

# Study on Demand and Intelligence of Light Environment in Guest Rooms of High-End Resort Hotels

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## **Abstract:**

No matter what type of resort hotel it is, guest rooms always play a pivotal role. A guest room is the signage and characteristics of a hotel, and is the most important experience area for guests when staying in the hotel. Therefore, in a comprehensive hotel design, the light environment in a guest room is an indispensable part for guests to have a comfortable experience. Starting from the current visual-physiological-psychological requirements of the indoor light environment in resort hotel rooms and by combining the new applications and development trends of LED lighting technology, this article proposes technical suggestions for the intelligent light environment of the guest rooms based on location settings and light perception as well as the health and comfort of hotel guests.

**Keywords:** Resort hotel; Light environment; LED; Intelligent lighting.

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## I. INTRODUCTION

The concept of resort hotel was first produced in European and American countries. It is different from the functional attributes of business reception of business hotels. It is more to provide tourists with a good living experience during vacation and meet their spiritual needs. Because resort hotels are often built on a certain city or a certain scenic spot, guests come from all over the world, facing disadvantages such as jet lag, physiological effects, etc. A well designed hotel should be able to strengthen the display of local cultural and humanistic characteristics, and make the hotel the most impressive symbol of the city or scenic spot for tourists through implementation of various comfort measures which improve sleep quality and reduce stress.

Chinese resort hotels first came to being in modern times when they were introduced to China as an import product. Although the development history of resort hotels in China is relatively short, with the continuous development of China's economy, people's consumption demands keep increasing. Traveling has become the most common way for many people to relax, gain knowledge, and understand culture. China's hotel construction continues to mature, and industry standards are also becoming very

standardized and clear. In recent years, resort hotel guest room design has increasingly become “people-oriented”, while advocating integration into the local natural and cultural environment, and light environment design as an important part of guest room design. The guest room light environment design of high-end hotels has shifted from green lighting that emphasizes energy-saving to human-oriented smart lighting that emphasizes healthy features [1,2]. The comfort and experience of the guest room’s light environment can only be maximized by focusing on the guests needs and with in-depth consideration of the guest’s behavioral psychology, emotional regulation, and circadian rhythm, which also helps surpass guests’ psychological expectations to a certain degree corresponding to the hotel fees paid.

Based on the vacation nature and cultural attributes of high-end resort hotels, most of their target customers are domestic group or individual tourists and overseas business groups or tourists. Regardless of whether it is a group outing or an individual outing, most tourists hope to get a good rest in the hotel while obtaining services and living experiences that match their consumption. Based on data research on the internet, a survey questionnaire was designed based on factors such as age, purpose, length of stay and other factors on the needs of hotel room light environment. A total of 120 questionnaires were received, including 35 questionnaires for middle-aged and elderly people over 50 years old, 35 -56 questionnaires for young and middle-aged 50-year-olds (22 for traveling with children), 30 for 25-34-year-olds (9 for traveling with children). The survey results are as follows:

Most of the middle-aged and elderly people in the tourist population have a good education, and either have stable jobs or have retired. Their schedules are relatively free and abundant, and they have certain spending power. Most of them travel together and have higher requirements for resort hotels. The cultural demand is high, and it is biased towards the light environment formed by the lamps with high brightness and high-quality color rendering ability.

Secondly, there are middle-aged and young people with certain spending power. Most of them have stable jobs, tight or fixed schedules and have high requirements for living environment and living experience. Most of them are on personal trips and travel with companions. They prefer an environmental lighting and focus lighting combined light environment with low brightness and warm color temperature.

Family outings are also large groups of tourists. They hope to take children to experience nature, increase their knowledge, promote the feelings between different generations, and enjoy the heterogeneous experience that the resort hotel rooms can provide. They prefer a light environment with warm color temperature with a focus on warmth, simplicity and low brightness.

Through the questionnaire survey, although there are certain differences in the demand for the light environment of the guest rooms due to age, gender and north and south regional differences, where winter indoor heating in the north is suitable and people are not sensitive to the cold and warm light environment, and while people in the south prefer warm color lightings since there is no heating in winter and the indoor temperature is low [3]. It is consistent with the research of Liu Wei et al. that people of different ages and

genders have different feelings of comfort in the lighting environment of the same illuminance and color temperature [4]. But there are still common needs. People want not only simply living and resting, but also hope to get a more luxurious and enjoyable living environment than their usual residence. A common sense warm light, self-satisfying lights that guests can self-adjust, and high color rendering lamps can enhance the beauty and comfort of the space. Therefore, due to the different needs of different races, ages and groups of people, the lighting environment of high-end hotel guest rooms should cover the three aspects of visual function, physiological adjustment and emotional intervention, to create a continuous and healthy lighting environment that meets the needs of all staying tourists.

