Journal of World Architecture, 2024, Volume 8, Issue 2
https://ojs.bbwpublisher.com/index.php/JWA
Online ISSN: 2208-3499
Print ISSN: 2208-3480

Application of Landscape Smart Lighting in Construction Projects

Yingling Dai*, Qinghua Zhao

China Merchants Chongqing Communications Technology Research & Design Institute Co., LTD., Chongqing 400067, China

Corresponding author: Yingling Dai, daishushu@163.com

Abstract: Currently, to effectively construct high-quality smart cities and achieve comprehensive governance goals, various industries must embrace the transformation and upgrading of traditional management methods through the integration of new technologies. Among these, landscape smart lighting serves as a crucial tool for advancing smart city development. By judiciously applying this technology, it is possible to enhance traditional lighting methods and offer people novel experiences in their daily lives. Recognizing this importance, this article analyzes and organizes the content of landscape smart lighting, delves into its system characteristics, and summarizes its principles and practices in the field of architectural engineering as practical references for application scenarios.

Keywords: Landscape smart lighting; Smart city; Construction engineering

Online publication: May 21, 2024

1. Introduction

The landscape smart lighting system can be seen as an upgrade of traditional lighting systems. Different from traditional lighting systems, landscape smart lighting systems can achieve real-time control and optimization of lighting by combining new-generation information communication and automation control technologies. This capability not only fulfills various lighting requirements across different scenarios but also enhances lighting experiences. The most important thing is that the landscape smart lighting system aligns with the goals of smart city transformation and upgrading by prioritizing energy conservation and user comfort. This approach ensures better user experiences and meets application needs across diverse scenarios. Currently, landscape smart lighting systems have been successfully promoted and applied in both social production and daily life, particularly within the realm of construction engineering.

2. Overview of landscape smart lighting systems

2.1. Smart city concept

Smart cities can essentially be viewed as a novel form of sustainable innovation, primarily achieved through the

integration and utilization of next-generation information technology alongside comprehensive communication terminals and other tools. The overarching objectives include comprehensive perception, smart integration, and interconnected sharing. Central to the realization of smart cities are new technologies such as the Internet of Things, big data, and cloud computing, which form the backbone of the new generation of information and communication technologies. Additionally, comprehensive communication terminals leverage tools and methods like Wikipedia, social networks, and online multimedia platforms. In recent years, with the seamless integration and high-quality application of network communication technology, gaining a comprehensive understanding of the development and construction of smart cities has emerged as a pivotal means to drive urban development towards more advanced forms.

The smart city explored in this article represents a novel phase in information city development, following digital cities, and holds immense promise and feasibility. It embodies this potential through two key perspectives: firstly, from a technological standpoint, smart city construction integrates next-generation information and communication technology to realize comprehensive perception and seamless interconnection, fostering a highly connected urban environment. Secondly, from a social development angle, smart cities prioritize sustainable development goals driven by user innovation and collaborative approaches, utilizing tools like social networks and wikis to encourage citizen engagement and innovation. By harnessing intelligence and fostering collaboration, smart cities aim to ensure economic, social, and environmental sustainability, thereby driving holistic and enduring progress [1].

2.2. Landscape smart lighting

Landscape smart lighting represents an innovative approach to advancing smart cities. By leveraging emerging technologies and tools, landscape smart lighting addresses the limitations of traditional lighting systems, including low energy efficiency and inadequate automatic control capabilities. From a developmental perspective, China's landscape smart lighting has progressed through stages of incubation, germination, growth, and maturity. Initially, urban landscape lighting relied heavily on government-led initiatives, with limited public enthusiasm leading to a relatively simplistic structure for urban landscape lighting systems.

As the economy and society have continued to develop, there has been a notable improvement in people's material living standards, leading to increased investment by government departments in the construction of urban landscape lighting systems. In response to the growing emphasis on meeting the spiritual and cultural needs of the populace, urban landscape lighting has placed greater emphasis on artistic and scientific elements. Consequently, there has been a significant increase in the variety of lighting materials and equipment, with the emergence and application of new types of lighting equipment such as light-emitting diode (LED) and computer numerical control (CNC) electronic dimming. In recent years, in alignment with the imperative of sustainable development, urban landscape lighting has shifted its focus away from mere scale construction and brightness aesthetics towards considerations of energy conservation, environmental protection, and smart management. In line with this shift, landscape smart lighting systems have emerged and are being actively promoted and applied to meet the requirements of smart city construction and development [2].

3. Analysis of 2 landscape smart lighting systems

3.1. 3-phase 4-wire N-line current monitoring

Conventional landscape lighting systems often rely on a large number of LED lamps to conserve electricity. However, these LED lamps' switching power supplies can lead to issues with harmonic currents, which fail to balance the three-phase current vector and may increase the zero line current, undermining energy conservation

and environmental protection efforts. Additionally, some lighting projects necessitate determining cable diameters based on phase line loads [3]. During this process, it is crucial to ensure that the cross-sectional area of the neutral line remains within the numerical value of the phase line's cross-sectional area. Failure to do so may lead to overload issues with the neutral line, compromising the safety of the lighting system. In contrast, landscape smart lighting systems leverage RTU devices and measurement and control modules to accurately measure three-phase current vector values, thereby enhancing electrical safety and energy efficiency within the lighting system [4].

