Hindawi
Journal of Sensors
Volume 2023, Article ID 9188907, 13 pages
https://doi.org/10.1155/2023/9188907

Research Article

Landscape Architecture Design and Implementation Based on Intelligent Monitoring Sensing Network

Ge Liu [1,2]

[1]*Lincoln University College, Selangor, Malaysia*
[2]*Zhengzhou University of Finance and Economics, Zhengzhou 450011, China*

Correspondence should be addressed to Ge Liu; liuge@lincoln.edu.my

Received 23 September 2022; Revised 27 March 2023; Accepted 12 May 2023; Published 1 June 2023

Academic Editor: Chih-Cheng Chen

Nowadays, in the context of smart city construction, the changes brought by the smart system to the city are not only material intelligence, but also because the smart system is completed by the cooperation of human wisdom and the wisdom of things, it is even more enhanced. There are various connections between people and people and cities. In this paper, the construction of urban parks, its management, and service requirements also show a trend of diversified development. However, some traditional urban parks cannot meet the new social needs. The application of smart park systems in their renovation is an important way for urban parks to rejuvenate and is an indispensable part of smart city construction. For urban parks, the upgrade of smartization in the traditional park model is not only an inevitable trend in the development of information technology but also an important direction for the future construction of parks. The purpose of this paper is to study and discuss the systematic methods applied by the smart park system in the renovation and renewal of urban parks, to discuss the common problems and solutions faced in the renovation and renewal of urban parks today, and to realize the renovation of the smart park system of urban parks. And by studying the application background, ways, and needs of the smart park system, it will carry out practical exploration on the renovation and renewal of Wuhan Jiefang Park. Through the analysis of the current situation of the Jiefang Park and the interpretation of the existing problems, special transformation is carried out under the guidance of the smart park system according to the existing problems, and the methods and systems of the application of the smart park system are summarized through practice. From a practical point of view, the update design strategy proposed in this paper is tested.

1. Introduction

Many cities take the construction of smart cities as a strategic choice for transformation and development, setting off a boom in the construction of smart cities [1]. With the rapid development of new-generation information technologies such as the Internet of Things (IoT), big data, and cloud computing, as well as their wide application in smart city construction, the management and service needs of urban parks also show a trend of diversified development. The functional layout, management methods, and service activities of many traditional urban parks today cannot fully meet the various needs of the current information age [2]. How to maintain urban green space such as urban parks can adapt to the development of the age of wisdom, meet the current needs of urban managers and residents, and exert greater ecological benefits are issues that need special attention in the development of urban parks. To become an indispensable part of smart city construction, the construction of urban parks must rely on scientific and technological means to realize smart management and smart services through the construction of smart park systems [3]. The goal of smart operation and smart facilities is to lay a solid foundation for the sustainable development of urban parks.

Due to changes in the society and environment, our landscape types have also become complex and diverse. However, because the development of landscape architecture information technology in China is relatively backward, the theoretical system of digital chemistry has not yet been formed, and the platform is weak, resulting in a lower threshold for the landscape architecture industry [4]. The mastery level is uneven, the theory is not solid, the practical experience is not rich enough, and there is a lack of software technical talents. In addition, the project construction period is generally shortened, and the designers cannot be like the ancient gardeners [5]. After the garden is completed and landed, it will be continuously adjusted through long-term observation experience, so that the garden landscape will reach a near-perfect state. Therefore, if we want to make good use of the benefits of the development of the times and follow the pace of the times, we should give priority to the use of digital technology and the participation of multidisciplinary professionals to help designers optimize the design and make the landscape more scientific and ecological. The application of smart park systems can greatly satisfy urban residents' [6] travel needs. The application of the smart park system enables urban parks not only to better play traditional functions such as ecological protection and scientific propaganda and education but also to enhance the landscape interaction of urban parks, to use digital information technology to make the relationship between urban parks and urban residents closer, to achieve the harmonious coexistence of man and nature, and to enhance the image of the city and the happiness of residents' life.

