LUMINAIRE DESIGN WITH SOFTWARE SUPPORT

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ELECTRICAL AND ELECTRONICS ENGINEERING

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Farid Ahmed Asmida Abu ABDALLAH

ABSTRACT

M.Sc. Thesis

LUMINAIRE DESIGN WITH SOFTWARE SUPPORT

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Institute of Graduate Programs
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Thesis Advisor:
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Lighting has evolved throughout human history, in various ways including oil lamps, torches and candles. Electronics engineers must consider the rules of lighting and color for successful designs. Brightness in the workplace affects comfort, with automation systems being preferred to save energy.

This research deals with the design of alternative lighting for the main courtyard of the Jaafar bin Abi Talib Mosque, based on international standards and experiences. The design aims to reduce energy consumption and eliminate the shortcomings of the existing lighting system. Field visits and data collection were used to model the mosque structure and lighting system using DIALux Evo software. The results were compared to international standards and experiences to identify technical and operational deficiencies. An alternative lighting design was presented based on international standards and user experiences related to lighting systems for holy places.

The research highlights the importance of implementing specialized lighting systems for various aspects of life, including health, economics, safety and aesthetics. The study proposes new alternative lighting schemes for holy places, such as the Jaafar bin Abi Talib Mosque in Bani Waleed, to reduce energy consumption, lamp use and cost. The proposed schemes aim to improve visibility, reduce glare and increase accessibility to the mosque, while reducing the project cost by 40%.

A new computational method for direct illumination is proposed, valid for any shape or surface, including MATLAB. Offers a comprehensive lighting modeling solution. The program is crucial for improving the lighting environment in spatial environments, especially in Islamic architecture. The study focused on the design of the Jaafar bin Abi Talib lighting system, identifying technical and operational defects, and proposing alternative lighting schemes. Based on global standards and existing lighting systems, the alternative proposed in this study used specialized projectors to distribute light uniformly and reduce glare indoors, resulting in lower overall energy consumption.

Key Words : Light, Brightness levels, LED chips, Digital data.
Science Code : 93404

ÖZET

Yüksek Lisans Tezi

YAZILIM DESTEKLI ARMATÜR TASARIMI

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Işıklandırma, insanlık tarihi boyunca çeşitli şekillerde evrim geçirmiştir; bunlar arasında yağ lambaları, meşaleler ve mumlar bulunmaktadır. Elektronik mühendisleri, başarılı tasarımlar için ışıklandırma ve renk kurallarını dikkate almak zorundadırlar. İşyerindeki aydınlık, konforu etkiler ve enerji tasarrufu sağlamak için otomasyon sistemleri tercih edilir.

Bu araştırma, uluslararası standartlar ve deneyimlere dayanarak Jaafar bin Abi Talib Camisi'nin ana avlusuna alternatif aydınlatma tasarımı üzerine odaklanmaktadır. Tasarım, enerji tüketimini azaltmayı ve mevcut aydınlatma sisteminin eksikliklerini ortadan kaldırmayı amaçlamaktadır. Araştırma için saha ziyaretleri ve veri toplama, cami yapısını ve aydınlatma sistemini DIALux Evo yazılımını kullanarak modellemek için kullanılmıştır. Elde edilen sonuçlar uluslararası standartlar ve deneyimlerle karşılaştırılarak teknik ve işletme açısından eksiklikler belirlenmiştir. Uluslararası standartlara ve ibadet mekanları için aydınlatma sistemlerine ilişkin kullanıcı deneyimlerine dayanarak alternatif bir aydınlatma tasarımı sunulmuştur.

Araştırma, sağlık, ekonomi, güvenlik ve estetik gibi hayatın çeşitli yönleri için özel ışıklandırma sistemlerinin uygulanmasının önemini vurgulamaktadır. Çalışma, enerji tüketimini, lamba kullanımını ve maliyeti azaltmak için Bani Waleed'deki Jaafar bin Abi Talib Camisi gibi kutsal mekanlar için yeni alternatif aydınlatma şemaları önermektedir. Önerilen şemalar, camiye erişimi artırırken görünürlüğü iyileştirmeyi, parlamayı azaltmayı ve maliyeti %40 düşürmeyi amaçlamaktadır.

Herhangi bir şekil veya yüzey için geçerli olan, MATLAB dahilinde yeni bir doğrudan aydınlatma hesaplama yöntemi önerilmektedir. Kapsamlı bir aydınlatma modelleme çözümü sunar. Program, özellikle İslam mimarisinde aydınlatma ortamını iyileştirmek için önemlidir. Çalışma, Jaafar bin Abi Talib aydınlatma sisteminin tasarımına odaklanmış, teknik ve işletme açısından eksiklikleri belirlemiş ve alternatif aydınlatma şemaları önermiştir. Küresel standartlara ve mevcut aydınlatma sistemlerine dayanarak, bu çalışmada önerilen alternatif, iç mekanda ışığı homojen bir şekilde dağıtmak ve iç mekandaki parlamayı azaltmak için uzman projektörler kullanmıştır, bu da genel enerji tüketimini azaltmıştır.

Anahtar Kelimeler : Işık, Parlaklık seviyeleri, LED çipleri, Dijital veriler.
Bilim Kodu : 93404

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CIE : International Commission on Illumination

COB : Chip-On-Board

CSP : Chip-Scale Package

DIPs : Dual Inline-Pin Packages

FDCSP : The freeform-designed chip scale package

LED : Light-Emitting Diode

MOCVD : Metal Organic Chemical Vapor Deposition

OLED : Organic Light-Emitting Diode

QFPs : Quad Flat Packages

SMDs : Surface Mount Diodes

SPD : Spectral Power Distribution

TSVs : Through-Silicon Vias

UNESCO : United Nations Educational, Scientific, and Cultural Organization

UV LED : Ultraviolet Light-Emitting Diode

WLP : Wafer Level Package

PART 1

INTRODUCTION

Throughout the course of human history, people have tried to find a solution to the basic challenge of illuminating their surroundings. when viewed in a more general sense, the issue of lighting was first encountered in prehistoric times and was eventually handled by the facilities that were available at the time. over the course of prehistoric times, people made use of a variety of lighting methods, including oil lamps, torches carried by hand, embers put on trivets and stove fires. candles and portable lamps were added to them over subsequent time periods (Faruk, 2007).

The introduction of town gas was a significant turning moment in the history of lighting, being one of the most crucial turning events in the process of burning bituminous coal, a form of gas known as town is created particular, town gas was used for the purposes of lighting and heating. after the illumination of the streets in London in the year 1807, it started to become a fundamental component of everyday life. after the year 1820, the streets of Paris were illuminated by town gas, and the streets of Baltimore, which is located in the United States, were lit by town gas in the year 1817. as a consequence, oil lamps were used less and less. the process of lighting in Istanbul occurred concurrently with changes on a worldwide scale. considerable amount of time, candles were the primary method of illumination in Istanbul by inhabitants. candles of many kinds, including oil candles, spermaceti candles, wax candles, and oil lamps, were used to illuminate homes and public spaces. olive oil was also used to light candles (Faruk, 2007). The fact that the candle was a generally acknowledged method of illumination led to the eventual development a craftsmen group that was responsible for the casting and sale of candles (Doğan, 1975).

At night, the city was a pitch-black place until the streets were illuminated by contemporary means. because of this, it was against the law to go about the streets at night without a lantern, and everyone was required to carry one with them always. those individuals who disobeyed this regulation were either sentenced to jail or sent to labour in hamam furnaces, where they were required to stoke the furnaces till daybreak. during the reign of sultan Abdülmecid (1839-1861), the lighting of Dolmabahce palace in 1853 marked the beginning of the use of town gas in Istanbul. they were freed in the morning, coated in mud, after having completed chores, such as delivering wood and cleaning the furnaces. town gas was first utilised in Istanbul following the lighting of Donmabahce palace (Faruk, 2007).

The luminous flux that is acquired from a lighting vehicle is of utmost significance for this one reason. after a radiation has left its source, it is the magnitude of light that enables living beings to see in the world around them. the way in which one perceives the items in their immediate environment is directly influenced by the lighting. since this is the case, it is necessary to calculate several aspects, including daylight, lighting, and illumination level, in the most effective manner possible, and then to get the suitable answer (Mehmet, 1999).

Taking into consideration the fundamentals and rules of lighting and colour, the ability of the interior designer to create and shape is essential to the success of the interior design profession. choosing raw materials, calculating reflection and absorption coefficients for colours and materials, and determining how these factors relate to natural lighting are all important steps in the process, where the job of the interior designer is decided in the distribution and calculation of lighting for engineering projects by sketching a preliminary framework at the location where the work is determined in order to ensure that there is no disparity in the lighting of the surfaces that are included into the design, the designer has to make a number of adjustments to the components of the proposed interior design. these adjustments range from the lighting sources and raw materials to the suggested design and colours. consequently, this causes the people who utilise the location to have both bodily and psychological difficulties (Bachi, 2013; Buyukkinaci et al., 2019).

Road lighting is an important application area for energy saving projects. It is also considered a starting step towards saving the energy used in street lighting. It is also considered the process of replacing the sources of lighting that are generally located inside the currently existing lighting fixtures by using other sources of lighting that perform the same role as lighting while consuming less energy, that is, with sources There are many other lighting units in addition to lighting units that are considered more efficient. The use of lighting sources is considered effective, and lanterns are considered new lighting units for open roads. Also, the process of dimming the light source is considered another and second step for lighting sources, and this matter requires an approach that is considered more complex (Boyce et al., 2009).

There are many studies conducted in the literature that ultimately led to the development of this study one of the factors that has been shown to have an impact on the level of comfort that users experience at their places of employment is the level of brightness of the lighting. When it comes to the lighting in the workplace, it has been shown via study that persons suffer discomfort that is larger than 1500 lx (Sawada, 1999). According to Shikakura (2003), people feel greater levels of discomfort in circumstances that are higher than this value than they do in conditions that are lower than this value. 960 lx has been shown to be the lowest limit of comfort circumstances in workplaces, and this is comparable to what has been defined as the lowest limit of comfort conditions.

An other study (Onaygil and Tenner, 1993) discovered that an average illumination level of 800 lx had a positive influence on working persons in working environments such as offices, which are locations where people spend a large amount of time. This was proven to be the case in the workplace. It was seen that the brightness level was increased from the level of pleasant feeling to 1300 lx levels, and it was observed that this did not have any effect on the individuals who were working in the surroundings. Gabriela wrote in the year 2003.

There is a broad variety of comfort conditions, which vary not only according to the brightness level but also according to the colour temperatures that are included in the settings. These conditions may be found when the brightness level is adjusted. When people are exposed to low light levels in warm light sources, it has been shown that they feel a sense of comfort and tranquilly. This was discovered over the course of study that was conducted on persons who are working in the office environment. On the other hand, Fleischer (2001) found that participants experienced an increase in their degree of pleasure when they were exposed to high amounts of light.

Those persons who work in situations that have high levels of brightness report higher feelings of comfort, as shown by the results of another piece of study (Sawada, 1999). In addition, the colour temperatures that are present in the world around you do not have any effect on the amount of comfort that you experience. When the colour rendering properties of the ambient light sources were also taken into consideration, the researchers came to the conclusion that the colour rendering index (Ra) was effective in the development of the feeling of brightness in an indoor environment, and that the colour temperature changes in environments where this effect was present did not change the impression of brightness in humans (Kanaya et al; 1979). This was the conclusion reached by the researchers in a different study. Researchers came to this realisation as a result of their investigation.

Ishida and Ogiuchi (2002) state that when people are given the ability to control the brightness levels of their surroundings, positive changes have been seen in both their behaviour and their perceptions of the environment. This is the case when individuals are given the ability to adjust the brightness levels of their surroundings. Onaygil et al. (2002), Onaygil et al. (1998), and Onaygil and Tenner (1993) came to the conclusion that the use of automation systems in work offices is preferred by working people because it enables them to be given the authority to control the level of brightness in the environment and, as a result, saves energy. This is the reason why working people prefer the use of automation systems. Following the completion of a research study that was carried out inside this particular setting, this conclusion was arrived at.