3.2. Smart recording and analysis of events

The smart control features of landscape smart lighting systems are notably pronounced, particularly in their ability to record and analyze events. Regarding smart event recording, the measurement and control equipment within the landscape smart lighting system can capture real-time electrical quantity data, enabling a comprehensive understanding of the system's current operation by analyzing fluctuations in this data. Furthermore, upon identifying events exceeding predefined limits, the system proactively initiates protective measures to prevent the escalation of potential hazards. For instance, if the circuit leakage current becomes uncontrollable, the system's leakage protection circuit breaker automatically triggers a trip operation, mitigating the risk of large-scale faults. In terms of smart event analysis, the system employs passive protection mechanisms, leveraging its smart event recording function to integrate and analyze relevant data accurately, thereby identifying the root causes of fault occurrences with precision [6].

3.3. Automatic control of on/off switches

The automatic control function of landscape smart lighting systems enables automated scheduling and timed activation/deactivation of lights, facilitating energy-efficient operation of equipment while enhancing maintenance safety. In practice, automatic control of light activation/deactivation primarily involves managing switching scenarios and individual circuits. Through a designated list of reserved switches, personnel can access information regarding reserved switch settings in the distribution box [7]. Additionally, the remote terminal unit (RTU) module within the system continuously monitors real-time electrical quantity data, enabling it to identify any abnormal operating conditions within the landscape smart lighting system. In the event of such abnormalities, the system automatically switches off the lights and alerts professional personnel, ensuring timely repair and maintenance interventions.

3.4. Smart alarm information

When the landscape smart lighting system encounters abnormalities like module offline or gateway device disconnection, it automatically triggers a fault alarm. This alarm information is promptly displayed on the platform interface, alerting management personnel to address it promptly. Typically, the fault alarm information includes details such as the time of occurrence and the location of the affected module. Upon receiving this information, trained professionals are promptly assigned to perform maintenance and resolve the issues, aiming to restore the landscape smart lighting system to its normal operational status as quickly as possible [8].

3.5. Smart dimming control and scene control

Smart dimming control and scene control represent crucial function applications within landscape smart lighting systems. Dimming control integrates automation and smart control technologies to precisely adjust the number of lights and their brightness automatically, catering to the specific illumination and brightness requirements of different areas. Currently, this control method enables automated monitoring of illumination and brightness across various locations such as corridors, public areas, and conference rooms. Additionally, the

scene control function facilitates adjustments to illumination and brightness based on different scene modes. By pre-configuring multiple application scene modes within the system, smart control and management of lighting fixtures are achieved according to specific scenes, ultimately enhancing lighting comfort and efficiency.

3.6. Smart operation and maintenance management

The landscape smart lighting system is capable of automating the collection and analysis of lighting energy consumption data across various time periods and regions. For instance, in electricity consumption statistics, the system can segment and accurately integrate consumption data, presenting it to management personnel in graphical formats for easier analysis and tracking. During system fault handling, it automatically identifies fault locations and severity levels, issuing warning messages to management personnel for timely repairs. Most importantly, during the smart operation and maintenance phase, the system autonomously backs up data and stores it securely, ensuring convenient access for personnel when needed [9].

4. Analysis of the application principles of landscape smart lighting in building engineering

4.1. Zoning

The application of landscape smart lighting in construction engineering necessitates strict adherence to zoning principles to ensure smart operation and scientific control. Zoning involves the rational configuration and application of landscape smart lighting systems based on building structures. It entails determining the number and installation locations of lighting equipment according to overall operational conditions and communication requirements, facilitating centralized control and system integration. This approach ensures efficient management and optimized performance of the lighting system within construction projects [10].

4.2. Functional division

Smart lighting systems for architectural engineering landscapes require the rational allocation of control targets based on monitoring and management requirements. Lighting systems are categorized into various types according to their functions, such as task lighting, safety lighting, and decorative lighting. Different lighting zones demand distinct control and dimming methods to ensure the effective application of landscape smart lighting across diverse scenes. Furthermore, landscape smart lighting systems can be classified based on control methods, costs, and other factors. It is important to emphasize that the lighting design for building engineering must establish a sensible loop control mode tailored to specific control objectives. For instance, in areas of buildings with low personnel entry and exit rates, simple circuits suffice for control and management, effectively reducing costs and conserving power. However, public spaces like corridors and elevator lobbies necessitate the addition of automatic switches and smart electronic components, such as common smart detectors, to enable automatic light switch control. Moreover, areas with heightened lighting requirements, such as lecture halls and conference centers, mandate a thoughtful design of lighting schedules and effects tailored to diverse scene-specific lighting needs.