The connection between urban parks and urban residents is very close, and excellent urban parks can greatly improve the quality of life of urban residents. After decades of construction, development, management, and operation, many urban parks have become indispensable green spaces in cities [7]. In view of the problem that some traditional urban parks cannot meet the needs of current urban residents in a timely manner, these urban parks need to be upgraded and updated intelligently to enhance the vitality of urban parks and to create smart parks that meet the background of smart city construction. By applying the smart park system to the renovation and reconstruction of some traditional urban parks, the image and service level of urban parks can be greatly improved [8]. Therefore, this paper is devoted to the research on the specific application and approach of smart park system in the process of urban park renovation and renewal and to design smart garden system based on wireless sensor technology [9]. Introduce the smart park system into the development process of the renovation and reconstruction of the park and build an urban smart park that provides residents with a comfortable green space experience and provides an intelligent operation and management model for the city park management department.

2. Related Works

At present, with the effective development and continuous progress of social economy, modern science and technology have made more achievements, and the development of wireless sensor networks has become more mature. Because the wireless sensor network itself has many advantages such as low cost and low energy consumption, its application scope in the field of environmental monitoring is gradually expanding, and good application results have been achieved. Cheng and Wu proposed that through the investigation and analysis of the actual application of wireless sensor networks in environmental monitoring, it is found that the hardware resources of wireless sensor networks are limited, and the wireless sensor nodes will be affected by the energy consumption of the body and the storage space in the process of environmental monitoring [10]. The power consumption of related equipment is relatively large. If the wireless sensor resources are limited and the battery cannot be replaced in time, the overall effect of environmental monitoring will be affected. Harfouche et al. pointed out that the improvement of network monitoring data reliability provides a guarantee. In such systems, the construction of the system generally includes sensor nodes, routers, gateways, and supervision centers [11]. Among them, the sensor nodes include data monitoring nodes and aggregation nodes, which are mainly responsible for the data collection and transmission. The router is responsible for the communication gateway between the supervision center and the information collection point based on a specific routing protocol and is responsible for transmitting the received data to the supervision center. The data storage center and the remote control center are responsible for storing monitoring data and sending control commands, respectively. Overall, the wireless sensor network is a dynamic network system. The sensor nodes can move freely. When the battery energy is used up or the node is disconnected from the network due to the failure of the node, it will also join the network due to the needs of network work. Bredikhin et al. pointed out that the network can carry out effective analysis and processing under certain limited conditions and clarify its specific request quantity, which is the energy efficiency of the wireless sensor network. The energy efficiency of wireless sensor networks is also one of the most important and critical performance criteria in wireless sensor networks [12].

The research on smart gardens is mainly divided into two parts: theoretical research and applied research. In terms of theoretical research, Bakshi and Charles proposed that the current main digital design methods are sorted out, and a preliminary and relatively accurate concept of digital planning and design of landscape architecture is made [13]. In the lineage delineation, the first is the computer-aided design lineage, the second is the digital design media and information management lineage, and the third is the digital information model of landscape architecture. The computer-aided design spectrum includes computer-aided design and analysis, computer-generated design, and parametric design. Computer-aided design is to carry out targeted analysis of site conditions and project requirements at the beginning of the design according to the results of investigation and inspection and convert this information into computer-identifiable digital information for further processing in other computer-aided design tools. Computer-aided evaluation is to evaluate and judge the plan according to specific standards after the preliminary design plan is formed, analyze the advantages and disadvantages, and provide possible directions for the modification of the plan. Monteiro et al. pointed out that computer-generated design, using computational geometry and algorithm generation technology, generates dynamic and beautiful formal structures, analyzes the dynamic evolution of landscape architecture, analyzes the spatial activities of creatures in the habitat, including human beings, and is also used to predict the changing trend of ecological environment metabolism [14]. It can also perform architectural and spatial scale layout, road generation, and sculpture creation. Parametric design can temporarily be understood as parametric modeling. A geometric model controlled by specific parameters is established on a software platform with parametric functions. After the geometric model passes the design evaluation stage, the evaluation information is fed back to the parameterization in the form of parameters. The software platform is further optimized. In the application research section, A. Atilgan and C. Atilgan pointed out that the application content of landscape digital technology includes digital analysis, digital aided design, digital modeling, digital media, and virtual visualization technology; for digital analysis, my country was originally applied in the field of geographic information, using GIS technology to digitally analyze and simulate hydrology, terrain, climate, ecological suitability, and landscape patterns and use network multisource data analysis to conduct research on spatial heat, urban spatial distribution, and road accessibility [15]. For the development of related software, digital aided design is also gradually applied to landscape planning and design, using GIS, Sketchup, 3DMax, Photoshop, Illustrator, InDesign, Lumion, and other software for preanalysis, establishment of 3D models, program text and rendering production, and virtual animation video [16].