According to the results of a study that was conducted on the topic of light sources that are used for the purpose of lighting, it was revealed that different lighting systems cause people to have different perceptions of the ambient lighting. This was one of the conclusions that emerged from the research. The study that investigated the connection between the lighting systems in office settings and the effects that these systems have on individuals used fluorescent lights with a colour temperature of 5000 degrees Kelvin (K) and incandescent lamps with a colour temperature of 2700 degrees Kelvin (K) as lighting systems. The purpose of the research was to evaluate the impact that various lighting schemes had on persons who were being studied. When the ceiling and walls are lighted with a high degree of illumination utilising cold light sources, it has been shown that individuals perceive a sense of spaciousness and an improvement in visual clarity. This is because the ceiling and walls are illuminated with a cool light. According to Manav and Yener (1999), when it is lighted with a low lighting level employing hot light sources, individuals have a sense of comfort, and the area is seen as being calming. This is the case when the lighting level is low. This study aims to automatically control the selected lighting elements according to the appropriate characteristic (energy consumed, lighting efficiency, light quality). In addition, taking into account the level of lighting, lighting efficiency and its provision.

PART 2

LITERATURE REVIEW

2.1. LIGHT DEFINITION

In recognition of light's central role in photonics, solar power, and emerging lighting technologies—not to mention its pervasiveness in our daily lives and the quality of life it enhances—2015 has been declared by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as the International Year of Light and Lighting Technologies. as Figure 2.1. Depending on the context, light may signify a variety of things (Zwinkels, 2015). The phrase "optical radiation" is used to describe what is called electromagnetic radiation in its broadest sense, which scientists have classified to include the ultraviolet and visible parts in addition to infrared radiation across what is called the "electromagnetic spectrum", and whose wavelengths are between about 10 nm and 1 mm. In its most common application, the International Lighting Vocabulary (CIE, 2011).

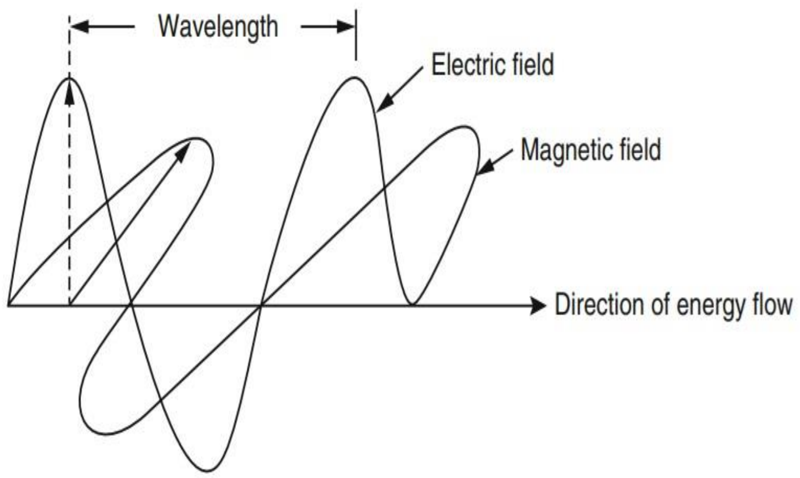

Figure 2.1. Illustration of an electromagnetic wave in its simplified form (Zwinkels , 2015).

The optical stimulus, which is a unique property of all sensations and perceptions of vision, and is a type of radiation that excites the human visual system, is limited to electromagnetic radiation with wavelengths in the visible spectral region between 380 and 780 nanometers. Light is sometimes used to describe electromagnetic radiation, including ultraviolet, visible, infrared, X-rays, gamma rays, and radio bands. Energy transmitted or emitted as photons or electromagnetic waves is known as electromagnetic radiation. The quantum of electromagnetic radiation known as a photon is most commonly linked with monochromatic radiation, which has a single wavelength or frequency. The speed of an electromagnetic wave is directly proportional to the value of the medium's refractive index; in a vacuum, the wave travels at the speed of light, but in other media, its speed is lowered by a factor of the medium's value. A visual depiction of electromagnetic waves organised by wavelength is called an electromagnetic spectrum (Zwinkels , 2015).

2.2. HISTORY

Throughout history, the study of light's properties has captivated thinkers and doers. Light was long thought to be composed of particles (corpuscles) that emitted from the source due to its rectilinear propagation, which means that it travels in straight lines. A distinct model of light was required for certain of its qualities, such as the fussiness caused when light goes around barriers or through apertures (diffraction), which is a form of spreading disturbance. Both the particle theory and the wave theory of light were popular in the early 17th century. Some, like the Dutch physicist Christiaan Huygens, strongly believed in the former, while others, like Sir Isaac Newton, believed in the latter. However, the wave model of light became the prevailing idea in the early 1800s after English physician Thomas Young demonstrated that light interfered and distorted to create fringes as it travelled through a double slit. By applying particle behaviour and a new sort of theory—quantum physics—to the photoelectric phenomenon, Einstein brought the particle theory of light back into vogue towards the end of the nineteenth century. The three behaviors—particle, wave, and quantum—used to describe light have now been generally acknowledged as being present in light (Chodos, 2024).

The experiment by Galileo indirectly demonstrated that light can travel in free space at constant speed without a medium. Michelson improved on Galileo's echo technique by replacing lanterns with mirrors and a telescope. By adjusting the mirror rotation speed and the known light distance, he could determine the speed of light to about six significant figures. The speed of light is now the most accurately known fundamental constant of nature (Zwinkels , 2015).

2.3. LIGHT AND ELECTROMAGNETIC RADIATION

The term "emr" can refer to both the outward manifestation of electric and magnetic field oscillations and the energy transfer that results from charged particles vibrating (Purcell and Morin, 2013). Electric potential Field of magnetic resonance The path that energy takes. Both the axes of the oscillations and the energy flow are perpendicular. Electromagnetic waves got their name from the fact that electric and magnetic waves in the electromagnetic spectrum usually happened in tandem, or linked. It was also discovered that the electric and magnetic wave lines of force were always transverse, never longitudinal, and perpendicular to both each other and the direction of wave propagation. Due to the fact that light is inherently transverse, polarization-related phenomena are born. Radiation that has a transversal electromagnetic field that is orientated in certain directions is called polarised electromagnetic radiation (Jenkins and White, 1976).

This polarisation can be either linear, elliptic, or circular. All electric field vectors in a beam of light must be perpendicular to a constant direction—the polarisation direction—for the beam to be considered fully linearly polarised, sometimes called plane polarised. When the electric field vectors of a beam of light are not polarised, their vibrations are uniform and perpendicular to each other. The phase relationship between the two orthogonal components describes the radiation's polarisation state, which can be linear, circular, or elliptic. There are three types of radiation polarisation: linear, circular, and elliptically polarised. Linear polarisation occurs when the phase difference is zero or 180 degrees, while circular polarisation occurs when the phase difference is 90 or 270 degrees and both components have the same amplitude. If the electric vectors are biassed in one direction, we say that the light is partly polarised.

The electric vector is said to be s-polarized (or TE) if its polarisation is perpendicular to the plane of incidence, and p-polarized (or TM) if it's perpendicular to the plane of incidence. There are a variety of additional quantifiable characteristics of electromagnetic waves besides their polarisation state, such as their oscillation size, the number of oscillations per second, and the distance between peaks and troughs. There are three variables that characterise these quantities: frequency (n), wavelength (l), and amplitude (I). Intensity, which is a measure of the electromagnetic wave's energy flow, is directly proportional to the square of the amplitude. Another important detail to note is the wave's direction of travel, as an arrow. A sinusoidal pattern, in which the wave front moves up and down, is visible in the crests of these waves. It is crucial to specify the phase difference between waves when more than one is in motion. When the peaks and troughs of two waves match, we say that they are in-phase. When the peak of one wave meets the bottom of the other, we say that the two waves are out-of-phase. Any wave with infinitely parallel lines perpendicular to the direction of motion and surfaces that are in phase with one another is called a plane wave. A coherent emr is one in which the wave vibrations are all in phase with one another. One kind of coherent light source is the laser. An incoherent emr occurs when the light waves released by a source do not follow a regular phase pattern. Incandescent lamps and other commonplace light sources are instances of light that is not coherent (Zwinkels , 2015).

2.4. PROPERTIES OF ELECTROMAGNETIC WAVES

A wave is often defined as a perturbation that travels across a continuous medium, disrupting the equilibrium condition within. But electromagnetic waves may travel through air without any special equipment. Einstein initially proved this characteristic of electromagnetic waves in 1905, and it distinguishes them from other kinds of waves that might be thought of as mechanical in character. Additionally, he put out the notion that light may act as both a wave and a particle to clarify the radiation spectrum given off by a heated object (shining). All electromagnetic waves, including this kind known as black body radiation, fall within this category. Continually moving at the same velocity in a vacuum. The speed of light in a vacuum, abbreviated as c, is a fundamental constant of nature. There are 299,792,458 metres per second that it is worth as Table 2.1(Zwinkels , 2015).

Table 2.1. Different parts of the electromagnetic spectrum and light (Zwinkels , 2015).

Wavelength range (nm)	Frequency range (s^{-1})	Description
<0.1 mm	10^{20}–10^{23}	Gamma rays
0.1-10 mm	10^{17}–10^{20}	X-rays
10-400 mm	10^{15}–10^{17}	Ultraviolet
400-700 mm	10^{14}–10^{15}	Visible
700 mm to 1 mm	10^{11}–10^{14}	Infrared
1 mm to 1 cm	10^{10}–10^{11}	Microwaves
1 cm to 100 km	10^{3}–10^{10}	Radio waves
100-1,000 km	10^{2}–10^{3}	Audio frequency

Relativity between frequency (v) and wavelength (l) is given by n = cl1. The wave number, abbreviated as s, is another way waves are defined; it is the inverse of wavelength and is defined as s = l1. The speed and wavelength of an electromagnetic wave are both lowered by a factor, n, which is the refractive index of the material, when it passes through different media like water, air, or glass, but the frequency stays the same. The frequency-dependent value of n, for widely-used optical glasses, falls between 1.52 and 1.72. You may ignore the value of n for standard air, which is 1.00028 (Ciddor, 1996), for most practical applications. A system of wave equations called Maxwell's equations describes the behaviour of electromagnetic waves at the interface between two media, which causes phenomena including reflection, transmission, and refraction. A connection between electricity and magnetism is established by these four equations, which have evolved into the basic rules of lectromagnetics. The shape of electromagnetic waves and the wave equation are both revealed by solving these equations (Munz, 2017).

According Zwinkels (2015) provide a decent summary; however, the equations of Maxwell are not included here as they are outside the scope of this item. "Photon" is the atomic symbol for the smallest unit of electromagnetic radiation. The formula for a photon's energy, E = hn, uses Planck's constant, h, which is 6.62606 x 10^34 J s. One way to look at light is as a continuous flow of individual photons, or particles, which have their own unique energy and may interact with one another in wavelike ways and even bend and distort when they encounter obstacles. The identical set of Maxwell wave equations govern the travel of these photons (Zwinkels , 2015).

A wide variety of physically achievable electromagnetic radiation wavelengths, from the smallest to the longest, make up what is known as the electromagnetic spectrum. Radio waves, infrared, visible, ultraviolet, X-rays, and gamma rays are all part of this spectrum, which extends from almost zero to near infinity and may be roughly classified into the sections given in Figure 2.2 shows a schematic of the visible and ultraviolet zones, which illustrate that there is a gradual transition from one to the other, therefore this separation is not accurate (Williamson and Cummins, 1983).

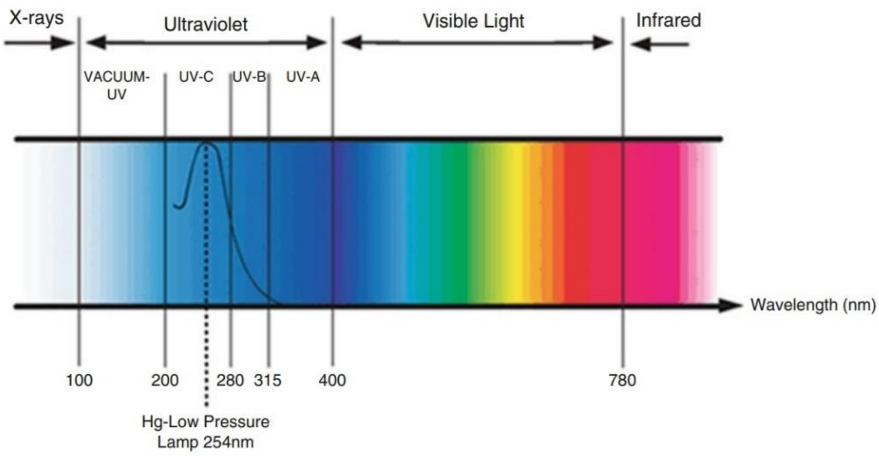

Figure 2.2. Electromagnetic spectrum areas, with an emphasis on the visible and ultraviolet light spectrum (Yahya, 2012).

