Research on Indoor Environment Control System of Theme Parks under Smart Cultural Tourism Mode

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Abstract: With the vigorous development of smart travel, the optimization of indoor environment control of theme parks is very important to improve the tourist experience and operational efficiency. The purpose of this article is to explore the influence of the intelligent travel mode on the indoor environment control of theme parks, and to build an adaptive control system. Through the comprehensive application of theoretical research and system design, the application of related basic theories, such as thermal and humid environment theory, air quality theory and ergonomics theory, in indoor environment control is deeply analyzed. It is found that the smart travel mode promotes the transformation of theme park operation and management to accurate data-driven, and tourists pay more attention to all-round immersion in the indoor environment experience demand. Technology integration brings opportunities and challenges such as compatibility and safety. Based on this, an indoor environment control system covering subsystems such as environmental perception and data collection, intelligent control and decision-making, tourist interaction and feedback is constructed. The system can effectively meet the individual needs of tourists, improve the operation and management level of theme parks, and provide powerful practical guidance for the scientific control of indoor environment of theme parks in the era of smart travel.

1. Introduction

With the rapid development of information technology, the cultural tourism industry is undergoing profound changes, and the intelligent cultural tourism model came into being [1]. Smart travel combines cutting-edge technologies such as big data, Internet of Things and artificial intelligence, bringing new opportunities for the innovative development of the travel industry [2]. As an important part of the cultural tourism industry, the comfort and experience of the theme park's indoor environment play a key role in tourists' satisfaction [3]. Therefore, it is of great practical significance to deeply study the indoor environment control system of theme park under the mode of smart travel.

In recent years, with the improvement of people's living standards, tourists' demand for theme parks is no longer limited to traditional amusement projects, and the quality requirements for indoor environment are becoming more and more stringent [4]. The traditional indoor environment control mode of theme parks has been difficult to meet the expectations of tourists in the new era because of the lack of intelligence and personalization [5]. By virtue of its intelligence and accuracy, the intelligent travel mode provides the possibility for optimizing the indoor environment control of theme parks.

From the perspective of academic research, the current research on intellectual travel focuses on the macro-industrial level, and the research on the micro-field of indoor environmental control system of theme parks is relatively scarce [6]. Especially, there is still a lot of room to be explored in the deep integration of smart travel mode and indoor environment control of theme parks.

The purpose of this article is to fill this research gap, and through interdisciplinary theoretical analysis and other methods, to deeply explore the influence and demand of the smart travel mode on the indoor environment control of theme parks, and to build a scientific and reasonable indoor

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environment control system. It is expected that this study can provide support for theme parks to enhance visitors' experience, optimize operation and management, and promote the sustainable development of smart travel industry.

2. The related theories of intellectual travel and indoor environment control of theme parks

2.1. The concept and characteristics of intellectual travel

Wisdom Travel is a new generation of information technology, such as big data, cloud computing, Internet of Things and artificial intelligence, to fully and fully empower and innovate the travel industry [7]. It breaks the time and space restrictions of the traditional cultural tourism industry and realizes the intelligent integration and efficient allocation of cultural tourism resources, services and management. It has remarkable characteristics. In terms of intelligence, with the help of intelligent equipment and systems, the automation and accuracy of cultural travel services are realized. Individualized, according to tourists' preferences and behavior data, provide customized experience. Integration is to promote the deep integration of cultural tourism industry with science and technology, finance and other fields, expand industrial boundaries, and create novel cultural tourism products and service models. These characteristics make theme parks innovate constantly in operation management and visitor experience creation.

2.2. Elements of indoor environment of theme parks

The indoor environment of theme parks covers multiple elements such as physics, space and culture. Among the physical environment factors, temperature, humidity, air quality and illumination are directly related to the physiological comfort of tourists [8]. Among the elements of space environment, reasonable layout and smooth streamline design are very important. Reasonable layout of different amusement projects and service facilities to ensure that tourists can reach various areas conveniently; Smooth streamline can prevent people from being congested and improve the efficiency of play. Cultural environment elements focus on the creation of theme atmosphere, and through interior decoration, scene layout and theme activities, tourists are immersed in specific cultural situations and enhance the sense of theme experience.

2.3. Basic theory of indoor environment control

Indoor environment control relies on the theory of hot and humid environment, air quality and ergonomics. The theory of heat and humidity environment aims at the law of heat and humidity transfer in the laboratory, and maintains suitable indoor temperature and humidity conditions by adjusting HVAC systems and other equipment [9]. Air quality theory focuses on indoor air composition and pollutant control to ensure tourists' respiratory health. Ergonomics theory optimizes the indoor space design and facilities layout from the perspective of human body scale, physiological and psychological needs, improves the convenience and comfort of tourists, and provides a solid theoretical basis for the scientific control of the indoor environment of theme parks.