5. Application of landscape smart lighting system in building engineering in practice

5.1. Hotel architecture

Landscape smart lighting systems are widely utilized in hotel construction projects, encompassing various types

such as indoor smart lighting systems and multimedia smart lighting systems. Unlike other building types, lighting systems in hotels must cater to diverse scene requirements, necessitating adjustments and optimization of lighting brightness and light source distribution accordingly. Through practical application, landscape smart lighting systems deployed in hotel projects demonstrate exceptional performance in dimming consistency, stability, and light accuracy. Leveraging smart and automated control technology, these systems dynamically monitor the operational status of lighting fixtures. Additionally, smart control modules facilitate real-time scene-dimming processes on-site, ensuring that the hotel's lighting brightness aligns with scene-specific requirements.

5.2. Civil buildings

Landscape smart lighting systems play a significant functional role in civil buildings, offering automatic control and adjustment of lighting time and brightness according to specific needs. Crucially, smart control-based lighting systems facilitate power resource conservation by automatically adjusting lighting system switches based on outdoor brightness, thereby minimizing energy wastage. Structurally, landscape smart lighting systems in civil buildings typically comprise smart sensors, dimming modules, and human-machine interaction interfaces. Through collaborative operation, these components work to reduce energy consumption and alleviate power supply pressure. Moreover, diverse landscape lighting modes can be configured based on different scenarios to enhance the artistic and aesthetic appeal of the lighting design.

5.3. Educational buildings

Traditional lighting systems in educational buildings often exhibit high energy consumption and inefficient management practices. Over time, these systems may suffer from aging circuits and shortened service life. To address these shortcomings, modern teaching building lighting systems leverage smart lighting technologies to automatically adjust light intensity and chromaticity. This not only reduces energy consumption but also mitigates the negative effects of poor lighting on students' vision. Additionally, smart lighting systems can automatically adjust lighting fixture brightness according to outdoor lighting conditions, ensuring optimal illumination levels throughout the day.

5.4. Emergency lighting in buildings

The smart lighting system utilized in emergency lighting within buildings offers powerful light source penetration, effectively guiding and indicating escape routes even in conditions of smoke interference, facilitating the swift evacuation of personnel. Moreover, this smart lighting system can integrate voice commands, enabling trapped individuals to evacuate following instructions from evacuation light sources and voice reminders. It is important to note that power facilities for emergency lighting in buildings typically feature built-in batteries and a centralized power supply. While built-in battery power supplies require regular maintenance to uphold the effectiveness of the emergency lighting system, centralized power supplies boast superior performance despite their higher installation costs, making them suitable for specific needs.

6. Conclusion

In conclusion, the adoption and implementation of landscape smart lighting systems not only align with the objectives of smart city construction and development but also comply with energy conservation and environmental protection policies, offering significant feasibility. The building engineering application scenarios examined in this article effectively mitigate energy consumption issues and low lighting efficiency through the utilization of landscape smart lighting systems. Looking ahead, researchers should focus on enhancing the

development and utilization of application scenarios and modes for landscape smart lighting systems. This ensures that these systems yield favorable outcomes across multiple domains, delivering high-quality lighting services to diverse settings.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Xie X, Gao Q, Gao Y, et al., Exploration of Urban Smart Lighting and Its Artistic Development. Light Sources and Lighting, 2022(S1): 107–110.

[2] Chao D, Yang Y, Shi Y, 2022, A Brief Discussion on Smart Control of Landscape Lighting. Journal of Lighting Engineering, 33 (05): 49–54.

[3] Feng J, Zhou Q, 2022, Research on the Application of Smart Control System in Outdoor Landscape Lighting. Light Sources and Lighting, 2022(07): 1–3.

[4] Liu J, 2022, Exploration of the Application of Landscape Smart Lighting in Building Engineering. Construction Technology, 2022(06): 27–29.

[5] Zhou N, Li J, Yang G, 2020, A Smart Control System for Urban Landscape Lighting Based on Internet of Things Technology and its Application - Taking the Landscape Lighting Improvement Project of the North Bund of Hongkou in Shanghai as an Example. Journal of Lighting Engineering, 31(05): 131–136.

[6] Yu M, Protecting and Developing Ancient Buildings from the Perspective of Landscape Lighting Construction: Taking the Landscape Lighting Project of the Palace Museum as an Example. Light Source and Lighting, 2023(5): 14–18.

[7] Chen L, 2023, Smart Lighting Illuminates the "Splendid New Tianfu" - A Record of Urban Landscape Lighting Guarantee Work for the Chengdu Universiade. Urban Management and Technology, 24(5): 16–18.

[8] Xue K, 2022, Application of Smart Lighting Systems in Urban Landscape Lighting Engineering. Smart Buildings and Smart Cities, 2022(12): 169–171.

[9] Kong D, Xu Q, 2022, Urban Color Development and Exploration Under the Influence of Architectural Lighting Color. Smart Building and Smart City, 2022(1): 157–159.

[10] Gong J, Lv Y, Zhou N, et al., 2022, Design and Implementation of Smart Landscape Light Sensing Dimming System. Wireless Internet Technology, 19(17): 49–52.