This region-based light categorization is also displayed as a frequency-dependent function. Remember that the wavelength is the single determinant of electromagnetic radiation type across all of these areas. The connection between its frequencies and those stimulated in the various materials that electromagnetic radiation can interact with gives rise to distinct descriptions. Contrast this with the extremely restricted frequency range (400-700 nm) that electromagnetic radiation may reach the human eye's visual receptors; X-rays, on the other hand, can activate characteristics in the body that are as small as a single atom (0.1 nm) (National library of medicine, 2013).

2.5. LIGHT INTENSITY DISTRIBUTION AND COLOR

The different wavelengths in the visible spectrum can also directly stimulate different colors in the human visual system. This dependence of color on wavelength was shown in Table 2.2 (Zwinkels , 2015).

Table 2.2. The dependence of color on wavelength in light, the electromagnetic spectrum (Zwinkels , 2015).

Wavelength range (nm)	Color
400-430nm	Violet
430-480nm	Blue
480-560nm	Green
560-590nm	Yellow
590-620nm	Orange
620-700nm	Red

Radiation of one wavelength is called monochromatic. But lasers are excluded, as are some specialized lamps. Optical radiation usually emits energy over an area with a wide wavelength, and the curve that describes the power at each wavelength is called the spectral power distribution (SPD). The color stimulus generally contains an SPD that differs when it is with the wavelength when it is within the visible spectrum, which usually produces a sensation or produces a color or sometimes a mixture of colors. Also, the stimulators may contain proportions that are considered equal to the lengths of the positive type. It displays the white color, as is evident in passing the white color of light through a glass prism that permanently spreads light into a wide range of colors, as in Figure 2.3 Yahya, 2012).

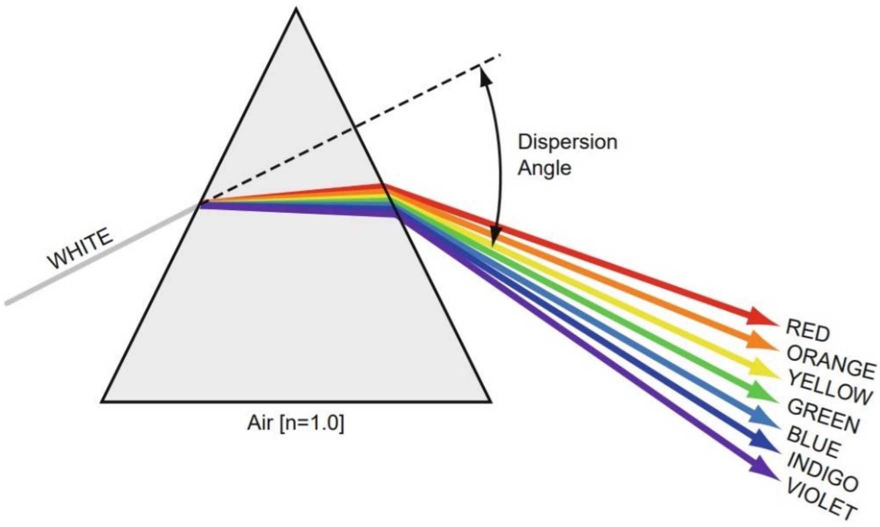

Figure 2.3. Electromagnetic light uses a prism to separate white lights into a spectrum of colors (Pelton et al., 2013).

Scientists suggest that it is possible to produce white light by combining various lights, including red, green, blue, or all of them together, in specific proportions. Thomas Young was the first to globally demonstrate this, using practical experiments to confirm the previously proposed theory that human eyes generally contain three types of cones, distinct from what is known as color receptors. Scientists termed this the trichromatic theory for human color vision. Additionally, white light production can be achieved by utilizing a large number of different “SPD” devices (Zwinkels , 2015).

Due to the concept of trichromatic vision, it is also possible to produce white light by using various SPD devices. Differences in SPD types can be observed in typical tungsten lamps, fluorescent lamps, and light-emitting diode (LED) lamps. “LEDs” producing white light can vary in their “SPD” types, utilizing blue “LEDs”, yellow phosphor-coated LEDs, or both, as well as other configurations used in daylight illumination. The most prevalent light source on the planet, the sun, naturally exhibits a specific “SPD” type that can vary significantly throughout the day, transitioning from a bluish hue at midday to an orange hue at sunset. These variations in “SPD” types for light sources are crucial for various evaluations related to colored goods. Therefore, devices with specific “SPD” types may be utilized across different stages of daylight, standardized by the International Commission on Illumination (CIE), which scientists categorize as a series of type D SPDs. One such standardized daylight illumination type is CIE D65, known for its average daylight spectrum and correlated color temperature of approximately 6500 Kelvin (Zwinkels , 2015).

2.6. APPLICATION OF TECHNOLOGY OF LED LIGHT

For some time now, “LED” technology has been the talk of the town as a potential replacement for traditional mercury gas-filled lamps in curing, printing, and, more recently, disinfection applications. While UV low-pressure lamps have found increasing use in the food industry, “LED” technology is still in its infancy as a tool for processing and preserving food. Instead of using traditional UV lamps, LEDs use a different manufacturing process and light-generation mechanism. A deeper familiarity with the fundamentals of “LED” technology, including chip design, array and component manufacturing, system design, and commercialization, is necessary for the effective application and commercialization of ultraviolet light-emitting diode (UV LED) technology (Koutchma, 2019).

2.6.1. Led Chip

LED lamps are a type of semiconductor device, also known as solid-state devices, that convert electrical energy into either visible light or sometimes into infrared (IR) or ultraviolet (UV) energy. Scientists categorize this energy conversion process into two stages. The first stage involves the excitation of charge carriers within the semiconductors to states higher than their ground state when electrical energy is applied. The second stage occurs when these previously excited carriers release energy, such as through the spontaneous emission of photons with energy equal to the bandgap of the semiconductor material. To emit photons of light, multiple specified elements are integrated into specific configurations, through which an electric current is passed. LED lamps are often referred to as "chips" or "dice," consisting of multiple layers of semiconductor materials, including an n-type layer providing electrons and a p-type layer providing holes for electron recombination. The junction of these semiconductor types, known as a p-n junction, is where electron injection and hole injection occur in an active region (IESNA, 2005).

There are 12 essential elements for the construction of LEDs: B, Si, Ge, As, Sb, Al, Ga, In, and Sn as p-type dopants, and Ni, P, and C as n-type dopants as Figure 2.4. When a voltage source is connected to the LED, electric current flows from the pside to the n-side, releasing excess energy in the form of photons that can transport electromagnetic radiation of all wavelengths (IESNA, 2005).

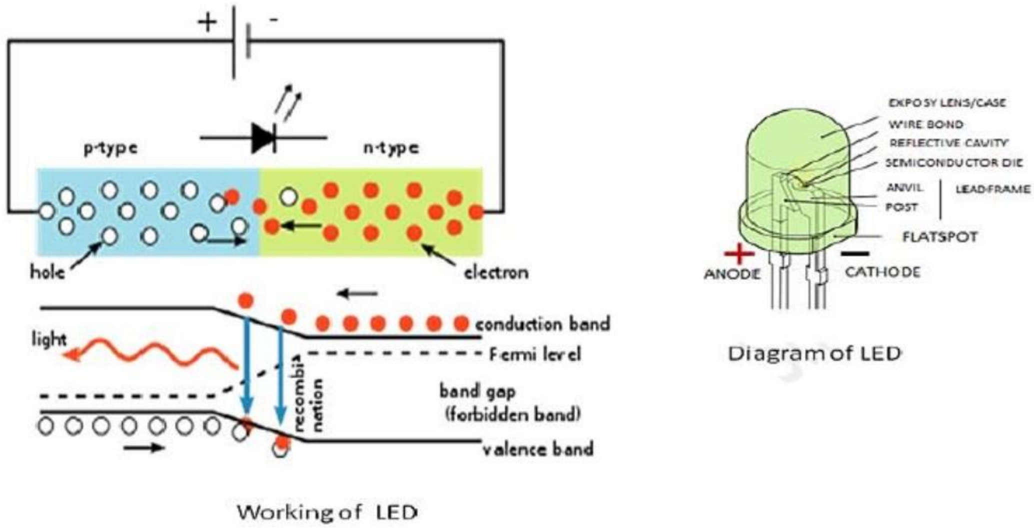

Figure 2.4. The fundamental concept of the light-emitting LED chip (Mishra et al., 2019).

“UV LED” lamps are a type of light source that emits light in a beam pattern using “UV LED” chips. They are composed of various components, including a material called gallium aluminum nitride or sometimes indium gallium nitride. Additionally, mercury vapor lamps exhibit multidirectional emission characteristics, which scientists attribute to the entire surface area of the full glass tube being considered an emission area. It is possible to produce a type of lamp called “UVC LED”, which features chips with a diameter of up to 50 mm and can reach up to a thousand individual devices. These chips are grown epitaxially using a technique called Metal Organic Chemical Vapor Deposition (MOCVD), where multiple thin layers of atoms are deposited in chip form inside semiconductors (RadTech, 2016).

Temperature, when coupled with alternating current input, constitutes two primary factors that may regulate the operational lifespan of LED lamps. Operation within a specific temperature range, termed junction temperature, is crucial. This temperature range ensures that the LED remains functional, converting electrical energy into light, until its expected end-of-life without the use of any thermal management. However, improper thermal management can lead to internal heat buildup, resulting in premature LED failure. Therefore, specialized heat sinking for UV diode LEDs is essential, as excessive temperatures within the junction may cause degradation. LED chip sizes can vary from fractions of millimeters for miniature signaling to larger than millimeter-scale power packages. Self-powered LED lamps of larger sizes, up to a substantial 12 square millimeters in area, along with rectangular-shaped chips, are available in the market (RadTech, 2016).

The wavelength that is needed, the peak UV irradiance, and the capabilities of the LED chip maker all play a role in the unique design of each individual UV LED chip or diode. Initial achievements were accomplished by employing longer wavelengths in both visible light and infrared signals. In the year 1992, a laboratory in Japan was the first place in the world to manufacture a UV LED with an efficiency of around 1%. There are a number of technological problems that must be overcome in order to design and produce ultraviolet light-emitting diodes (UV LEDs). These challenges include understanding how to create epitaxial layers of the needed compounds that have a high crystalline quality and a low defect density on top of CIS AlN substrates, attaining low resistance, making excellent electric connections, and packaging the device (Koutchma, 2019).

2.6.2. LEDs in packaged form

The technology that is used in packing is an essential component of packaging. The dependability of the package and the length of time the gadget may retain its functionality are both determined by the quality of the packaging technique (Ben Abdelmlek et al., 2017).

Research and development as well as the technology of greater output LEDs have been actively developed in order to fulfil the growing need for illumination. Additionally, the technology of LED packaging has advanced from single-chip packaging to multi-chip packaging in order to accommodate this escalating demand. Surface mounts and power packages are both examples of examples of single-chip packaging (Chen et al., 2012). Applications that need little power are the only ones that are suitable for these packages. Different types of packages, such as dual inline-pin packages (DIPs) (Teng et al., 2010) and quad flat packages (QFPs) (Stoyanov et al., 2013). , have been developed throughout time. DIP is welded by the use of perforation, which results in the package being cumbersome and difficult to operate. In most cases, QFP is utilised for large-scale integration since it renders the distance between the pins and the chip unimportant. Packages that include many chips are referred to as chip-on-board (COB), wafer level package (WLP), and chip-scale package (CSP). The chips are coated with a phosphorescent glue (Zhou et al., 2018), which is done at a greater packing density (Hamidnia et al., 2018). COB assigns chips directly to the board and covers them with the adhesive. The most common types of LED packages available on the market are COB, WLP, and CSP (Liu et al., 2022).

Even for chips that originate from the same wafer, the light output power of UV or visible LED might vary by a factor of two due to the intricacy of the procedures involved in the production of wafers and chips. The chips that have been binned are then sold to a packager, who then places the chip in a protective package that includes optics and leads that may be soldered. Obtaining the required level of light intensity and power for the application can be accomplished through the utilisation of numerous chips or groups of packed LEDs. A typical packed LED system is comprised of many components that are layered on top of one another to achieve maximum performance as Figure 2.5. (Koutchma, 2019).