## II. MATERIALS AND METHODS

In a resort hotel, a guest room is the space where tourists stay for the longest time. Compared with other spaces, the guest room is more private and an area where personal experience is the most concentrated. The lighting design goal should not just be limited to its task to illuminate for the object to be effectively identified (functional), thereby ensuring or obtaining visual comfort", and the goal of "shaping the overall atmosphere of the space and achieving good spatial perception and interaction" should also be achieved. The lighting quality is composed of the brightness distribution related to visual function, user comfort, safety, etc. in the space. The main indicators are glare, light source color temperature, lighting uniformity, reflectance, etc. At the same time, the lighting design of the guest room should be consistent with the overall hotel light environment design, not just to satisfy the basic needs, but to combine with decoration, paying attention to the creation of an overall atmosphere that visitors will not feel abrupt when they enter the guest room. Intelligent lighting is automatically adjusted according to the environment or predefined conditions to provide the required high-quality lighting [5]. The comfort of the light environment and the adaptive adjustment of brightness, human body induction control, color temperature control, etc., meet people's multiple needs for light. In particular, the light environment can be adjusted according to the characteristics of the elderly's vision, mood and circadian rhythm. For example, since the elderly's ability to adapt to dynamic light is weakened, their color perception and visual acuity are reduced, and their dark adaptation time is prolonged, it is necessary to for them to have increased light stimulation and so on [6,7]. The light environment of high-end hotel rooms is not only to meet the requirements of light quality and visual needs, but also to meet the photobiological needs of the human body's circadian rhythm and the emotional needs of psychological comfort and health. (see Figure 1).

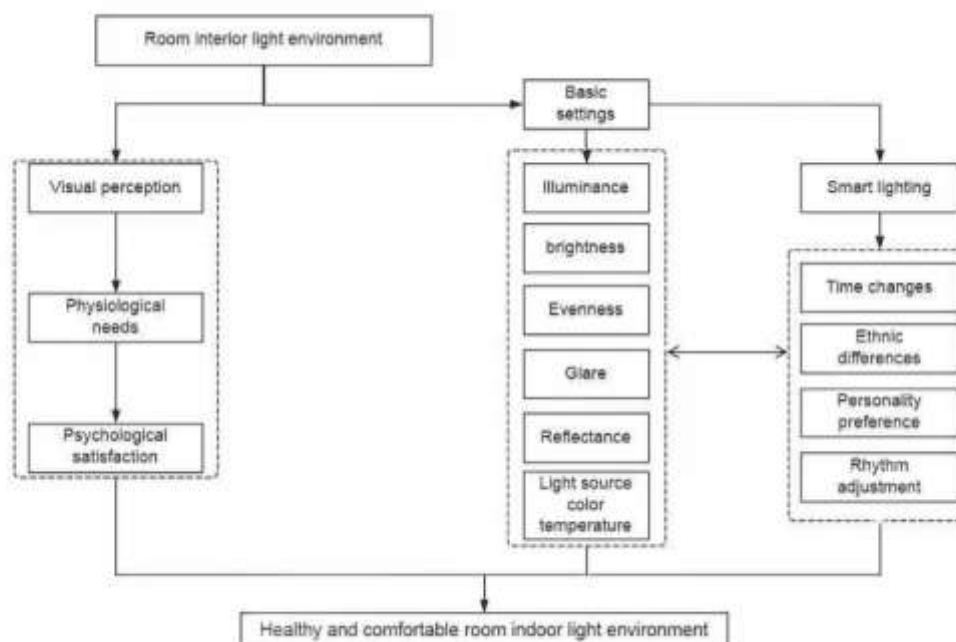


Figure 1: Setting diagram of healthy and comfortable guest room light environment

## 2.1 Intelligent Light Environment based on Visual Sense

Using computer, network communication, automatic control and other technologies guest rooms lighting control is set up according to the specific age and gender of visitors. Through the analysis and processing of environmental information and user needs, the scene with different color temperature and illumination ratio is simulated, the spatial connotation is strengthened, the formal aesthetic feeling of lamp and light is implemented, and a better visual experience of light environment is created.