3. The influence and demand of intelligent travel mode on indoor environment control of theme parks

3.1. Operation and management changes under the mode of smart travel

Smart tourism model has effectively promoted the transformation of theme park operation and management concept from traditional extensive to accurate data-driven. The traditional operation mode mainly relies on managers' experience and historical data to make decisions, which leads to the lack of dynamic adjustment ability of operation strategy. In the traditional mode, the indoor environment control system usually adopts a unified preset timing control scheme, which is difficult to meet the differentiated needs of different regions and time periods [10]. In the smart travel mode, with the help of big data analysis, operators can grasp information such as tourist traffic, distribution and behavior preferences in real time. This requires the indoor environment control

system to have a higher level of intelligence and automation, which can quickly respond to operational management decisions and realize dynamic and accurate environmental regulation.

3.2. The change of tourists' demand for experience

With the development of intellectual travel, visitors' demand for the indoor environment of theme parks has changed significantly. In the past, tourists mainly paid attention to the amusement project itself, but now they are pursuing an all-round immersive experience. They expect that the indoor environment can be closely integrated with the theme, and they can create unique situational awareness from temperature, humidity to lighting atmosphere. Table 1 shows this shift in detail. In order to meet these needs, the indoor environment control system needs to have stronger situational simulation and interactive functions, and can flexibly adjust environmental parameters according to different themes and tourists' needs to create a personalized immersive experience space.

Table 1 Changes in Visitors' Demands for Indoor Environmental Experience in Theme Parks in the Era of Smart Cultural Tourism

Experience Demand Dimension	Traditional Demands	Demands in the Era of Smart Cultural Tourism
Environmental Comfort	Basic suitable temperature and humidity	Personalized comfort settings, such as temperature adjustment based on individual physical conditions
Thematic Immersion	Simple thematic decorations	All-round thematic atmosphere creation, including environmental sound effects, scents, etc.
Interactivity	Passive acceptance of environmental services	Active participation in environmental regulation, such as adjusting lighting via a mobile app

3.3. Opportunities and challenges brought by technology integration

The integration of smart travel related technologies such as big data, Internet of Things, artificial intelligence and indoor environment control of theme parks has brought unprecedented opportunities. Internet of Things technology realizes the interconnection of indoor environment equipment, making data acquisition and equipment control more convenient and efficient. By arranging various sensors indoors, real-time data such as temperature, humidity and air quality are collected and transmitted to the cloud for analysis. Based on these data, the artificial intelligence algorithm predicts the demand of tourists, automatically optimizes the environmental control strategy and improves the energy efficiency.

However, technology convergence also faces many challenges. The first is the technical compatibility. Different brands and models of environmental control equipment and sensors may adopt different communication protocols and data formats, which makes system integration difficult. Secondly, the risk of data security has increased, and the collection and storage of a large number of tourist data and equipment operation data are easy to be targeted by hackers, and data leakage may cause tourists' privacy and operational safety problems. In addition, with the rapid upgrading of technology, theme parks need to continuously invest resources to upgrade and maintain their systems in order to maintain their competitiveness. Therefore, while taking advantage of technology integration, theme parks need to focus on solving these challenges to ensure the stable and safe operation of indoor environmental control systems.

4. Construction of indoor environment control system of theme park under the mode of smart travel

4.1. System overall architecture design

The indoor environment control system of the theme park under the smart travel mode adopts a layered architecture, which consists of a perception layer, a network layer, a platform layer and an

application layer (see Figure 1). The perception layer is responsible for collecting indoor environmental data in real time, the network layer realizes efficient data transmission, the platform layer processes and analyzes the data, and the application layer transforms the processing results into actual environmental control strategies and interactive services for tourists. All levels cooperate with each other to ensure the stable operation of the system.