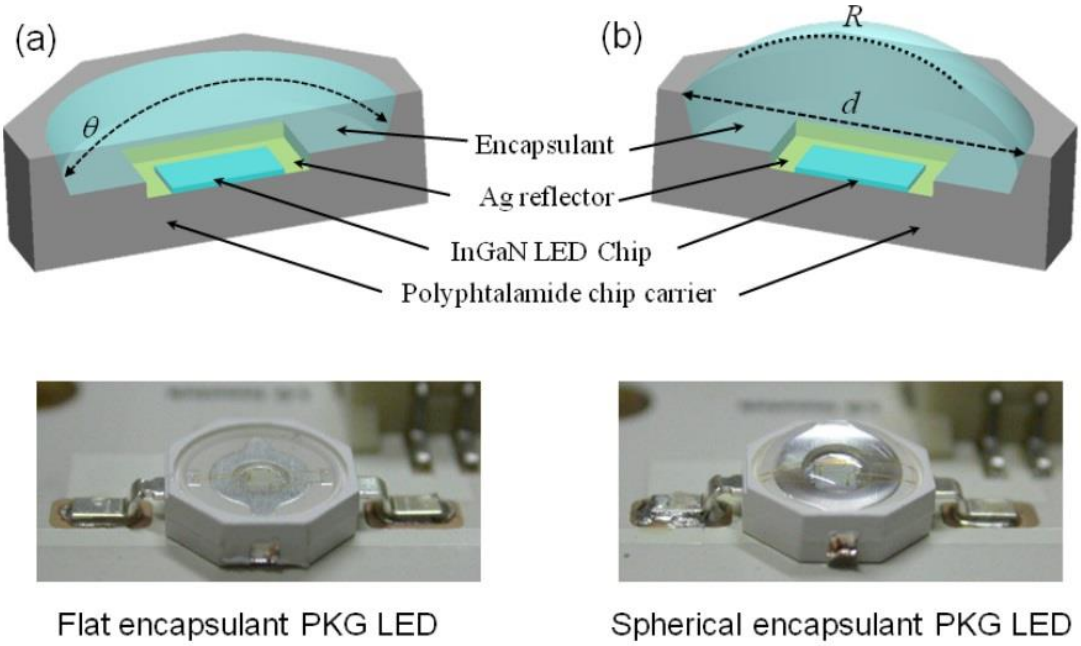

Figure 2.5. The PKG LED structures with the flat encapsulant and the spherical encapsulant, respectively. Two types of encapsulants were created for a chip carrier: one with a flat surface and one with a spherical one. The chip carrier had an inner diameter of 7 mm and a side-wall angle of 34 degrees (Jo et al., 2010).

An LED chip is placed on the reflector cup of a packed (PKG) LED, along with the wire that is used for current injection, and the LED chip is then filled with an encapsulant. Enhanced light extraction from the chip is achieved by the use of the encapsulant, which also shields the wiring and the chip from the surrounding environment. It is the total internal reflection (TIR) of the incident ray at the interface that is responsible for the effect of light extraction; thus, the refractive indices and the geometrical shapes of the encapsulants are highly essential determinants in the LED output power (Zukauskasm et al., 2002).

Through-hole (T-Pack style) LED packages, surface mount devices (SMD), and chip on board (COB) LED packages are the three most common forms of LED packages. The vast majority of ultraviolet light emitting diodes (UV LEDs) are surface mount diodes (SMDs), which can be any number of chips contained within a ceramic package and soldered onto a printed circuit board. Chip on board (COB) LEDs are utilised in situations where a high packing density is required for a greater intensity or when the working distance is relatively short in comparison to the irradiated area. Furthermore, these LEDs require specialised equipment. An LED array often consists of a large number of chips that are stacked in a matrix pattern, whereas a simple LED package may consist of one or many chips. Both the optical power of the chip and the packing density of the LED array are factors that determine the power density of the array. Circuitry for the driver, thermal management, mechanical mounting, controls, lenses, and optics are all components that are included in an optimised LED system package (Koutchma, 2019).

2.6.3. 3D Package and TSV

The emerging technology known as three-dimensional packaging, in addition to silicon interposers employing through-silicon vias (TSVs), is considered a solution to the challenges posed by all types of LED packages, particularly those featuring foldability, vertical integration, and chip stacking. Assembling such packages involves incorporating integrated circuit chips that are vertically and laterally interconnected, resulting in a much smaller form factor and lighter weight, as well as enhanced heat dissipation. The TSV technology used for electrical interconnection within and between chips at the three-dimensional level increases package density and vertical interconnect density, significantly improving signal transmission speed and reducing power usage and consumption. Combining three-dimensional packaging with TSV technology facilitates the creation of efficient thermal management, predominantly utilized within high-power LED lamps (Chen et al., 2013).

The application of TSVs to chip-level packages reduces signal delay and loss, substantially increasing signal transmission speed and enabling direct heat dissipation through the silicon pathway. Zhang et al. (2014) designed user-level LED packages with somewhat low thermal resistance, including LED dies, metal bumps, and TSVs. LED dies are placed on a metal protrusion surface passing along the front side of the silicon base structure, along with a heat sink and electrically conductive and insulating posts, serving as thermal conductors on the back side. TSVs are positioned outside the area aligned with the LED die, facilitating heat dissipation and improving thermal dissipation through external package screws, as illustrated in Figure 2.6. The emerging technology known as three-dimensional packaging, in addition to silicon interposers employing through-silicon vias (TSVs), is considered a solution to the challenges posed by all types of LED packages, particularly those featuring foldability, vertical integration, and chip stacking. Assembling such packages involves incorporating integrated circuit chips that are vertically and laterally interconnected, resulting in a much smaller form factor and lighter weight, as well as enhanced heat dissipation. The TSV technology used for electrical interconnection within and between chips at the three-dimensional level increases package density and vertical interconnect density, significantly improving signal transmission speed and reducing power usage and consumption. Combining three-dimensional packaging with TSV technology facilitates the creation of efficient thermal management, predominantly utilized within high-power LED lamps (Chen et al., 2013).

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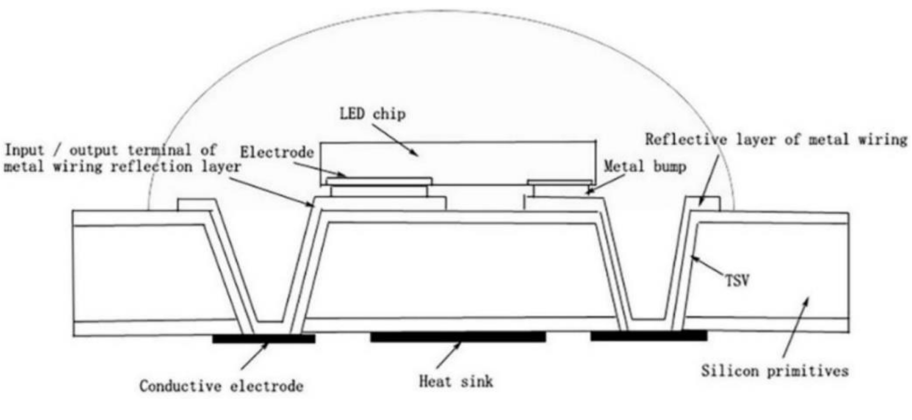

Figure 2.6. Chip-level LED package with low thermal resistance (Liu et al., 2022).

The implementation involved the incorporation of a technique called "TSV" into product manufacturing, enhancing the heat dissipation path and integrating with the optical design of LED arrays. Furthermore, the system was refined to improve phosphor conversion efficiency and manage heat dissipation from the phosphor layer. The energy level intended for a predetermined LED unit was coupled with a ceramic phosphor converter adapter on the silicon chip, interlaced with a specific type of TSV, which links to a utilization source through multiple seals, enabling light proximity to the silicon chip frame. Additionally, the LED type was encapsulated via ceramic housing that acts as a phosphor, ensuring optimal light reflection and high efficiency (Liu et al., 2022).

Direct ceramic-type adapter connection was not established through the LED chip but associated with a specific segment of each, leading to heat dissipation from light type conversion to the equipment. This process resulted in an uninterrupted LED chip and also influenced its lifespan. Failure to manage partially generated heat between chips, especially during stacking, could compromise device reliability. The use of TSV technology for the substrates, along with other encapsulating materials, highlights the importance of addressing mismatches in expansion coefficients among various materials to prevent failure (Zoschke et al., 2018).

2.1.4 Ultra-Thin Package

Thanks to this technology, a specialized three-dimensional chip with a technique called "TSV" has succeeded in innovating electronic packages that are significantly smaller and different. A unique design for these packages has been developed to provide much less contact area, reducing a specific wire width, and then using an easily applicable phosphor coating to reduce the amount of phosphor used. Cliff et al. (2013) established a new type of LED package that became extremely compact and higher level than the first released at the chip level, which can participate in the inclusion of a specialized package in LED chips that are vertical. It does not use a special wire bonding, making it a commercial product (Kleff et al., 2013).

The technology known as Flexible LED Suits (FLED), characterized by flexibility, has become commercially viable for operation through a significantly reduced thickness, reaching up to 82.7%, compared to so-called "COB", which is even thinner, up to 35%

of the total light output compared to the light-emitting diode (OLED) through Panasonic (Lee and Lin, 2015). A specific type of comprehensive package is used for various electronic optical devices and is used for different packages such as WLP and CSP types. It is operated for a reason, defining the package as a CSP type package, as there is a 120% total edge, and it functions internally for reliability and further memory identification after long-term operation (Liu et al., 2014).

According to Huang et al. (2019), backlighting and direct lighting can be combined to design a specially characterized package design, such as chips, and then operated to produce an appropriately sized LED lamp. It also works on a special package method by measuring the chip (FDCSP), and it can be designed freely by registration to effectively and efficiently reduce the package size for subscription and then dissipate heat. Wendel et al. (2014) considered a physically skilled professional who installs silicon-type LEDs vertically with thin films directly on a special base package to form a new type of LED package from the first Oscar for swimming (TFP). It performs a special process of removing the structure that holds the chip, in addition to bonding the first one, and reduces the structure of the structure by intersecting the LED type to the base (Wen et al., 2014).

Although the credit packaging technology, which now seems very good, works very little and can switch heat, it must change reliably with a reduction in thickness as shown in Figure 2.7.

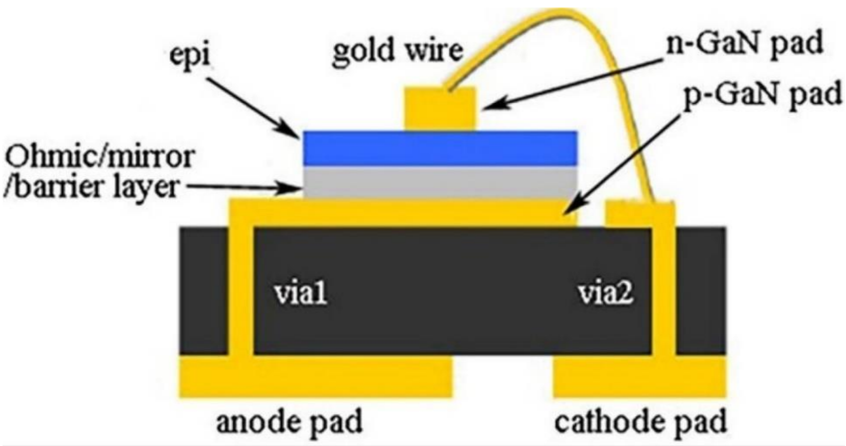

Figure 2.7. A schematic diagram showing the construction of a TFP LED (Liu et al., 2022).

2.6.4. Package Structure

The heat dissipation paths in LED packages are limited and can be improved by modifying the package structure, material with higher thermal conductivity, or adding an external heat sink. The design of the package substrate, lens, and phosphor layer significantly impacts heat dissipation. To enhance heat dissipation, new packaging structures and materials can be developed, allowing for better thermal conductivity and a more efficient LED package (Liu et al., 2022).

2.6.4.1. Substrate Design

The package substrate serves as a crucial bridge in the package, acting significantly as a thermal channel essential for heating the LED chip inside the package of a high-power LED device. It should be noted for its high electrical insulation performance, stability, high thermal conductivity, as well as the presence of a thermal expansion coefficient, flatness, and strength, while also being compatible with the chip (Chen, 2012).

