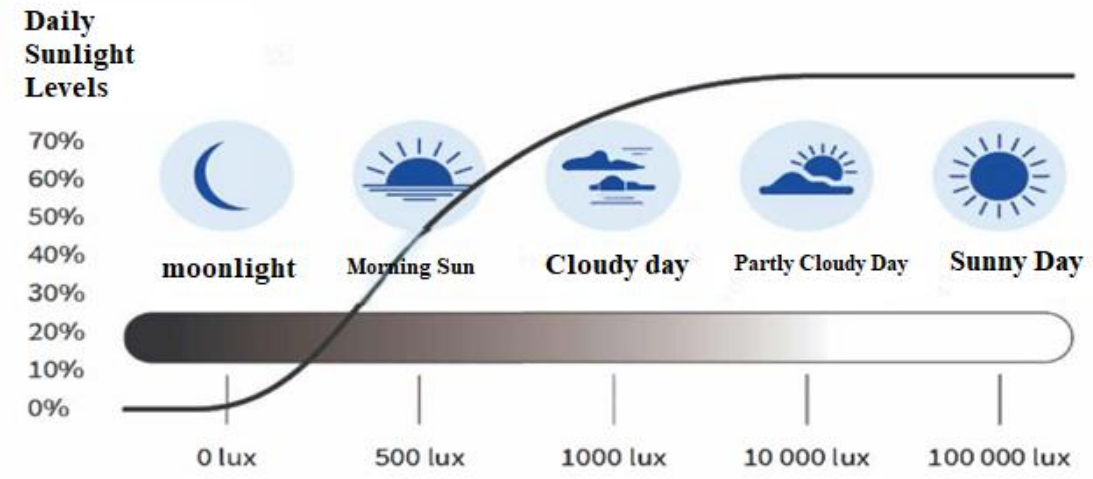

Figure 1. Daily Solar Radiation Levels.

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An important characteristic of light is its color temperature, which changes throughout the day. In everyday life, we often don't pay much attention to this. While all people generally react similarly to light intensity, their response to color temperature is more a matter of personal preference. However, blue light with a color temperature above 4500 K is believed to have a stimulating effect on our body. This is thought to be related to the fact that the human brain has evolved under the blue sky for the past 7 million years.

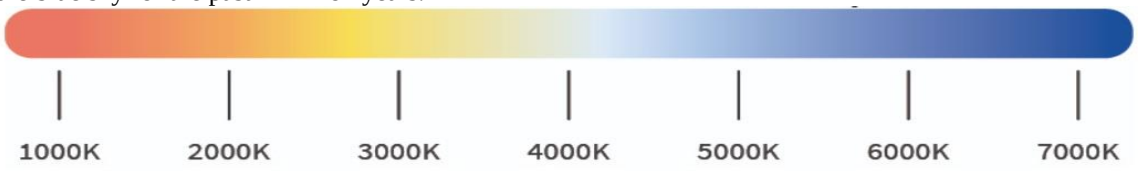

Figure 2. Spectrum of Light Colors.

It has been scientifically proven that light is necessary not only for human vision but also for the proper functioning of our circadian rhythm and physiological functions. Light affects many aspects of our well-being: from mood and sleep to productivity and visual perception. As we already know, adjusting the light level and color temperature in accordance with natural daylight and our circadian rhythm is of great importance for the well-being of people who spend a lot of time at home. With the development of technology, the use of artificial indoor lighting has become possible, which mimics the rhythm of natural light. Lighting that matches the movement, intensity, and color of sunlight.

We perceive color temperature differently, but warm light has a calming effect on us, while blue light has a warning effect. Our bodies are influenced by changes in the color temperature of light, which in turn affects the changes in the surrounding environment. This means that we are not exposed to constant, uniform light; in daily life, people no longer notice the effect of light sources with a single color temperature, as it only has a beneficial impact during certain periods of the daily cycle. The color temperature of artificial light sources should change slightly throughout the day.

Figure 3. Light environment throughout the day.

More light makes us more active, while less light makes us tired. Artificial light allows us to adjust light intensity in accordance with the body's circadian rhythm throughout the day. The combination of sensory and biological components creates a lighting environment that optimally mimics daylight.