3. Design of Smart Garden System Based on Wireless Sensors Network

3.1. Selection of Wireless Sensors. The wireless sensor network architecture consists of wireless sensor network protocols, which are mainly responsible for signal modulation and effective transmission and reception of signals, such as infrared and data link layer. The data link layer is responsible for the detection of data framing and is responsible for expanding the media for strict access to the protocol; it can also achieve point-to-point and point-to-multipoint communication goals without socket control.

Wireless sensor network (WSN) is a form of network formed by freely organizing and combining tens of thousands of sensor nodes through wireless communication technology. The units constituting the sensor node are the data acquisition unit, data transmission unit, data processing unit, and energy supply unit. It is a wireless network composed of a large number of static or mobile sensors in a self-organizing and multi-hop manner, which cooperatively senses, collects, processes, and transmits information about sensed objects within a geographic area covered by the network and ultimately sends this information to the network owner.

Wireless sensor networks have many types of sensors that can detect a variety of phenomena in the surrounding environment, including earthquakes, electromagnetism, temperature, humidity, noise, light intensity, pressure, soil composition, size, speed, and direction of moving objects.

The soil moisture sensor is mainly used to measure the moisture content in the soil, which plays an important role in understanding soil moisture and realizing scientific and precise irrigation. According to the needs of the automatic control system for precision irrigation of sunken gardens of Beijing Forestry University for soil moisture measurement, the HYSWR-ARC soil moisture sensor independently developed by the Precision Water-Saving Irrigation Control Laboratory of the School of Engineering, Beijing Forestry University, was selected to monitor the sunken gardens. Soil moisture content provides important data parameters for precise irrigation decision theory. The principle of the HYSWR-ARC soil moisture sensor is to use a signal source with a frequency of 100 MHz to send out a wireless wave signal, and the wireless wave signal is transmitted to the probe composed of four stainless steel probes through a coaxial transmission line. When the impedance is different, the voltage amplitudes of the incident wave and the reflected wave are different when the signal propagates on the transmission line. The superposition forms a standing wave, and the voltage at each point on the transmission line changes. The analog acquisition module can convert the value of soil moisture content by collecting the voltage value of the sensor signal line, and its performance indicators are shown in Table 1.

Table 1: Performance index of soil moisture sensor.

Performance	Numerical value
Model	HYSWR-ARC
Operating voltage	15VDC
Working current	30 nA
Measuring range	0~100%
Precision	±1%
Output method	0~2.5 V
Range of working temperature	-50~+50°C
Dynamic response time	<1 s
Effective measuring radius	10 cm
Measurement principle	Standing wave rate principle

The sensor measures soil water content based on the principle of standing wave rate. The product has the functions of analog signal output (0~2.5 V) and RS232 digital signal. It has the advantages of convenient use, accurate measurement, and rapid response. It is widely used in scientific experiments, water saving irrigation, greenhouses, and other water content measurement.

In this project, the soil moisture sensor is buried in the area where soil moisture content needs to be detected as shown in Figure 1, and the soil moisture content is monitored in real time to provide important data parameters for irrigation decision-making.

Installation diagram of soil moisture sensor air temperature and humidity, carbon dioxide sensor monitoring air temperature, humidity and carbon dioxide content, and other microenvironmental information can be displayed in digital form to understand the current environmental information more intuitively. It can provide data parameter guidance for future analysis of plant growth status by detecting carbon dioxide content.