### 2.1.1 Intelligent setting of light environment in different scenes

The activities of people in hotel guest rooms are mainly rest, sleep, entertainment (TV), work, study, meeting guests, etc. Corresponding to the different scenes required by these activities, through smart scene control, various light environment can be constructed considering different color temperature, brightness and color rendering, light source performance, environmental atmosphere layout, and different visual operation requirements. The focus of lighting design in guest rooms is generally designed around the bed. At this stage, hotel rooms generally have the main lighting control device placed at the head of the bed, so that visitors can control the lighting and brightness of each space on the bed. Bedside lamps will also be placed to the side of the head of the bed to meet the needs of tourists. It is generally not advisable to set more lights at the entrance hallway, to avoid glare. The lighting requirements of the reception area, dining area and other spaces pay more attention to color rendering, and the configuration of high color rendering

lamps is conducive to clearly identifying the face and expression of the other party and can make the food look more delicious. Writing desks, dining tables, artworks, etc. are generally also set up with separate lighting or equipped with movable lamps with unique shapes. The toilets in guest rooms are different from other areas. Usually, lamps with a color temperature above 3500k are used, and the illuminance of the lamps should be increased accordingly. The lamps with high color temperature will give people a clean and refreshing feeling. The washstand is generally set up with separate lighting to avoid facial shadows when doing shaving and makeup.

At present, there are many kinds of intelligent lighting control system products on the market. According to their own technical characteristics, for the purpose of protection and competition, various suppliers have formulated a variety of mutually incompatible communication protocols, which is very inconvenient for users. The resort hotel often adopts the method of networked control in the intelligent joint control. The lighting system of the entire area is connected to the master control. The subnet is set under the master control, and then each guest room and other spaces are controlled [6]. At the same time, each guest room is also given a certain amount of autonomous control, which is convenient for guest to self-regulate the lights in the guest room. Different scene lighting settings can be realized by the communication mechanism of the bus adopted by the system. The basic principle is that each lighting control device has three addresses, group address, physical address and switch address. The functions of different "scenes" are realized through "groups". It is usually set to four modes: welcome mode, meeting mode, reading mode, and entertainment mode. Generally, different lighting and lighting arrangements are set up in different areas such as entrance area, rest area, bedroom area, and sanitary area. Guests only need to press a few buttons on the control panel to easily realize the switching and control of different scenes such as "reading", "entertainment", and "meeting guests". If the entertainment mode is set in the system in advance, when a guest turns on the TV or projection in the guest room, the room will automatically adjust the overall illuminance and set up different work scene modes. With the advent of the 5G era, intelligent control systems based on mobile phone APP and voice control are constantly being developed and improved.

### 2.1.2 Intelligent light environment changing with light perception

Due to the different geographical locations of the longitude and latitude of the resort, the color and time of the light will vary with the change of the longitude and latitude. The same hotel has different sunrise and sunset times throughout the year, and there are great differences in the time of day and evening. Therefore, at a time when China aims to achieve carbon neutrality, intelligent lighting technology can automatically calculate the daily sunrise and sunset times according to the hotel's geographic location, and automatically track and adjust the daily lighting switch time, which can greatly improve the use of natural light. This is an intelligent lighting that automatically changes the light environment by self-perception according to the actual lighting situation.

The intelligent lighting system can input the reference longitude and latitude according to its own geographic location, and automatically adjust the lighting in the guest room according to the actual time throughout the year to construct the light environment in the guest room at different time periods. When it is in normal weather, there will be sufficient sunlight before 17:30. The light sensor at different positions in the guest room can automatically adjust the room illuminance according to the sunlight exposure in different areas. Then closer to the window, stronger the sunlight is and lower is the required illuminance. (see Figure 2).