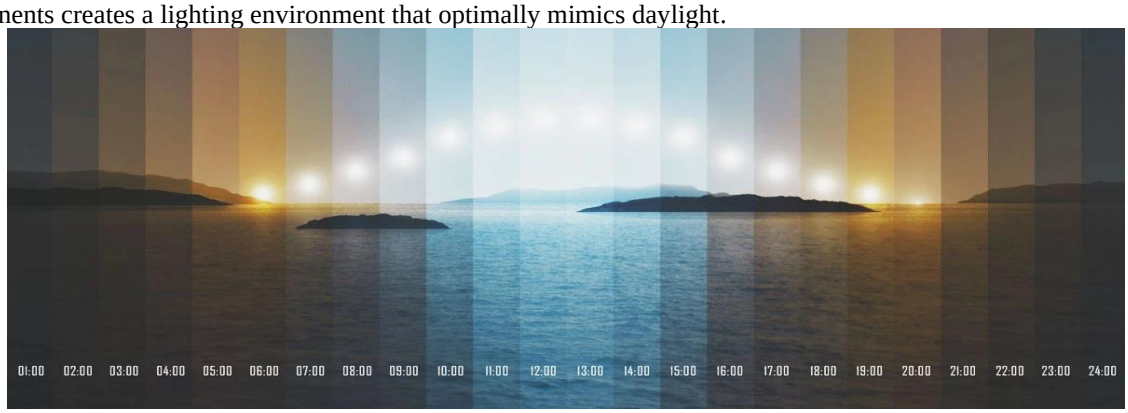

Figure 4: Combination of Sensory and Biological Light.

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Light Interior residential buildings, offices, and public spaces, as well as equipment, lamps, and lighting systems for bathrooms and the wellness industry, are based on selected equipment. The daytime simulation mode is controlled via a wall switch, remote control, or smartphone. The adjustment of light flux and color temperature can be done manually or automatically.

The selection of light therapy equipment is carried out within the framework of the interior design proposed by designers and architects. There are no restrictions in choosing the style, shape, or size of the lamps. Our company installs light therapy light sources and controls into lighting fixtures or systems from various manufacturers. Specialized companies are also actively offering a wide range of ready-made light therapy lamps.

People spend 90% of their lives at home. However, for the proper functioning of the internal clock, a person should be exposed to bright white light, preferably sunlight, for at least 2 hours every day. If it is an artificial light source, it should include all wavelengths. The four-channel vitaLED® color lighting system from the German company Brumberg mimics the dynamics of sunlight, ensuring the daily variation of light. The planning of light with varying levels of white light and the variable blue light component of the vitaLED® system has a positive impact on mood and, therefore, productivity. Studies have shown that vitaLED® helps maintain the circadian rhythm in alignment with human biorhythms, aiding concentration or relaxation phases.

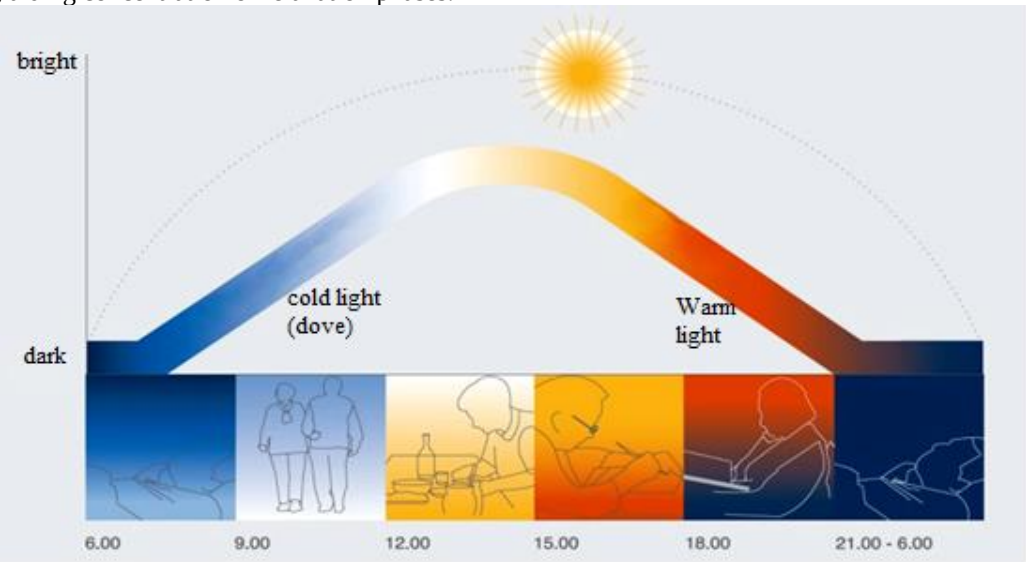

Figure 5. The role of light in our lives throughout the day.