Substrates include various types such as LED packaging, ceramics, silicon, and glass, along with diverse metallic substrates like Cu and Al. Metallic substrates offer several advantages, notably their superior thermal conductivity compared to non-metallic substrates. When working with them, it's essential to consider their conductivity for electrical safety. To prevent leakage within circuits, metallic substrate types should be coated with insulating layers, while ceramic substrates inherently act as insulators, thus not requiring additional layers (Lan et al., 2012).

Huang et al. (2020) developed substrates composed of copper and aluminum by placing an anode made of an aluminum plate, alongside the use of certain explosive compounds known for their high temperature and malleability. These substrates, whether Al or Cu types, coated with an insulating layer, ensure efficient heat dissipation, though Cu substrates may increase packaging costs.

Creating composite substrates of copper and aluminum involves a high-temperature explosion process, somewhat costly. They exhibit a heat dissipation effect similar to copper, addressing the issue of direct aluminum soldering. Direct heat from the chip may surpass the insulating layer's thermal resistance after primary and secondary milling processes, where sheets coated with copper material are used (Liu et al., 2022).

The channel works to dissipate heat within LED packages while reducing its insulating layer to enhance insulation, leading to significant temperature increases inside the junction due to heat accumulation, resulting in very high temperatures under the mold. To improve heat dissipation, integrating the chip on board (COB) with the electronic substrate used for power can reduce the specific impact for overall heat dissipation within the package (Ha and Graham, 2012).

A study by Wu et al. (2019) found that applying a carbon-like coating resembling diamond on a specific substrate, designed for a special LED packaging, enhances light emission and thermal dissipation performance. Thermal imaging evaluation demonstrated the coating's effect on the layer thickness closely resembling diamond and its impact on heat dissipation performance. The simulation results were somewhat compatible with experimental results, indicating that a thick carbon film resembling diamond enhances thermal radiation inside the substrate.

Enhancing substrate heat dissipation can be achieved by modifying the substrate material composition and providing various types of holes for heat dissipation (Xu et al., 2017). Improvements were made in utilizing thermal holes filled with copper material within a ceramic substrate structure to enhance DUV-LED lamp lifespan. This led to a significant 23.04% decrease in thermal resistance compared to traditional structures. However, substantial shortening of the heat dissipation path can be achieved by removing the substrate (Liu et al., 2022).

Nie et al. (2016). proposed a new chip-on-package (COB) packaging structure consisting of six parts: lens, phosphor, chip, plastic layer, adhesive layer, and heat sink. The structure removes the substrate, allowing the LED chip to be embedded in the plastic layer using a pre-plastic film packaging method. The heat generated by the chip is dissipated to the outside through a heat sink, reducing the junction temperature and shortening the cooling path. This method reduces costs and requires careful attention to lateral and vertical heat transfers between the chip and plastic material. This approach is advantageous due to the different thermal expansion coefficients of different materials (Nie et al., 2016)

PART 3

MATERIALS AND METHODS

The lighting design for the Jaafar bin Abi Talib Mosque, which began in November 2023 - March, 2024, a design was conducted using DIALux Evo for the mosque and a proposed alternative lighting model was drawn up.

Jaafar bin Abi Talib Mosque is located in the city of Bani Waleed, specifically in the Al-Husna tribe, where the city of Bani Waleed consists of 53 tribes and the city of Bani Waleed The city of Bani Waleed is a city located in the northwest of the State of Libya, about 180 km from Tripoli towards the southeast, with an area of 19,710 km, and its population exceeds 100 thousand people and was previously called the popularity of Bani Waleed, and the city contains 365 water wells and was previously a desert land working Its people in livestock breeding and agriculture

3.1. DESIGN

Within the scope of this investigation, an alternate lighting design for the main courtyard of the Jaafar bin Abi Talib Mosque is under consideration. These plans are offered on the basis of pertinent international experiences and standards for lighting systems, with the goals of lowering energy consumption and removing the deficiencies of the current lighting system. In the beginning, the DIALux Evo software was used to model the general structure of the Jaafar bin Abi Talib Mosque. This included the dimensions, height, and architectural structure of the mosque. Additionally, the DIALux Evo software was used to model the existing lighting system of the mosque, which included the number of projectors, their location, and the amount of energy they consumed.

Following that, the technical and operational deficiencies of the present design were found by utilizing the results acquired from the software simulation and comparing the data output by the software with lighting standards and experiences from across the world. The presentation concluded with the presentation of two alternative lighting designs that were based on international standards and user experiences connected to lighting systems for holy places.

When it comes to the importance of space in holy places, the lighting system is one of the most essential things that can be considered. With regard to Islamic architecture in particular, light is not only utilized to illuminate the architectural space, but it also possesses a mystic and sacred quality, and it influences and highlights other qualities of space, such as color, texture, and so on.

The evolution and sequence of space in Islamic architecture can be explained in large part by the rhythm of light, which plays an essential role in their design. The sequence of space with light is a visual sequence. As a result, it is possible to assert that the implementation of the sequence of space with light, which is considered to be an element of Islamic art, is seen as a matter that is highly appreciated in Islamic architecture. The spiritual element known as light is capable of penetrating solid materials, transforming them into a wonderful shape, and transforming them into something that is beautiful and deserving of recognition. The notion of manifestation is emphasized through the use of light in Islamic architecture, which plays a significant part in the process. The presence of light causes the material to become transparent, which in turn decreases the building's solidity and coldness. The lighting of mosques, as well as the development of the lighting system within the mosque, is believed to be a symbol of mysticism and spirituality, in addition to being a decorative element. The use of light in Islamic decorations in mosques gives them a sense of motion and life. Generally speaking, the lighting system that is put in place at holy places is a potent instrument that may be used to reflect the history and evolution of the location. To put it another way, designers need to make sure that the lighting system is a part of the history and backdrop of the location. The fact that the lighting system preserves the identity of the location and the historical event that took place there is something that designers ought to take into consideration.

3.1.1. Software simulation

The software known as DIALux Evo was utilized in this investigation because it is among the most popular software programs for the purpose of building an appropriate lighting system. This lighting software has numerous advantages over other lighting applications, including compliance with EN 12464–2, the ability to summarize the results on a transparent spreadsheet, simultaneous visualization modeling, and alarms to attain minimum values. For the purpose of confirming the lighting system, the DIALux Evo software is utilized in the reference. In addition, the object is appraised in three dimensions by means of a realistic visual depiction, as well as the selection of the appropriate light color and lighting direction. Within the scope of our investigation, we utilized the DIALux Evo program to discuss the effectiveness of the lighting system in the working environment. Considering that DIALux Evo is the most efficient software for doing in-depth analyses of lighting systems, a portion of the research that is being conducted is centered on the development of a method for the construction of complicated spatial lighting settings. This piece of software features an environment that is very user-friendly, which makes the design process much easier. It is possible to develop a simulation system for virtual, night, or mixed illumination in a single user experience, which eliminates the need to test numerous units. This is one of the most significant advantages. For the purpose of designing, measuring, and simulating outdoor lighting, this software was built for single rooms, buildings, streets, and outdoor lighting.

PART 4

SPECIAL PROBLEMS IN CALCULATING LIGHTING SYSTEMS

4.1. CALCULATING LIGHTING SYSTEMS FOR HERITAGE BUILDINGS

4.1.1. DIALux

It is a program that enables the user to perform basic brightness calculations with the help of lighting calculation software, specially designed for use in lighting projects. They will help you choose the ideal lighting solutions, including lights and modules, to meet your client's requirements. The project can be built in an integrated manner using BIM (Building Information Modeling) technology. You can see all the steps and interfaces of this function. In this approach, the cost is reduced without sacrificing the quality of the information produced. The German company DIAL developed this software in 1994, and since then, it has been widely adopted globally, especially in Europe. Moreover, he has collaborators providing information: companies from Brazil and 126 other countries have pooled their resources to pay to have their luminaires included in the program. In addition to Philips, files of other luminaire manufacturers, referred to as "ies Curves", may be included in this application (SXLIGHING, 2024).

In addition, DIALux 6.1 is updated by an independent company that maintains the software. Natural lighting, indoor space, and general lighting can be estimated using this tool. Furthermore, the developer's website offers training tutorials for anyone who wants to gain a deeper understanding of the tool's functionality. But that's not where the program really stands out. It is possible to meet the technical requirements of international associations, the lighting levels imposed by ABNT 8995-1 standards (dealing with workplace brightness), and NBR 5101 with the help of DIALux (SXLIGHING, 2024).

4.1.2. Matlab

MathWorks' MATLAB, an acronym for "MATrix LABoratory"(MATHWORKS, 2024), is a proprietary numerical computing environment and multi-paradigm programming language. You may construct algorithms, visualise functions and data, create user interfaces, and connect with programmes written in other languages using MATLAB. A supplementary toolbox that makes use of the MuPAD symbolic engine gives access to symbolic computing capabilities, even though MATLAB is mostly designed for numerical computations (MATHWORKS, 2024)

Visual multi-domain modelling and simulation, as well as model-based design for embedded and dynamic systems, are features of a supplementary package called Simulink. More than four million people throughout the globe are using MATLAB as of 2020. The They hail from a wide range of academic disciplines, including economics, engineering, and science. More than 5,000 educational institutions across the world have used MATLAB as a teaching and research tool as of 2017 "(MATHWORKS, 2024)

4.2. A NEW COMPUTATIONAL METHOD FOR DIRECT ILLUMINATION

The classical methodology for calculating direct illumination is provided in a classic monograph (Lavric et al., 2014) , but serious limitations of the method are known, as it is only applicable to horizontal or vertical surfaces. The historic building has many other situations in which the classical approach is not useful (Lohote et al., 2018).

Geometric considerations are shown in Figure 3.1, and the method can be extended to any other shapes, taking into account custom software such as MATLAB as in Figure 3.1 The calculation surface is generated by the points X1, X2,…, XI,…, XMAX, respectively Y1, Y2 ,…,YJ,…, YMAX It is clear that Z1, Z2,…, ZK,…, ZMAX where NX, NY, NZ are the finite element numbers. The quotas for these carriers will be fixed, but not mandatory. The example in Figure 1 is for a rectangular surface, placed at an angle, but the calculation method is valid for any surface, including a curve. For Figure 5.1 it can be explained

$$\Delta X = \frac{X_{MAX}-X_1}{N_X-1} \tag{3.1}$$

$$\Delta Y = \frac{Y_{MAX} - Y_1}{N_Y - 1} \tag{3.2}$$

$$\Delta Z = \frac{Z_{MAX} - Z_1}{N_Z - 1} \tag{3.3}$$

At this point the horizontal projection of the vertical growth step is calculated (Figure 3.1):

The classical methodology assumes that the angles could be measured, but it is proposed. Calculation of the angle β in the horizontal plane, angle between the line of intersection between the working plane and the horizontal plane:

$$\beta = atg \frac{X_{MAX} - X_1}{Y_{MAX} - Y_1} \tag{3.4}$$

For constant increment there is also the equality:

$$ZOT = \Delta ZO \times (N_Z - 1) \tag{3.5}$$

X, Y, Z coordinates for the current calculation point I, J, K

$$X_{I,J,K} = X_1 + (1 - 1) \times \Delta X + \Delta ZO \times (k - 1) \cos \beta \tag{3.6}$$

$$Y_{I,J,K} = Y_1 + (1 - 1) \times \Delta Y + \Delta ZO \times (k - 1) \sin \beta \tag{3.7}$$

$$Z_{I,J,K} = Z_1 + \Delta Z \ \times (k - 1) \tag{3.8}$$

With these coordinates, the horizontal projection of the distance between each is calculated calculation point and position of the lighting fixture:

$$DPO_{I,J,K} = \sqrt{\left(X_{I,J,K} - XC\right)^2} + \sqrt{\left(Y_{I,J,K} - YC\right)^2} \tag{3.9}$$

The angle γ is defined in the vertical plane, between the optical axis of the lighting fixture and the direction of lighting calculation, respectively will identify the light intensity that will produce the lighting direct. The light intensity will have two components, longitudinal $I(\gamma)_{I,J,K}^{long}$ and transverse $I(\gamma)_{I,J,K}^{trans}$

$$\gamma = atg\,\frac{DPO_{I,J,K}}{ZC - Z_{1,J,K}} \tag{3.10}$$

In the horizontal plane, the angle ω is defined between the projection of the light ray to the calculation point ($DPO_{I,J,K}$) and the OX axis:

$$\omega = atg\,\frac{Y_{I,J,K} - Y_C}{X_{I,J,K} - X_C} \tag{3.11}$$

The angle ω could be useful for the weighted average between these two light i $I(\gamma)_{I,J,K}^{long}$ and transverse $I(\gamma)_{I,J,K}^{trans}$ respectively:

$$\mathrm{I}(\gamma, \omega)_{\mathrm{I,J,K}} = \frac{\mathrm{I}(\gamma)_{\mathrm{I,J,K}}^{\mathrm{trans}} \times \omega + \mathrm{I}(\gamma)_{\mathrm{i,j,k}}^{\mathrm{long}} \times (90 - \omega)}{90} \tag{3.12}$$