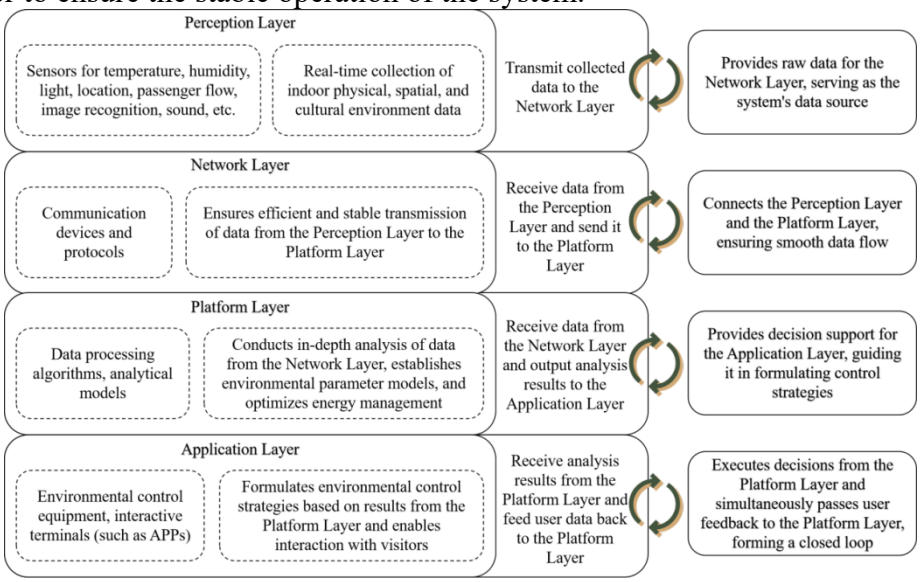

Figure 1 Indoor environment control system of theme park

4.2. Environmental perception and data acquisition subsystem

The subsystem realizes comprehensive perception and accurate data acquisition of indoor physical, spatial, cultural and other environmental elements through various sensors. In terms of physical environment, temperature sensor monitors indoor temperature, humidity sensor detects humidity, and light sensor obtains light intensity. Spatial environmental elements are collected with the help of position sensors and passenger flow sensors to understand the distribution and flow of tourists. The perception of cultural environment is relatively complicated, such as analyzing the integrity and attractiveness of theme decoration by image recognition sensor and collecting the feedback of theme sound effect by sound sensor. Table 2 lists the main sensors and their functions in detail:

Table 2 Sensor Types and Functions of the Environmental Perception and Data Collection Subsystem

Sensor Type	Monitored Environmental Element	Specific Function
Temperature Sensor	Physical Environment - Temperature	Real-time measurement of indoor temperature values
Humidity Sensor	Physical Environment - Humidity	Precise detection of indoor air humidity
Light Sensor	Physical Environment - Lighting	Acquisition of lighting intensity and spectral information
Position Sensor	Spatial Environment - Visitor Position	Location of visitors within the indoor space
Passenger Flow Sensor	Spatial Environment - Visitor Traffic	Counting of visitors in specific areas
Image Recognition Sensor	Cultural Environment - Thematic Decorations	Analysis of the integrity and visual effects of thematic decorations
Sound Sensor	Cultural Environment - Thematic Sound Effects	Collection of volume and sound quality feedback of thematic sound effects

4.3. Intelligent control and decision subsystem

The intelligent control and decision subsystem uses artificial intelligence algorithms and models to make in-depth analysis and decision on the collected data. Based on big data analysis, the system can establish environmental parameter models in different scenes, such as the best combination of temperature, humidity and lighting in different theme areas at different time periods and different tourist flows. The artificial intelligence algorithm can also optimize energy management, minimize energy consumption and achieve energy conservation and environmental protection goals on the premise of meeting environmental needs.

4.4. Tourist interaction and feedback subsystem

The subsystem of tourist interaction and feedback builds a communication bridge between tourists and indoor environment control system. Through the mobile APP or the interactive terminal set up in the park, visitors can realize personalized regulation and control of the environment, such as self-regulating the illumination brightness and temperature preference of the area. The system collects tourists' feedback information in real time, including the evaluation of environmental comfort and theme atmosphere. On the one hand, these feedback data are used to optimize the environmental control strategy in time, on the other hand, they provide reference for the theme park to improve the indoor environment design and operation management, so as to continuously enhance the participation and experience of tourists and create a more humanized indoor environment of the theme park.

5. Conclusions

In this article, the indoor environment control of theme parks under the mode of smart travel is discussed in depth, aiming at filling the research gaps in related micro-fields. By combing the related theories of intellectual travel and indoor environment control of theme parks, the concept characteristics of intellectual travel, the elements of indoor environment and the basic theory of control are clarified.

It is found that the intelligent travel mode has a profound impact on the indoor environment control of theme parks. Operation management has changed from experience-driven to data-driven, which requires higher system intelligence and automation. Tourists' experience needs have changed to all-round immersion, which has prompted the system to enhance the function of scenario simulation and interaction. Technology convergence brings opportunities, but also challenges such as technology compatibility, data security and system upgrade and maintenance. Based on this, a comprehensive and scientific indoor environment control system is constructed. From multi-element accurate collection of environmental perception and data collection subsystem, to intelligent analysis and decision-making of intelligent control and decision-making subsystem, to two-way interaction of tourist interaction and feedback subsystem, all subsystems work cooperatively. This system can not only accurately meet the personalized and immersive needs of tourists for indoor environment, but also help theme parks to achieve efficient operation and management, energy conservation and environmental protection goals. In the future, we expect more research to pay attention to this field and further improve and deepen relevant theories and practices.

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