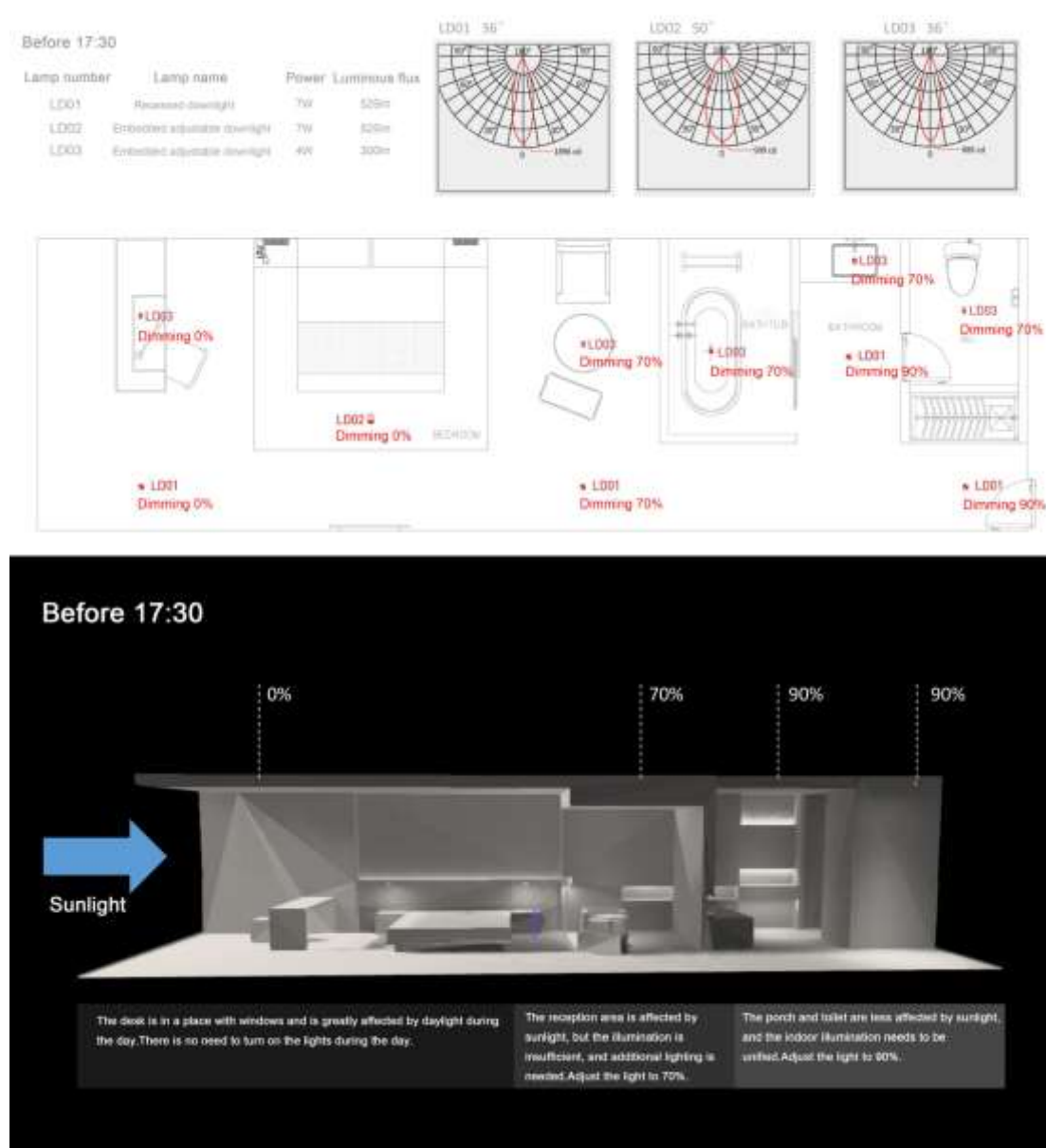


Figure 2: Schematic diagram of autonomous adjustment of guest room light environment before 17:30 during the day



From 17:30 to 19:30 in the twilight period, the sunlight intake gradually decreases, and the light environment in the guest room is gradually adjusted to maintain the uniform illuminance of the overall light environment of the guest room (see Figure 3).