The angle between the light intensity I,J,K,(ωγ), and normal to the calculation surface This is the point where the classical theory was not able to generate solutions, because this angle is not determined for some surfaces. Using vector algebra, the normal to the surface ABCD (but also to each elementary surface) could be described using angles α and β:

$$\vec{\mathrm{N}} = \mathrm{N_X}\,\vec{\mathrm{X}} + \mathrm{N_Y}\,\vec{\mathrm{Y}} + \mathrm{N_Z}\,\vec{\mathrm{Z}} \tag{3.13}$$

$$\mathrm{N_X} = \cos\alpha \sin\beta \tag{3.14}$$

$$\mathrm{N_Y} = \cos\alpha \sin\beta \tag{3.15}$$

$$\mathrm{N_Z} = \sin\alpha \tag{3.16}$$

For the current calculation point (I, J, K) obtain the direction from the luminaire to this point:

$$\vec{D}_{I,J,K} = X_{I,J,K}\vec{X} + Y_{I,J,K}\vec{Y} + (ZC - Z_{I,J,K})\vec{Z} \tag{3.17}$$

And now the angle between the light ray and the normal to the surface ABCD:

$$cos\theta = \frac{N_X X_{I,J,K} + N_X Y_{I,J,K} + (ZC - Z_{I,J,K})}{\sqrt{N_X^2 + N_Y^2 + N_Z^2}\sqrt{X_{I,J,K}^2 + Y_{I,J,K}^2 + (ZC - Z_{I,J,K})^2}} \tag{3.18}$$

With all these elements, the direct lighting could be calculated for a maintenance factor M f:

$$E_{I,J,K} = M_f \frac{I(\gamma,\omega)_{I,J,K} cos^3\theta}{(ZC - Z_{I,J,K})^2} \tag{3.19}$$

For several lighting fixtures the effect is additive. For the first moment, the complexity of the calculation requires the use of a general programming language (MATLAB), but DIALux is expected to offer important advantages, offering a complete lighting simulation. Surprisingly, for ancient buildings, even the DIALux EVO 9 has some limitations

4.2.1. Modeling Springs in Matlab

Many MATLAB functions are specifically used for directly calculating illumination, relying on a method that is particularly applicable to surfaces capable of performing analysis across any surface by utilizing various general MATLAB functions such as SURF, MESH, or CONTOUR. It is also impossible to perform a specific function for all of these functions, which cancels the results of a particular surface link, thus making it possible to interpret what is commonly called the general definitively. From the first understanding of how to make the presence of the original guidance suits.

4.2.2. Modeling Springs in Dialux Evo 6.1

This is accomplished by partially providing development opportunities in the Dialux Evo 6.1 program to provide a comprehensive solution for simulating a custom canopy in addition to the visual level and the exterior level. The representation of the model in recent developments has not been studied for any type of problems because it operates by importing what is called objects in AutoCAD and 3DS. Such a model is specific to lighting, specifically for the wall panel, where it is located appropriately. It also works on generating this additional budget when added to those tasks and features a number of artistic exhibitions such as text diversity, as well as contrasts, and uniformity, also working on creating subscriptions due to the absence of a cylindrical or spherical surface type within the DIALux EVO program. It consists of many elements that are already characterized as well as illumination can be obtained from many results entirely for each element whether by average or in other words the minimum value, or high illumination or so-called maximum value, for the text, as well as spotlighting through one of these cylindrical elements as in figure 2. But it is difficult to analyze the results better when there is a very high and required distinction in the model, but by using at least sixty cylindrical elements for one of the arcs. It will also be able to analyze each design separately, as it is difficult or impossible to execute it in the case of full lighting.

4.2.3. Optimize the Lighting Environment Using DiaLUX Software

First and foremost, it is classified as one of the most important factors that can contribute to performance enhancement in spatial environments, as it is characterized by a distinctive non-social time period and may enjoy many unique benefits when realized. As in the context of Islamic printer architecture, there is no reliance on the use of a specific type of lighting unit and some lighting from the other side, noticeably seen in a solution observed from time to time. Instead, it is a concept considered a Sufi type and a sacred type, suddenly and specially isolated to generally impact individuals as well as both with them, which may affect them psychologically as well as behaviorally. Bright light also plays a pivotal role solely in the special realm of interpretation and for special development of understanding within a number of aesthetics that are then considered activation by the elite of the Islamic type, as evident within the void space. Giza. Hence, there is a specifically functional role used for the purpose of continuous shaping of light in space, also widely used in this architectural genre, as elucidated on various occasions, signifying design followed by execution and subsequent reliance on it (Abdollahi and Aref, 2020).

This is achieved through a process that explores the use of light to create a distinct presence in the internal spatiality of mosques, contributing to the construction of an element within the perceptual space. The lighting employed in mosques represents a pioneering innovation in the development of lighting systems extensively utilized in mosques, symbolically, spiritually, and mystically, alongside ornamentation. Lighting plays a significant and vital role in corporate branding, often stimulating various human ideas to transcend limitations within the world. Moreover, light adds movement and vitality to the Islamic-inspired decor within the mosque (Abdollahi and Aref, 2020). I also particularly express the public and also consider physical factors as well as psychological factors, which are among the most important within residential buildings, industrial spaces, and workplaces (Uygun, Kazanasmaz, and Kale, 2015).

The expertise presented and the research conducted indicate that implementing a specialized lighting system, designed excellently, not only achieves the desired impact with minimal disruption but also proves beneficial for human life in daily activities, aiding in enhancing product quality. Furthermore, it can contribute to the improvement of various aspects of life, including health, economy, safety, and aesthetics. Opting for quality lighting options, especially those with good illuminance levels, not only relieves eye strain but also has a positive effect on reducing electricity costs. Selecting suitable lighting fixtures throughout the day and arranging them according to specific lighting types can result in significant energy savings. Lighting requirements vary based on factors such as space and intended usage during different times of the day or night. Therefore, it's essential to consider expert advice when selecting lighting, taking into account factors like sunlight exposure. Designing an appropriate lighting system requires considering specific temperature thresholds for heat dissipation, color rendering, light output, glare control, and uniformity of illumination. External agreement standards typically set a specific ratio defining the light intensity range from minimum to maximum surface brightness (Emin / Emax), with a minimum value of 0.16. User adaptation agreement measures a specific ratio of light intensity from surface to ambient (Emin/Eave), with a minimum value of 0.33. Evaluation of lighting system performance for visual comfort and fatigue-free environmental sustainability is crucial. This includes factors such as visual acuity and color consistency, along with uniform distribution of filters. Additionally, ambient lighting in a specific manner is necessary to fulfill the basic requirements for personal vision and overall well-being (Ekren, Dursun, & Aykut, 2007; Hu, 2017; Abdollahi and Aref, 2020).

The digitization process involves generating information and developing contemporary technologies to improve various aspects, such as climate conditions, through optimization and the creation of numerous advantageous circumstances. The overarching aim of this comprehensive digitization process is to utilize immersive computer-generated environments comprising diverse models, extensive testing, thorough analyses, and ultimately, three-dimensional visuals. It facilitates the integration of different methodologies, leading to the creation of simpler and more efficient techniques, thereby saving time and financial resources for private production companies. Moreover, lighting within workspaces has garnered significant attention among researchers, reflecting ongoing discussions. There is a notable focus on highlighting various lighting systems, optimizing them through detailed study, and analyzing individual differences to tailor simulation tools. Subsequently, suitable lighting parameters are determined, followed by an evaluation of energy efficiency and other relevant factors., etc (Avc & Memikoğlu, 2017; Domingues do santos, Faustino Agreira, & Perdigao, 2013; Li, Li,Wang, & Liu 2012; Na, Lili, Li, & Wenhai, 2016; Salata et al., 2015; Sanchez, Garcia, Domingo, Camachob, & Sebastián, 2015; Uygun, et al., 2015).

Internet comparison works by relying on efficient software, such as through the selection of a dedicated simulation tool. Dialux Evo software stands out for its numerous advantages over similar programs, including comprehensive compliance with EN 12464-2 standards (STN EN 12464-1), and synchronous modeling methods for various types of lighting, particularly designed for animation. It summarizes multiple results in a transparent and specific data table, cautioning towards achieving a specialized process to limit desired parameters. A specialized monitoring tool within the Dialux Evo software was utilized to verify a newly designed custom lighting system (Mangkuto, 2016; Meshkova, & Budak, 2013). According (Dupláková, Radchenko, Knapčíková, & Hatala, 2016; Dupláková, et al., 2019) The possibility of using DIALux software to evaluate the lighting quality of the work environment has been investigated. according (Fu, Chen, Qiu, & Chen, 2018; Guerry, Gălățanu, Canale, & Zissis 2019) a method for constructing complex spatial light environments.

Indeed, this is accomplished and cannot be further optimized within the illuminated environment through the use of specialized MATLAB DIALux software. Additionally, it points out the process through various simulation analysis techniques. There are many simulation programs conveniently used for customizing free solutions in Dialux Evo software, considered artistically superior and more intelligent practically for lighting testing. It operates to provide a dedicated simulation framework within a regular work environment, as well as adapts similarly to other scenarios, eliminating the need for hierarchical tree management. It is significant in its capability to work on constructing a lighting system that is virtual, wireless, or multifaceted through numerous links, utilizing a single-user experience without the necessity for separate testing in multiple units. This software is implemented for rooms that are sometimes diverse, whether in streets, buildings, or in exterior designs specific to vision and measurement. Catalog software is used in various units from different industrial lighting manufacturers, either effectively online or on specific web locations, or installed as an efficient component by investors. Dialux Evo software, thanks to its technical equations, is an effective tool for investing in analyzing various types of work. Specific calculations were made for lighting locations corresponding to STN EN 12464-2 lighting and illumination (STN EN 12464-1).According Kotsarenko & Ramos, (2012) An alternative approach for diffuse lighting and specular reflections is presented, and according Din, Kim, & Kim (2013) considers an energy-efficient utilization in lighting control systems. Based on the above issues, our study, and taking the international standards into account, the design of lighting system of the Holy of Abi Talib Mosque, is very weak, and it requires the introduction of an alternative scheme that provides the intensity required by standard according to the aesthetic discussion of sacred places and energy efficiency. Moreover, with a good visual representation, by choosing the right lighting direction and the light color, we can identify the objects in three ways At the dome, in the middle, and at the corners (Ahmadian, 2015; Standards DIN EN 12464-1; Rea, 2000).

The Jaafar bin Abi Talib Mosque in Bani Waleed city can be studied in separate parts, the Mosque Courtyard, as shown in Figure 4.1. Therefore, new alternative lighting schemes for the Mosque Courtyard were introduced in accordance with international standards that overcome the drawbacks of the Mosque Courtyard plans. Current lighting as well as optimal use of electrical energy. Initially, after collecting information and photographing parts of N Jaafar bin Abi Talib Mosque, the existing lighting scheme was designed and simulated by DIALux Evo software. Using simulation results and comparing them to global lighting standards, the technical and operational drawbacks of the current scheme were identified.

Figure 4.1. Parts of the Jaafar bin Abi Talib Mosque.

Finally, new alternative lighting schemes based on international standards and the existing lighting system for holy places were proposed (Uygun et al., 2015). Simulation results show that the proposed alternative schemes not only meet the technical indicators and standard illumination values, but also save the number of lamps, the amount of energy consumption and the corresponding cost. In terms of price as well, the cost of the proposed alternative schemes amounts to 40 percent of the current lighting scheme in the courtyard of the mosque

4.2.4. Design of the courtyard of the Jaafar bin Abi Talib Mosque

In order to simulate the existing lighting scheme of the shrine of Jaafar bin Abi Talib Mosque and provide a detailed examination and provide new alternative schemes, the architectural information including dimensions, volume, height and structure of Jaafar bin Abi Talib Mosque were calculated, according to the photography in the field study, and then simulated by DIALux Evo software.