In the initial phase of the project, our specialists, in collaboration with architects and designers, propose to properly plan the indoor lighting based on a combination of direct and reflected light. When a person is outside, they perceive light from the horizon, and the sky distributes light from all directions; a large amount of light spreads over a large area, providing optimal conditions for the retina to absorb light. In indoor spaces, light can be reflected from walls and ceilings (such as the sky), allowing the person to be more attentive. By planning more general lighting, we create a "healthy" lighting environment. Additionally, to achieve the highest comfort at home, our specialists offer solutions to maintain the circadian rhythm—cool, invigorating light in the morning and warm, comforting light for cozy family evenings. The global lighting scenario assumes that the night switching range will be from 10:00 PM to 6:00 AM. During these hours, automation adjusts the color temperature to 1800K and the light flux to 50 Lx, as a person should sleep for 8 hours a day, and this color temperature helps release the melatonin hormone. After sleep, in the morning, lamps are set to 6500K and 300 Lx. Correct lighting settings allow for the restoration of the biological rhythm. With respect to living spaces, our specialists adapt the modes for adjusting color temperature and light flux. In southern regions, people better accept cooler shades, while in northern areas, warmer shades are preferred.

Lux (lx): The unit of light intensity, indicating the amount of lumens falling on a square meter. Lumen (lm): The unit of luminous flux, measuring the amount of light emitted from a light source. Lux meter: An instrument used to measure light intensity in lux (lx) units. One lux = one lumen per square meter. Light intensity during the day depends on several factors: Sun height: Sunrise - light level gradually increases, Noon - light level is at its peak, Sunset - light

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level gradually decreases. Weather conditions: Sunny day - high light intensity, Cloudy day - lower light intensity, Rainy day - even lower light intensity.

Light Throughout the Day - The light intensity changes throughout the day as follows: Morning (sunrise): The light gradually increases. Noon: The sun is at its highest point, and the light is the strongest. Evening (sunset): The light gradually decreases.

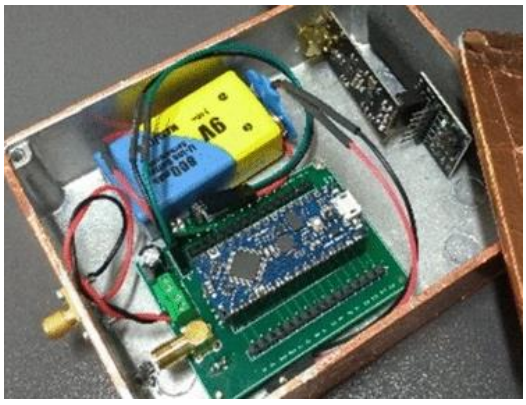
The days are longer, and the light intensity is higher. Winter: The days are shorter, and the light intensity is lower.

Light intensity (lux) and illuminance (lumen) levels are divided into different groups. Below are the light intensity levels and their corresponding illuminance values: • Low Light: 0 - 50 lux: Examples: Natural light in the evening, distant streetlights. Illuminance (lumens): Small light sources (10-100 lm). • Medium Light: 50 - 500 lux: Examples: Offices, shops, classrooms. Illuminance (lumens): Medium light sources (100-1000 lm). • High Light: 500 - 10,000 lux: Examples: Industrial areas, laboratories. Illuminance (lumens): Large light sources (1000-10,000 lm). • Natural Sunlight: 10,000 - 100,000 lux: Examples: Outdoors on a sunny day. Illuminance (lumens): Very large light sources (10,000-100,000 lm).

Examples: 10,000 - 25,000 lux: Shaded areas or open air on a cloudy day (10,000-25,000 lm).25,000 - 100,000 lux: Areas directly exposed to sunlight on a sunny day (25,000-100,000 lm).

The variation of light levels throughout the day is as follows:

1. Morning: 10-100 lux
2. Daytime: 10,000-100,000 lux
3. Noon: 50,000-100,000 lux
4. Evening: 100-10,000 lux
5. Night: 0.1-10 lux



A light sensor is a device used to detect and measure light radiation. They are used to measure the level of sunlight or artificial light. For example, the BH1750 is a digital light intensity sensor manufactured by ROHM Semiconductor. This sensor measures the ambient light level and communicates with microprocessors or microcontrollers via the I2C interface. Below is detailed information about the BH1750:

Technical Specifications and Operating Modes: Measurement Range: 1 - 65,535 lux. Interface: I2C (2.4V-3.6V VCC range). Measurement Speed: High-speed measurement (0.12 - 16 lx/Hz).Accuracy: ±20% (under standard conditions). Power Consumption: Active mode 0.12 mA, power-saving mode 0.01 mA. Measurement Modes:

- High-Resolution Mode: 1 lx accuracy (120 ms).
- High-Resolution Mode 2: 0.5 lx accuracy (120 ms).
- Low-Resolution Mode: 4 lx accuracy (16 ms).