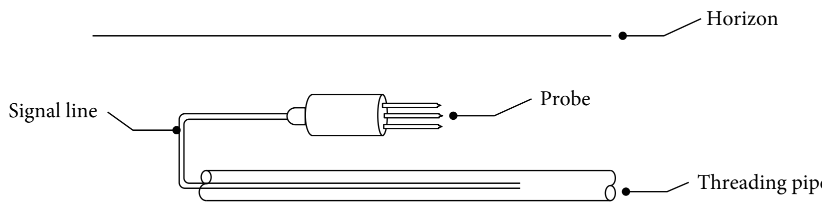

Figure 1: Schematic diagram of soil moisture sensor installation.

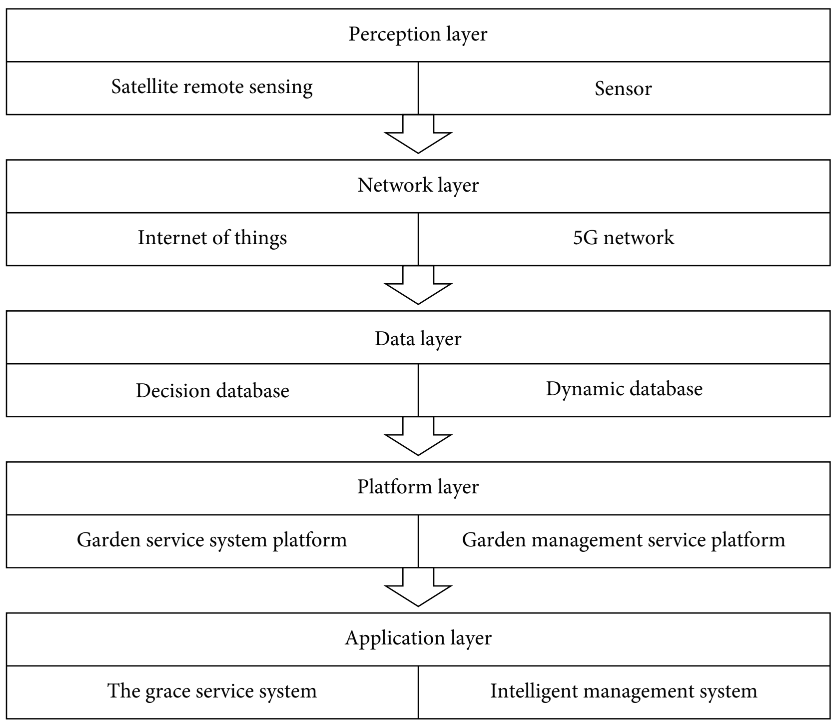

Figure 2: Smart garden system architecture.

The air temperature and humidity sensor selects SHT20 sensor pair for measurement and outputs real-time air temperature and humidity data through RS485 signal. The measurement accuracy of air humidity is 0.1%, and the measurement accuracy of air temperature is 1°C. The carbon dioxide sensor selects the SenseAir S80053 sensor imported from Sweden, which has high precision in measuring carbon dioxide. In the case of good environmental conditions, the measured value is generally 400 ppm.

3.2. Theoretical Research on Smart Gardens. "Smart gardens" are modern smart landscape gardens with smart service systems that meet the new requirements of the new era. In addition, the concept of smart garden in a broad sense is defined as follows: based on "the Internet of Things" technology, combined with many advanced science and technology such as big data, cloud computing, mobile Internet, and spatial geographic information system (GIS), in the planning and design of landscape gardens. In the construction, production, research, and management of garden and landscape facilities, many facilities and functions within the garden are connected with each other with high-tech hands, forming an intelligent unity of information collection, sharing, and feedback, while fully respecting the wisdom of nature, to further sublimate humanistic wisdom. In addition, it is necessary to use advanced scientific and technological wisdom to enhance and improve various functions of garden landscape, ecology, recreation, and so on from multiple angles, levels, and aspects, in order to achieve efficient garden intelligent service and management.