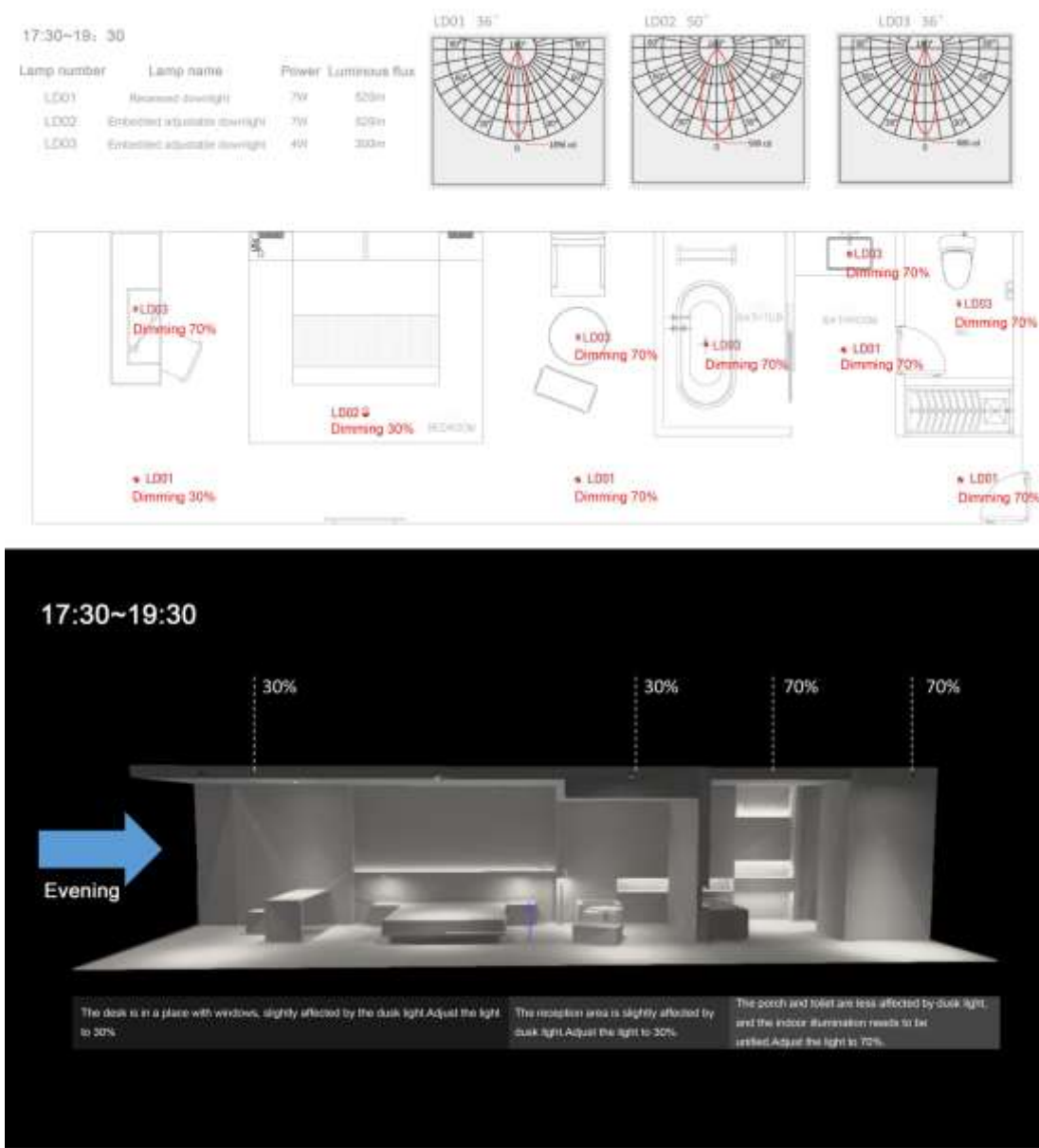


Figure 3: Schematic diagram of autonomous adjustment of guest room light environment from 17:30-19:30 in the evening

After 19:30, entering the night time, the sunlight intake is zero, and the overall light environment in the guest room changes again. The lack of natural light and the low overall illumination conforms to the human body rhythm (see Figure 4).