Main Advantages: High Accuracy: Accurately measures the ambient light level. Low Power Consumption: Equipped with power-saving modes. Simple Interface: Easy connection and control via the I2C interface. High Sensitivity: Enables precise measurement even in low-light conditions. Calibrated: Pre-calibrated by the manufacturer, no additional calibration required.

Application Areas: Smart Home Systems: Automatic Light Control. Cameras and Photographic Equipment: For Exposure Control. Weather Stations: Measuring Light Intensity. Handheld Devices: Mobile Phones, Tablets, and Other Portable Devices.

Usage**:** You can install the BH1750 library for Arduino. Installing Wire.h and BH1750.h libraries: You can search for and install these libraries via the "Library Manager" in the Arduino IDE. Measurements: The light levels measured with the sensor in the code are displayed in lux (lx) units. Using these units, it is possible to determine the time of day corresponding to the light level.

```
#include <Wire.h>
#include <BH1750.h>
BH1750 lightMeter;
```

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```
void setup(){
  Serial.begin(9600);
  Wire.begin();
  lightMeter.begin();
}
void loop() {
  float lux = lightMeter.readLightLevel();
  Serial.print("Light: ");
  Serial.print(lux);
  Serial.println(" lx");
  // Tong: 10-100 lux (100-1000 lm)
  if (lux >= 10 && lux < 100) {
    Serial.println("Tong: 10-100 lux (100-1000 lm)");
  }
  // Kunduz: 10,000-100,000 lux (10,000-100,000 lm)
  else if (lux >= 10000 && lux < 100000) {
    Serial.println("Kunduz: 10,000-100,000 lux (10,000-100,000 lm)");
  }
  // Tushlik: 50,000-100,000 lux (50,000-100,000 lm)
  else if (lux >= 50000 && lux < 100000) {
    Serial.println("Tushlik: 50,000-100,000 lux (50,000-100,000 lm)");
  }
  // Oqshom: 100-10,000 lux (100-10,000 lm)
  else if (lux >= 100 && lux < 10000) {
    Serial.println("Oqshom: 100-10,000 lux (100-10,000 lm)");
  }
  // Kechqurun: 0.1-10 lux (0.1-10 lm)
  else if (lux >= 0.1 && lux < 10) {
    Serial.println("Kechqurun: 0.1-10 lux (0.1-10 lm)");
  }
  }
  delay(2000);
}
```

In this program code - it reads the BH1750 sensor, determines the lux level, and prints the current time.

This program determines the light level at different times of the day using the BH1750 sensor and accordingly prints the times of dawn, daytime, noon, evening, and night. In the code, conditions are used to determine each time interval and write them accordingly. The BH1750 measures light using a photodetector and converts this signal into digital data. This data can be read via the I2C interface. The sensor's high sensitivity and wide measurement range make it suitable for use in a variety of applications. Through this program, it is possible to determine daily light levels and distinguish times like dawn, daytime, noon, evening, and night using the BH1750 sensor on the Arduino platform.

III. CONCLUSION

Accurate measurement of light levels and determining various times of the day based on these levels hold significant importance in various scientific, technological, and daily life applications. This article demonstrates the measurement of light intensity using the BH1750 light sensor in conjunction with the Arduino platform and its classification into different parts of the day, such as dawn, daytime, noon, evening, and night. The BH1750 sensor offers

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high precision and a wide measurement range, capable of detecting light intensity from 1 lux to 65,535 lux. Its low power consumption and simple I2C interface make it easy to integrate with various microprocessors and microcontrollers. Using the Arduino platform, simple software codes were written to utilize this sensor and determine light levels. Classification based on these light levels is crucial for various applications, such as automatic lighting systems, smart home systems, and environmental monitoring. This article highlights the practical aspects of using the BH1750 sensor and the Arduino platform, demonstrating the possibilities of accurate and reliable measurement of light levels. Overall, this project provides a cost-effective, simple, and efficient solution for monitoring and managing light levels. In the future, broader applications of these technologies may open new opportunities in various fields.

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