The technical level of the system architecture is divided into five layers: perception layer, network layer, data layer, platform layer, and application layer, which is shown in Figure 2. The perception layer is the foundation of the entire architecture and the main way to obtain and transmit data and information. Aerial survey, remote sensing, GPS, satellite positioning, and digital map technologies are used to collect various data in the park. The network layer is a bridge for information and data transmission, which can transmit various data information collected and realize the efficiency of data transmission based on the "5G network" and "Internet of Things." The data layer has a storage function. It can add and subtract, store, and analyze a large amount of data and at the same time make intelligent decision-making and intuitively display real-time data and decision-making prompts in the platform layer to achieve deep data sorting and real-time sharing. The last is the externalized form of the application layer. As the last step and the most important realization link of smart garden construction, the application layer of the smart garden includes two aspects: intelligent management system application and intelligent service system application. The intelligent management system is oriented to park managers, making intelligent decisions or artificial decisions through the collected real-time data and feedback to adjust the park intelligent management facilities such as park intelligent sprinkler irrigation facilities; the intelligent service system is oriented to park tourists, through big data analysis, information transmission feedback, application of intelligent service facilities, and other means to provide tourists with a variety of intelligent services.

3.3. Research on Smart Garden Facilities

3.3.1. Smart Management System Facilities. The smart management system is a system in the smart park system for park managers to manage the park intelligently through analysis, processing, and timely feedback adjustment through the park intelligent management facilities, in order to realize the intelligent management of the park as a whole. The perception layer, network layer, data layer, and platform layer in the five systems of the smart garden architecture serve for the intelligent practice of the management system, and the application layer is the goal and realization form of the intelligent management system.

The application of intelligent management system includes environmental monitoring system (environmental quality monitoring, water quality monitoring, and biodiversity monitoring), intelligent irrigation system (automatic sprinkler irrigation system and remote control system), intelligent lighting (automatic induction and remote control and intelligent detection of equipment failure), intelligent maintenance (intelligent cleaning, protection of pests and diseases, protection of ancient and famous trees, fire monitoring, and equipment management), intelligent security (people and traffic flow monitoring, real-time security positioning and scheduling, and emergency warning), intelligent transportation (entry park population analysis and unmanned vehicle scheduling), and smart energy consumption management (water and power consumption management and rapid fault location).

The successful realization of feedback regulation of intelligent management system requires the support of intelligent management facilities. Intelligent management facilities are mainly divided into sensor devices and intelligent feedback adjustment facilities. The intelligent management facilities in the environmental monitoring system include data collection devices such as integrated sensors and water quality sensors for collecting information such as park air and water quality. Cooling sprays, smart water pumps, etc. are used for feedback regulation facility for park cooling or water quality cleanup. The intelligent management facilities in the intelligent irrigation system include soil sensors for detecting soil conditions in the park and intelligent sprinkler irrigation devices for sprinkler irrigation. The intelligent management facilities in intelligent lighting are intelligent street lamps, which integrate infrared sensing and intelligent light adjustment. The intelligent management facilities in intelligent maintenance include wireless multimedia sensor network system for monitoring plant diseases and insect pests; DHT22, AM2302, and HP206C sensors for monitoring the growth status of ancient and famous trees; and fire detection sensors for monitoring fire. Intelligent management facilities in smart security include smart face recognition cameras, which can monitor tourists and road safety in the park in real time. The two applications of intelligent transportation and intelligent energy consumption management mainly use the combination of intelligent camera monitoring and manual rapid response to realize the intelligent management of parks.

Most of the existing routing protocols use clustering to optimize the network, and some network protocols preset the number of cluster heads. This algorithm cannot achieve network energy balance. When the number of cluster heads is set too small, the distance between the member nodes in the cluster and the cluster head node will be too far, causing the member nodes to consume too much energy in data transmission, and even some member nodes exceed the reliable communication range. Monitoring data loss when the number of cluster heads is too large will also cause excess energy consumption, because the cluster head node undertakes the tasks of data reception, forwarding, and fusion processing of the member nodes in the cluster. The relationship between the number of groups and network energy consumption is shown as follows:

$$d_{\text{to}}^2\text{CH} = \int\int \left(a^2 + b^2\right)\rho(a, b) d a d b, \quad (1)$$

$$d_{\text{to}}^2\text{CH} = \int\int r^2 \rho(r, \theta) d r d \theta, \quad (2)$$

$$d_{\text{to}}^2\text{CH} = \int_0^{2\pi}\int_0 \frac{M}{\sqrt{\pi N_{\text{CH}}}} r^3 \rho(r, \theta) dr d\theta. \quad (3)$$

The final solution is as follows:

$$d_{\text{to}}^2\text{CH} = \frac{M^2}{2\pi N_{\text{CH}}}. \quad (4)$$

3.3.2. Smart Service System Facilities. On the other hand, the main application of a smart garden is to build a complete smart service system. The smart service system is mainly oriented to tourists and applied to the needs of tourists in the process of visiting the park. The application research of smart service system in urban park is the research content of this paper, and this part of the content will be studied in depth in the next paper.