4.2.5. Evaluation of the current lighting system of Jaafar bin Abi Talib Mosque

Due to incorrect placement of projectors in terms of location and installation angle in the current design of the lighting system of the Jaafar bin Abi Talib Mosque, a large number of high-power projectors were used. However, these devices are unable to provide the minimum required lighting in some parts of the courtyard of the Jaafar bin Abi Talib Mosque, and in some places they cause severe dazzle. Figure 4.2 shows the placement of yard projectors in the current system. Table 4.1 shows the number of projectors used in the courtyard area, their energy consumption and their price. In the current design, there are (18) types of 216, 3616W, and 160 W LEDs for a total power consumption of 3992 W. as Table 4.1 This amount of energy consumption is very high and insufficient. Based on the final map of the existing lighting system and the information obtained from the field study and photography, the existing lighting system of Abi Talib Mosque in Sahn al-Masuma was designed and simulated by DIALux Evo software, as shown in Figure 4.3.

Figure 4.2. Placement of projectors in the existing Jaafar bin Abi Talib Mosque lighting system.

Table 4.1. The number and quantity of energy consumption of lamps used in the lighting system in Jaafar bin Abi Talib Mosque

Type of light	No.	Energy consumption (w)
12-watt LED	18	216-watts
32-watt LED	113	3616 -watts
40-watt FILLBS	4	160-watts
Total energy consumption	3992 watts	

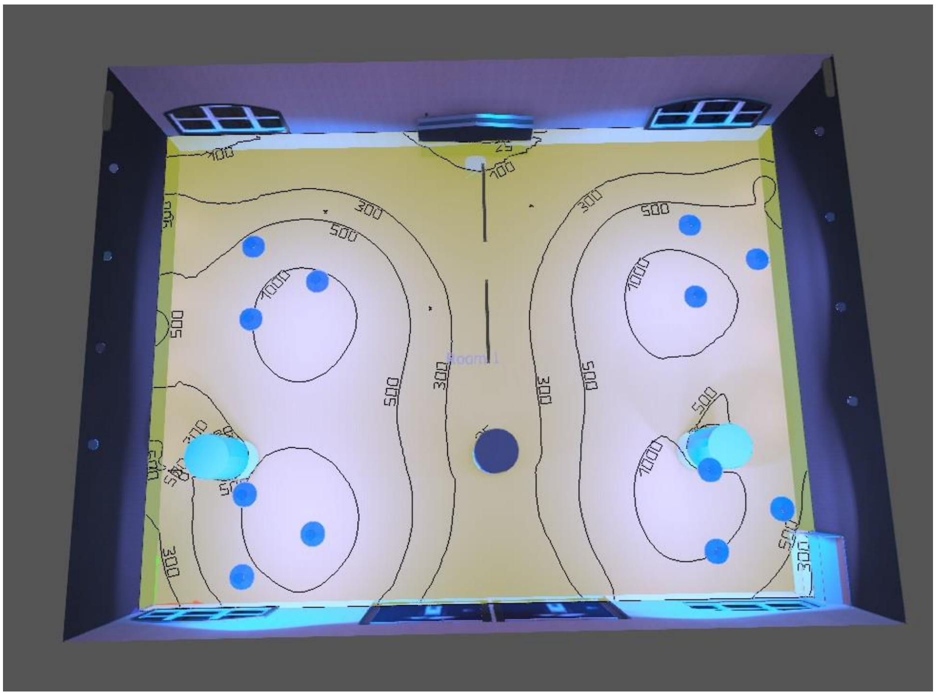

Figure 4.3. Dimensional output and false color curve of Deluxe's Jaafar bin Abi Talib Mosque Indoor current lighting system.

According to the our simulation results drawn from the Deluxe's, the presence of a central courtyard area in the mosque has significant considerations, regarded as the highest level of removing areas from the intensity of lighting. It contributes sixty percent of the total, considered higher than others, reaching up to 12 lux, representing a seating area for an unacceptable long period on one hand because it is used in these areas in Libya. On the other hand, through the use of a type of pseudo-fiber optics, the so-called strength was well noted, and then the clear, low-rise installation was observed for a certain period. Finally, the presence of centralized planning was noted, which does not suit the games in the display devices, as poor lighting causes a significant effect in some places inside Jafar bin Abi Talib Mosque, making it greatly impressive. Based on many of the aforementioned reasons, several alternative lighting sites were found; therefore, a specific replacement process was carried out for the existing central design of the display devices to be high energy reaching 84, 7, 99.1, 8, 13.9 in the mosque study site inside limited wattages, especially with display devices to be low as well as generally distributed on a wide scale to provide better lighting to avoid glare light used inside vacation. This can also be done using lighting towers (Figure 4.4), in addition to their independence as well as special lounge devices for displaying with the energy advantage in determining the locations that are supposed to be able to illuminate in the middle.

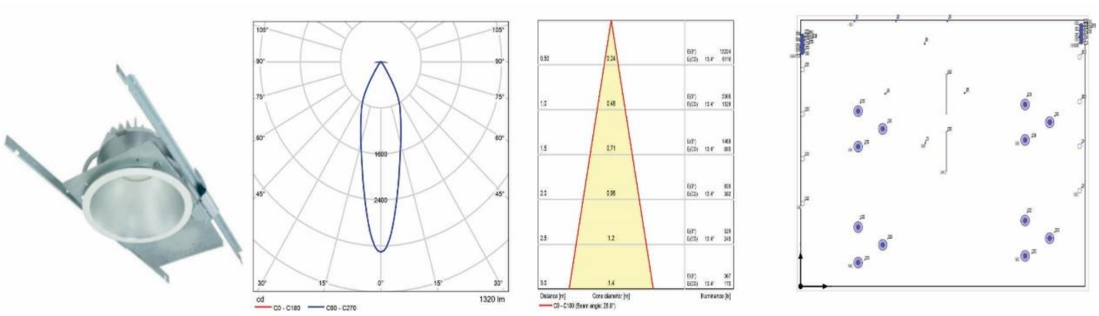

Figure 4.4. Dimensional output and false color curve of Deluxe's Jaafar bin Abi Talib Mosque outdoor current lighting system.

4.2.6. The Lighting System in the Mosque is Through New Alternative Schemes

Due to the energy-intensive consumption strategy, when it exists at a low level, and in the presence of the central height which is considered inappropriate in any form for display, the existing lighting method inside the Jafar bin Abi Talib Mosque courtyard causes glaring light. It is strong, in addition to being unevenly distributed in terms of light intensity. On the other hand, there is no light at a temperature degree in some places in many parts of the specification. Since a set of new alternative lighting plans are being implemented to provide a larger area of lighting, it is possible to avoid glare lighting present indoors, by working to replace many high-energy display devices simultaneously capable of reaching up to 99.1 watts, and they may be partially distributed within many sites in the limited indicator, in addition to devices considered low on the side as they cannot reach 7 watts. Then, many display devices are distributed widely. Additionally, in order to provide lighting inside the mosque, specifically in the center of cancellation place, we suggest implementing many lighting towers in terms of the locations available in places. Our proposed lighting schemes work by improving many lighting conditions, such as reducing some points of light to the minimum level and then unifying their costs, to get rid of the so-called glaring light and thus achieve a significant improvement in visibility inside the courtyard. This also enriches the policy, whether cultural or social, enabling agricultural signs in the mosque to be easily readable and environmentally safe, increasing people's entry into the mosque to be present in its courtyard.

To achieve this, and in order to uniformly distribute light and work on reducing glare indoors through alternative lighting systems, what we can arrive at from simulating various scenarios in the DIALux Evo program, and utilizing up to three different types of specialized display devices such as Ansell Lighting with a capacity of up to 8 watts, in addition to twelve also specialized display devices from ADUROLIGHT with a capacity of up to 99.1 watts, and eleven display devices from ACEVEL with a capacity of up to 7 watts, and four from Cooper Lighting with a capacity of up to 13.9 watts, as well as two from F Filippi S.p.A with a capacity of up to 84 watts. This scenario is considered ideal in many aspects, starting from meeting lighting standards to other aspects for economic fulfillment. Due to another special plan, a new set of innovative lighting inside the Jafar bin Abi Talib Mosque's clubs is launched, as many towers are used for lighting with the necessary tools in addition to all available points inside mosque. Therefore, it is inside the middle, in addition to being more for light distribution there.

Discovering what is considered a good alternative, it is used by using a specific distance between all planets in order to use a type of lighting that is more entertaining inside all points. As is the case in the field, lighting and its intensity range from 20 to 50 lux. Inside the mosque courtyard, due to the celebrations held on religious occasions in addition to the need to provide good lighting for studying many sacred books, such as reading the Quran and others, lighting and its intensity must be adjusted to be sufficient for use in the area. To achieve this, in our alternative plan, the amount of lighting has been adjusted to a level of 30-75 lux inside all points. Table 4.2 shows the number of display devices in addition to a specific amount in energy saving and finally the associated price, which can also be used in a lighting-specific plan within the proposal.

Table 4.2 Total number, power consumption and cost of projectors in the proposed alternative lighting scheme

Type of light	Number	Luminous intensity (Im)

99.1-watt ADUROLIGHT	12	114.8
84-watt F Filippi S.p.A	2	160.3
13.9-wat LED	8	1320
8-watt Copper lighting	30	88.9
7-wat LED	11	63.1
Total energy consumption	1785.4watts	

In above Figure 4.4 simulation results that have been identified as resembling the alternative and proposed schemes, including the three-dimensional renderings as well as the false colors presented by the DIALux Evo program. The results also serve to document the terms, enabling the specific conditions of the artistic lighting inside to be adjusted when working to find a visual guide inside. These include many requirements aimed at providing lighting to the extent of minimizing small points in the courtyard, in addition to avoiding so-called glaring light, and achieving uniform light distribution inside the mosque in the best alternative location. Moreover, where specific lighting locations are present, around sixty percent of the area in the quiet framed enjoys self-illuminating effects estimated at 20 lux, which does not align with the standards used in the Libyan region. As illustrated in the proposed alternative, lighting is chosen at its minimum limits in all mosque points in the specification for lighting, while avoiding the so-called glaring light, and then uniformly distributing light in the mosque.

According to the values stated in Table 4.2 (including the elements used in terms of quantity, on the one hand, and on the other hand, the energy consumed, and the cost of the display devices), the total energy consumed, the proposed alternative plan is now about 1785.4 watts, while the overall power consumption for the current alternative installed is 3992 watts. This confirms a certain fact stating that the proposed alternative option works to save energy and cost, which may be beneficial. Furthermore, in terms of project cost, where the cost is low in the proposed alternative interior by 40% of the current place price, it works to account for the cost inside the alternative building. Additionally, the results indicate sound effects and that there are lighting towers considered more efficient than the current lighting in the mosque, ultimately defining in the courtyard of the Jafar bin Abi Talib Mosque. On the other hand, the art used in this area, such as limiting light intensity, avoiding glare, and finally distributing light, as well as minimizing economic indicators, were contributed to by small indicators in addition to energy costs.

PART 5

CONTROL OF ARMATURES USING SOFTWARE

5.1. ARDUINO

The open-source software and hardware development board known as Arduino was created by Italian engineers. It is one of the advantages that comes with the advancement of technology. In relation to open-source hardware, including hardware PCBs, circuit diagrams, and so on. The information is made available to users on the website. The creation of open-source software is accomplished through the dissemination of the codes and projects that are developed on the internet. Previous initiatives and precedents are analyzed in this manner, which plays a role in accelerating the development process (Bell, 2014; Arduino, 2017; ARDUINO, 2024).

There are a variety of Arduino development boards available, each with its own unique input-output pins and use regions. There is a total of seventeen distinct varieties of Arduino. The Arduino Uno, which is the most cost-effective in terms of both price and the number of pins, was utilized in the research project under consideration (Lee et al., 2014) The Arduino Uno is equipped with twenty-four digital inputs and outputs, six analog inputs and outputs, 32 KB of Flash memory, and sixteen megahertz of open source hardware. According to Bell (2014), the bootloader program in Arduino does not require any additional software or hardware to be used for programming purposes.