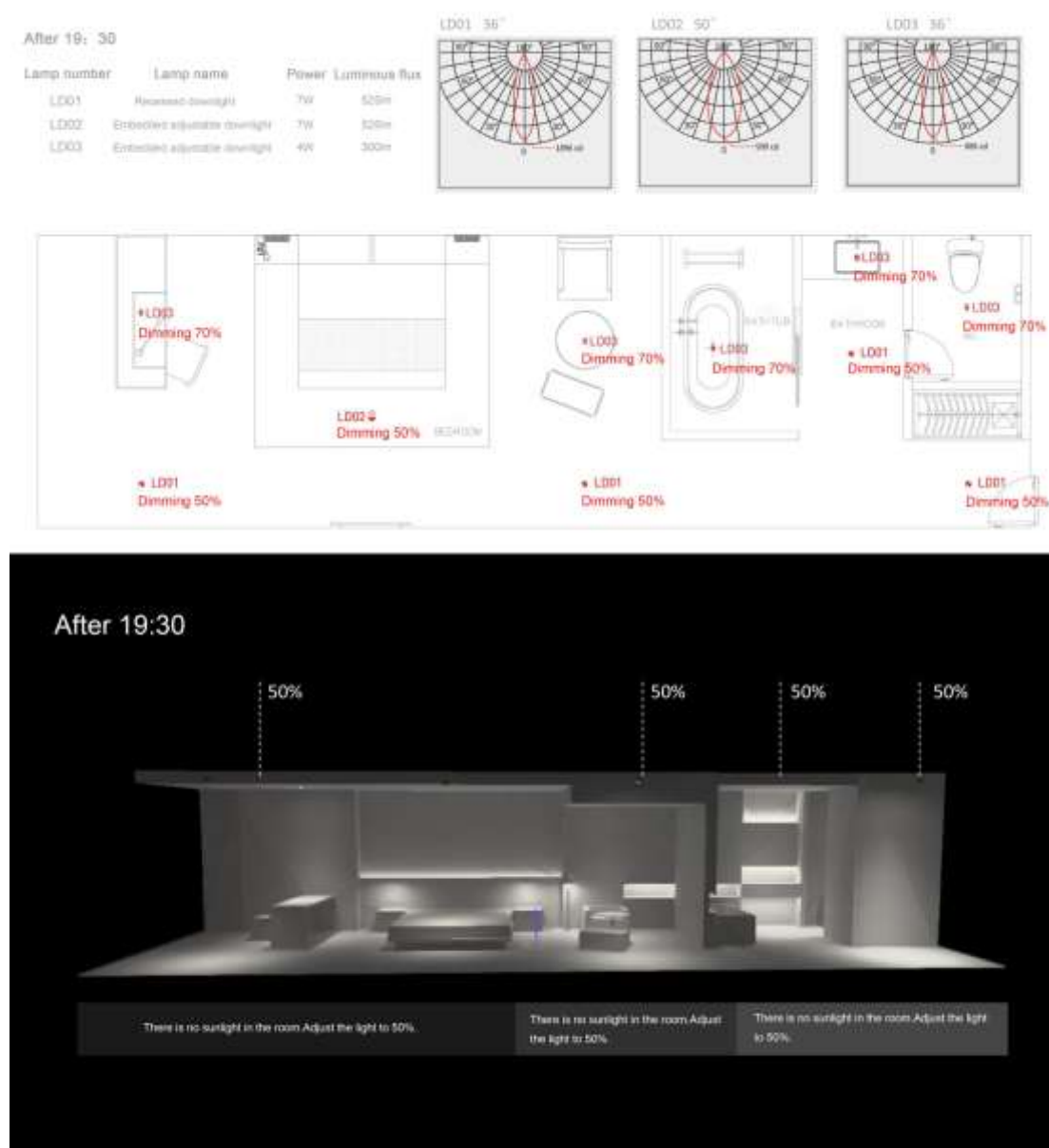


Figure 4: Schematic diagram of autonomous adjustment of guest room light environment after 19:30 in the evening

Therefore, according to the different natural light intake in the room, the sensor of the intelligent lighting system will self-identify and automatically adjust the light illuminance and color temperature. The



uniform and even distribution of the illuminance in the room will make people more comfortable. The distance from the window will increase during the same period of time. As you get farther and farther, you will receive less and less natural light, and the intelligent adjustment system will adjust the illuminance in different areas to keep the overall illuminance of the room uniform. At the same time, the intelligent lighting control system through regional networking also plays an active role in the maintenance and repair of lighting products. From the control terminal, the staff can intuitively see which area of the lighting equipment has a problem, which not only saves the hotel's labor costs, but can also perform equipment maintenance and replacement in time to improve work efficiency and avoid affecting the tourist's living experience.

## 2.2 Intelligent Lighting based on Adjusting the Circadian Rhythm of Tourists

Professor DeCoursey discovered as early as 1959 that light affects the human body's circadian rhythm. It only acts on the pineal gland through non-visual information pathways. The pineal gland secretes melatonin, which is called "sleep hormone", which controls the body's alertness and sleep [8]. Modern scientific research shows that this rhythmic, dark cycle of melatonin is recognized by the brain as a signal of light. Red light is the weakest inhibitor on melatonin, and blue light is the strongest inhibitor on melatonin. Also light intensity has different effects on melatonin. As a resort hotel, it is a high probability event to receive guests from different time zones. How to use the biological effects of light on the human body, adjust the human body's circadian rhythm and seasonal rhythm through intelligent lighting, and create a healthy light environment is of practical significance.

In addition to satisfying visual functions, intelligent lighting also needs to consider the influence of light intensity and spectral energy distribution on the human body's circadian rhythm. Adjusting the light intensity and spectral energy distribution through a scientific system can have a beneficial effect on the guests who need to adjust the time difference. For example, adding blue light that can inhibit melatonin to the room lighting spectrum during the day as much as possible can help the guest to stay relatively awake; in the night lighting environment, increasing red light that promotes the secretion of melatonin and minimizing blue lights that inhibits the secretion of melatonin promote better sleep, and to a certain extent alleviates sleep disorders caused by jet lag.