The smart service system also has five layers: the perception layer, the network layer, the data layer, the platform layer, and the application layer. However, compared with the smart management system, some smart service facilities in the smart service system can basically achieve autonomous feedback without going through the park's AI brain and performing data processing. Smart service facilities are more often used to collect tourist information such as fitness information or intention to visit the park. For example, the smart fitness system senses and collects various real-time data of tourists in the park by establishing a perception layer with sensors as the main tool, including exercise kilometers. Count, calorie consumption value, body temperature, body fat, and other indicators display the corresponding data feedback on the platform layer such as the smart display screen or the tourist mobile APP terminal. The intelligent service system is a set of more intelligent and modernized, more user-friendly and convenient, and more precise intelligent service system in line with the concept of people-oriented, built under the concept of smart garden.

The smart service facilities in the smart service system generally include multimedia touch screen interactive system, mobile APP guide, smart trail, smart AR fitness, fitness point system, rain garden interactive display device, interactive bicycle device, natural soundscape experience device, historical and cultural science, animal and plant science, smart seats, smart conference rooms, and smart unmanned vehicles.

3.4. Digital Landscape Garden Design

3.4.1. Related Technical Support. Mobile Internet technology can provide cloud-based services and real-time resources and have the advantages of sharing and open functions. Mobile Internet technology is an important technical support foundation for the smart upgrade and transformation of urban parks. Through its network construction in urban parks, real-time sharing of various information within the parks can be achieved to meet the management and use needs of urban parks.

The Internet of Things (IoT) refers to the real-time acquisition of any object or process that needs to be monitored, connected, and interacted with through various devices and technologies, such as various information sensors, radio frequency identification technology, global positioning systems, and infrared sensors, and through various possible network access to collect all kinds of information required, to achieve intelligent perception, recognition, and management of objects and processes. The Internet of Things is an information carrier based on the Internet, traditional telecommunication networks, etc. It enables all common physical objects to be addressed independently to form an interconnected network [2]. Wireless sensor networks (WSNs) are distributed sensor networks that detect the outside world through sensors placed at terminals and acquire and transmit the required data. The multihop ad hoc network composed of wireless sensors in a wireless sensor network is an important technical form of the underlying network of the Internet of Things. A typical sensor network structure includes distributed sensor points (clusters), sink nodes, Internet, and user interfaces.

Cloud computing is to decompose massive data computing processing programs into countless small applications through the Internet, process and analyze these small applications through a system application composed of multiple information processors and servers, and finally get the result and return it to the user. Through the application of cloud computing technology in the smart park system, the collection and processing of various complex information data in the park can be completed in a very short period of time, providing powerful information technology services for the park. Cloud computing is a type of distributed computing, which refers to decomposing huge data computing processing programs into countless small programs through the network "cloud" and then processing and analyzing these small programs through a system composed of multiple servers to obtain results and return them to users. In the early days of cloud computing, it was simply distributed computing, which solved task distribution and merged computing results. Therefore, cloud computing is also known as grid computing. Through this technology, it is possible to complete the processing of tens of thousands of data in a very short time (a few seconds), thereby achieving powerful network services.