There is a wide range of microprocessors and controllers that are utilised in Arduino board designs. Sets of digital and analogue input/output (I/O) pins are included on the boards, and these pins may be used to connect with a variety of expansion boards (also known as "shields") or breadboards (used for prototyping), as well as other circuits. Serial communications interfaces are included on the boards, and some of the versions have Universal Serial Bus (USB) connections. These interfaces are also utilised for loading programs. A standard application programming interface (API) that is also known as the Arduino Programming Language, which was influenced by the Processing language and utilised with a modified version of the Processing integrated development environment (IDE), may be used to program the microcontrollers. Embedded C is a combination of the C and C++ programming languages. In addition to the use of conventional compiler toolchains, the Arduino project offers an integrated development environment (IDE) as well as a command line tool that was written in the go programming language.

Beginning in 2005, the Arduino project was initially developed as a tool for students attending the Interaction Design Institute in Ivrea, Italy (Kushner, 2011). The project's primary objective was to offer a low-cost and straightforward method for both novices and experts to construct devices that interact with their surroundings through the use of sensors and actuators. Simple robots, thermostats, and motion detectors are all examples of gadgets that fall within this category and are often designed for novice enthusiasts (Lahart, 2009).

It was in a pub in Ivrea, Italy, where a number of the people who were responsible for the creation of the Arduino project used to get together. Arduin of Ivrea, who ruled Italy from 1002 to 1014 and was also the margrave of the March of Ivrea, was honoured with the naming of this popular drinking establishment (Lahart, 2009).

5.1.1. RFID Shield on the RC-522

An RFID Reader is a control card that uses radio waves and operates in the 13.56 Mhz band to read and write Radio Frequency Identification (RFID) cards. These cards include Mifare1 S50, Mifare1 S70, Mifare ultralight, Mifare pro, and Mifare desfire. It is possible to use this module card with a wide variety of development boards, particularly Arduino cards (Khan et al., 2016).

According to Khan et al. (2016), the RC522 is an integrated transmission module for contactless communication equipped with a communication speed of 424 kbit/s. This module is used in a wide variety of applications that include contactless communication.

5.1.2. Shield for SD Cards

The SD-Card shield, which is compatible with a wide variety of microcontroller platforms, particularly Arduino, may be used in a wide variety of applications, including the storage of information, the uploading of read information to the memory card, and the recording of information that is continuously received. Portable and real-time data recording is the second kind of data recording. This sort of data recording is carried out by using an SD-Card shield, and it does not need connecting a USB to a personal computer in order to save data (Ambar et al., 2011).

5.1.3. Shield for RTC

DS1307 RTC and 24C32 EEPROM integrated circuits are included inside the RTC Shield, which is used for the purpose of displaying the current time and date on the circuit that it is situated on (Zeebaree and Yasin, 2014).

5.2. A CIRCUIT FOR CONTROL

5.2.1. Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

The pins that are present in some way inside the so-called Arduino, in particular, are the specific places through which many wires can be connected inside them in order to carry out the process of creating a circuit that directly synchronizes with a special experimental board in addition to some Wires. It may also usually contain several “heads” that are black and plastic, and they also work to allow a process through which a wire is connected directly into the board. It may also contain many types of pins in many different and similar shapes, and each of them is clearly labeled on the plate so that it is used in its specific function, as each of them has a different function.

- GND (3): Abbreviation for "Earth". As there are many shapes and GND ports on the Arduino device, which can be used to ground the circuit.

- 5V (4) & 3.3V (5): This type operates to provide a 5Vpin and 5V volts type of total power, as well as operates on a method to provide a 3.3V type of total power. It also works with most of its distinguishing components, which are small and are utilized across the Arduino system to be at either 5V or 3.3V voltage.
- Analog (6): There is a dedicated area specifically containing pins labeled "Analog In" under the name and mark "Analog In." It encompasses types ranging from A0 to A5 present on the UNO, classified within the Analog In type of pins. Additionally, this serves as a particular option for reading the surroundings, achieved through a unique sensor such as a temperature sensor, where it converts it into a digital value for reading purposes.
- Digital (7): This type is located on the opposite side within the Arduino and is distinguished within the analog and non-distinguished, gradually ranging from 0 to 13 inside the UNO. It is also possible to utilize these pins for what is known as interfacing, such as detecting if a tank has been scanned followed by a digital result, as well as performing an LED lamp operation.
- PWM (8): The tilde symbol (~) is expected to be honored next to some pins electronically routed between 3, 5, 6, 9, 10, and 11 inside the UNO. It operates through several ports referred to as digital and analog specialized ones, capable of being used for input and output and called upon for modulation and pulse width modulation (PWM). A tutorial program has been successful in utilizing PWM. Simultaneously, consideration is given to selecting efficient credit processes through simulation by the product. Analog, like the special fading of LED light inside and outside.
- AREF (9): In order to identify the reference of the analog type, which sometimes may result in leaving this pin singular. Also, it is possible to perform the process using sometimes to do so, and the reference voltage may occasionally be between 0 and 5 volts, looking up from the analog mail ports.

5.2.2. Reset Button

It is done entirely as in the original Nintendo device, and among all, the Arduino-type program contains a special reset button. It will also perform the process of pressing it to create a precise reset connection to the pin, resetting it expertly to ground, and then restarting any type of codes that were previously uploaded to the Arduino program, as illustrated in Figure 5.1. It is noteworthy that this method can be useful in the event of code refinement that has been uploaded to it.

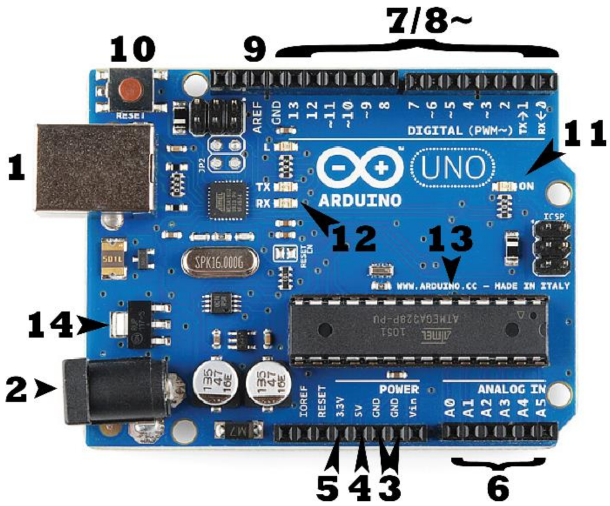

Figure 5.1. Arduino.

5.2.3. Power LED Indicator

From top to bottom on the other side of the board in the full cycle, the word "UNO" is located inside the board, where there is a small-sized LED indicator next to a specific word marked "ON" (11). It is also intended to carry out a special lighting operation with a smart LED indicator when connecting what is known as an Arduino to a dedicated power source. While no surgical procedure is performed on the lens, there is an error that cannot be rectified to re-copy the writings again.

5.2.4 TX RX LEDs

TX is a specific abbreviation used when creating, whereas RX is an abbreviation used during the transmission process. Additionally, markings are often placed on all electronic devices used as a type of signal indication to signify licenses that may be prohibited for a certain type of serially classified connection. In our case, there are binary positions within the Arduino type UNO, where TX and RX may appear - once through the use of digital diagnostics ranging between 0 and 1. Typically, they are located adjacent to special LED indicators when using a display called TX and RX (12). This is done using LED lights inside many indicators that are visible when Arduino data is shared or transmitted.

PART 6

CONCLUSIONS AND RECOMMENDATIONS

This research explores the design of alternative lighting for the main courtyard of the Jaafar bin Abi Talib Mosque, based on international standards and experiences. The aim is to reduce energy consumption and eliminate shortcomings of the existing lighting system. Field visits and data collection were used to model the mosque structure and lighting system using DIALux Evo software.

The results were compared to international standards to identify technical and operational deficiencies. The study proposes new alternative lighting schemes for holy places, such as the mosque, to improve visibility, reduce glare, increase accessibility, and reduce project costs by 40%. A new computational method for direct illumination, including MATLAB, is proposed for improving lighting environments in spatial environments, especially in Islamic architecture.

MathWorks' MATLAB is a proprietary numerical computing environment and multi-paradigm programming language used for constructing algorithms, visualizing functions and data, creating user interfaces, and connecting with other languages. It has over four million users worldwide, from various academic disciplines and over 5,000 educational institutions. A new computational method for direct illumination has been proposed, which can be extended to any shape using custom software like MATLAB. The method calculates the distance between calculation points and the position of the lighting fixture, identifying the light intensity and normal to the calculation surface. The DIALux EVO 6.1 offers a complete lighting simulation, but has some limitations for ancient buildings.

Matlab functions are used for calculating illumination, but they are not applicable to surfaces. Dialux Evo 6.1 offers a comprehensive solution for simulating custom canopy models, importing objects from AutoCAD and 3DS. This model is specific to lighting and can be analyzed separately. DiaLUX software optimizes the lighting environment, focusing on the unique benefits of bright light in spatial environments. Islamic printer architecture uses light to create a distinct presence in interior spaces, contributing to the construction of elements within perceptual space. Lighting plays a significant role in corporate branding, corporate branding, and Islamic-inspired decor.

The research highlights the importance of implementing a well-designed specialized lighting system for various aspects of life, including health, economy, safety, and aesthetics. It also helps reduce electricity costs and saves energy. Lighting requirements vary based on factors like space and usage, and expert advice is crucial. The digitization process aims to optimize lighting through computer-generated environments, facilitating the integration of different methodologies and saving time and resources. Dialux Evo software is a popular choice for evaluating lighting quality in workspaces, offering compliance with EN 12464-2 standards and synchronous modeling methods. It is used for virtual, wireless, or multifaceted lighting systems, and is considered artistically superior and more intelligent for lighting testing. The study of the Holy of Abi Talib Mosque in Bani Waleed highlights the need for an alternative lighting scheme that meets international standards and aesthetics. The Jaafar bin Abi Talib Mosque in Bani Waleed also presents new alternative lighting schemes to overcome the drawbacks of the current scheme.

The current lighting system in the courtyard of the mosque is insufficient due to incorrect placement of projectors and low energy consumption. The study suggests replacing the central design of display devices with low energy and distributed on a wide scale to provide better lighting and avoid glare. This could be achieved through lighting towers, independent lighting towers, or special lounge devices.

The Jafar bin Abi Talib Mosque courtyard is facing glaring light due to energy-intensive consumption strategies. To address this issue, new alternative lighting plans are being implemented, replacing high-energy display devices with more efficient options. The proposed lighting schemes aim to improve visibility, reduce glaring light, and unify costs. The proposed scheme uses specialized display devices such as Ansell Lighting, ADUROLIGHT, ACEVEL, Cooper Lighting

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APPENDIX 1

PROGRAM CODE USED

```
int role[] = {6, 7, 8, 9};
int role_sayisi = 4;
int ldr_pin = A0;
int deger = 0;
void setup()
{
  Serial.begin(9600);
  for (int i = 0 ; i < role_sayisi ; i++)
  {
        pinMode(role[i], OUTPUT);
  }
}
void loop()
{
  deger = analogRead(ldr_pin);
  if (deger > 0 && deger <= 200)
  {
    digitalWrite(role[0], LOW);
    digitalWrite(role[1], LOW);
    digitalWrite(role[2], LOW);
    digitalWrite(role[3], LOW);
  }
  if (deger > 201 && deger <= 400)
  {
    digitalWrite(role[0], HIGH);
    digitalWrite(role[1], LOW);
    digitalWrite(role[2], LOW);
    digitalWrite(role[3], LOW);
  }
  if (deger > 401 && deger <= 650)
  {
    digitalWrite(role[0], HIGH);
    digitalWrite(role[1], HIGH);
```

```
    digitalWrite(role[2], LOW);
    digitalWrite(role[3], LOW);
  }
  if (deger > 651 && deger <= 949)
  {
    digitalWrite(role[0], HIGH);
    digitalWrite(role[1], HIGH);
    digitalWrite(role[2], HIGH);
    digitalWrite(role[3], LOW);
  }
  if (deger > 950 && deger <= 1023)
  {
   digitalWrite(role[0],HIGH);
   digitalWrite(role[1],HIGH);
   digitalWrite(role[2],HIGH);
   digitalWrite(role[3],HIGH);
  }
  Serial.print("deger: ");
  Serial.print(deger);
  Serial.println("Farid Ahmed Asmida Abu ABDALLAH ");
  delay(1000);
}
```

CURRICULUM VITAE

Farid Ahmed Asmida Abu ABDALLAH Libya and he graduated primary, elementary, and high school in this city, after that, he started the Faculty of Engineering Bani Waleed, Department of Electronic Engineering in 2001. Then in 2021, he started at Karabuk University Electronic Engineering to complete his M. Sc. education