With the development of LED lighting products and technology, full-spectrum LED lighting technology has become the focus of the lighting field. Full-spectrum LED lighting technology is based on solar rhythm lighting, technically repairing the imbalance defects of ordinary LED light sources in the visible spectrum. It could play a greater role in regulating the rhythm of the human body, and thereby improving the comfort of lighting and improving the quality of LED lighting by simulating natural light spectrum, reducing blue peaks, effectively reducing blue light hazards. [9].

### 2.3 Healthy Intelligent Lighting based on Adjusting the Emotional Needs of Tourists

Human emotion is a complex multi-component process including cognition, feeling, motivation, body, and movement [10]. Every emotion, whether it is happiness, peace or longing, corresponds to a specific subjective experience, or physiological and behavioral response. The influence of different lighting environments on emotions and physical and mental health has always been a research hot topic in healthy lighting. Studies have shown that low color temperature lighting environment is more in line with people's emotional needs [11]. The chaotic lighting environment, such as mixed lighting colors, mismatched illuminance and color temperature, etc., will also have a negative impact on people's emotions. A pure light colors is more desirable in this circumstance. Byounghee Son evaluated user emotions by analyzing physiological indicators, and developed a comfortable emotional lighting system that can recognize human physiological indicators [12]. However, there are still some differences in the eyeball structure and eye functions of different races. For example, different races in different regions have different subjective feelings about the comfort of the light environment. East Asia generally prefers a light environment with low illumination and high brightness contrast. Northern Europeans prefer a light environment with high illumination and low brightness contrast (see Figure 5). Intelligent lighting can adapt to the light environment that suits the guests' mood better according to the different preferences of people of different races to the light environment.

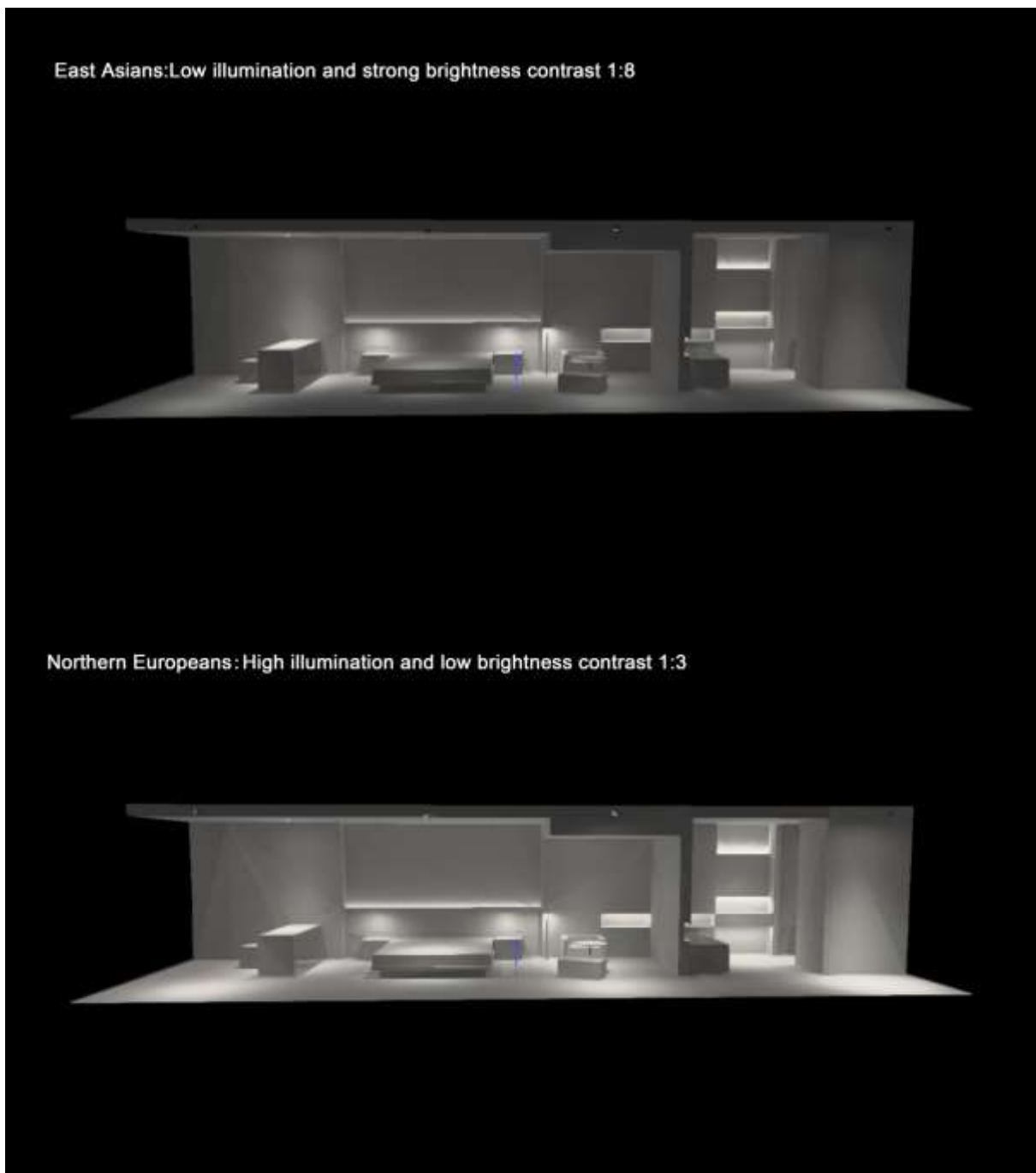


Figure 5: People in East Asia and Northern Europe prefer different light environments

The light environment of hotel rooms created by intelligent lighting products is no longer the mechanical stereotype of previous lighting fixtures. Through preset modes and intelligent adjustment, guests can feel more humane care and emotional expression. At the same time, selection of unique lamp shapes, ingenious design with human - lighting interaction, and an atmosphere with harmonious light and shadow will make tourists feel at home and relaxed and add to their pleasant staying experience.

While being intelligent, LED lighting products should also reflect human care and ease the emotional tension brought by unfamiliar environments. For example, the design of footlights when people wake up at night can be controlled by infrared induction. When the sensor senses the infrared radiation of the human body, it slowly lights up, and at the same time intelligently adjusts the illuminance of the toilet lamps to avoid the human eyes from being disturbed by visual stimulations in the dark. Similarly, the intelligent adjustment of the color temperature and illuminance of the bathroom should be judged according to the specific behavior of the guests, which can be actively adjusted by the sensors on the washstand, toilet, and bathtub; when a guest is shaving or putting on makeup, the color temperature and illuminance must be increased accordingly; When the guest is going to the toilet or bathing, the illuminance and color temperature can be appropriately lowered.

### III. CONCLUSION

The customized light environment in the guest rooms of a high-end resort hotel should bring guests satisfaction tailored to their individual preferences as well as the relaxation and pleasure of the body and mind. Besides that all the requirements of the objective light environment's illuminance standard, glare value, and color rendering index, the number of lightings determined by the lighting environment should be met, more attention should be given to people's feelings in the space. It also makes the control of the light environment and lighting design more humane care through comprehensive application of "visual-physiological-psychological multiple health and healing effects of "psychology". LED light source is given the important task of creating a healthy light environment because of its safety, energy saving, high utility, and easy spectrum regulation. The hotel rooms no longer only provide the function of resting, but carry a certain cultural attribute. The comfort and living experience of the guest rooms largely determine the overall evaluation of the hotel by tourists. Therefore, creating a light environment with a comfortable experience is of great benefits to the hotel's branding and advertising and marketing.

At the same time, the application of big data and the development of artificial intelligence provide new ideas for lighting design. By integrating the database of tourist behavior, the intelligent lighting system can actively analyze user behavior habits and make changes for it. For example, guests can fill in their own guest room environment requirements before checking in, so that guests can experience a personalized comfortable light environment when they check in. At the same time, due to the highly subjective nature of comfort, it also reserves the right of guests to change the light environment in the guest room, that is, guests can independently adjust the light environment to make themselves more comfortable. Through the interaction between people and the indoor light environment, the intelligent lighting system can actively adapt to people's habits and improve the overall quality of the guest room.

In addition, the realization of 5G and even 6G technology has greatly promoted the stability and speed of signal transmission of the intelligent lighting control system. The ecology of intelligent products is constantly improving, and the barriers of communication protocols will gradually be eliminated. With the

continuous advancement of technology, data analysis based on user behavior and habits allow hotel guest rooms to make changes for guests in advance, which will surely give tourists a greater sense of happiness when they check in.

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