For the division of various areas involved in the application of wireless sensors in smart gardens, the fuzzy clustering algorithm is used. In fuzzy clustering, the sample set X is divided into k fuzzy subsets $\bar{X}_1, \bar{X}_2, \cdots, \bar{X}_k$, $\bigcup_{i=1}^{k} \text{supp}\,(\bar{X}_k) = X$, where supp represents support sets of fuzzy sets. The membership function u_{il} of the sample extends from {0, 1} binary to [0, 1] interval, and $u_{\text{il}} \in M_f$.

$$
\begin{aligned}
M_f &= \{u_{\text{il}} | u_{\text{il}} \in [0, 1], \\
&\sum_{i=1}^{k} u_{\text{il}} = 1, \forall l, \\
0 &< \sum_{l=1}^{n} u_{\text{il}} < n, \forall i.
\end{aligned}
\tag{5}
$$

For a given set of samples, fuzzy clustering analysis can easily obtain a fuzzy k-partition $U = \{u_{\text{il}} | 1 \le i \le k\,;\, 1 \le l \le n\}$.

3.4.2. Basic Architecture. Garden planning first needs to build a perfect smart garden system. By establishing a perception layer, BIM information model, 3S (GPS, RS, GIS) monitoring system, sensors, etc., it can sense and collect the moisture and soil conditions and temperature of the garden; the real-time dynamics of information such as environment, humidity, and carbon dioxide concentration, using the Internet of Things; and a 5G network to build a network layer to transmit real-time information and then build a data layer through big data intelligent analysis to comprehensively process and analyze data and make corresponding intelligent decisions. Create a "one picture" intelligent platform layer for intuitive data display and finally build a professional application layer to implement the corresponding intelligent decision-making and set up environmental perception, energy consumption perception, traffic management, intelligent security, maintenance management, intelligent irrigation, and lighting. Manage seven functional modules and corresponding smart park facilities, which are shown in Figure 3.

By establishing a water quality, soil moisture, air quality, illuminance monitoring, and control management system, the smart garden system conducts data collection,

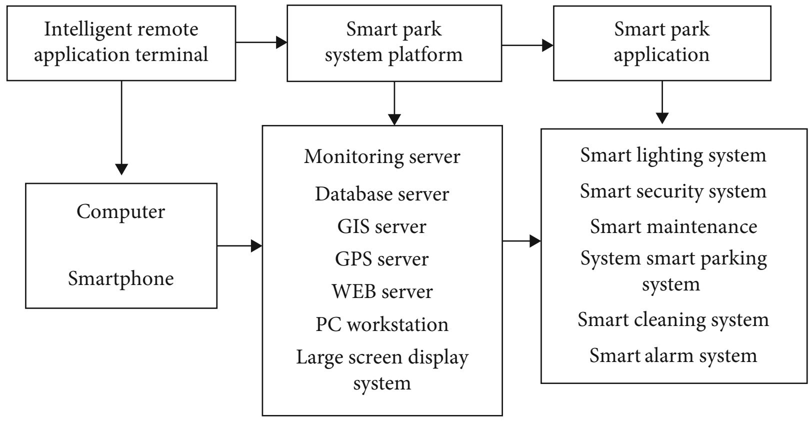

Figure 3: The framework of the comprehensive application platform of the smart park.

transmission, storage, and analysis of parks and tourists; realizes remote monitoring, prediction, control, and response on the PC or mobile phone, disposal, and other intelligent management; and fundamentally upgrade and transform the technology, refinement, and conservation of the daily management of the park. The establishment of the garden intelligent system can provide garden managers with an efficient and convenient management platform, save management resources, and reduce operation and maintenance costs. The system process is shown in Figure 4.

3.4.3. Model Construction. Collect the data information of the research object, select the required information, and analyze and use it through integrated processing and analysis research. Through the dynamic detection of advanced remote sensing technology, various kinds of accurate information of garden green space can be obtained regularly, so the dynamic monitoring of gardens increasingly relies on RS remote sensing technology. GIS (geographic information system) is an interdisciplinary subject closely related to multiple disciplines. GIS is closely related to earth science, information science, and even space science and other disciplines. GIS is based on geospatial data and uses the support of computer software and hardware technology to collect, store, process, manage, and analyze the required data in space. It takes building a geographic model as an analysis method and can efficiently and conveniently provide the required spatially related dynamic geographic information data. The smart garden GIS monitoring system can complete the centralized display of dynamic data such as environmental monitoring, garden animal and plant monitoring, and garden park service facilities, hold important events or emergency command, and dispatch assignments in emergencies.

GPS satellite positioning, RS remote sensing and GIS geographic information system (3S) synergy, combined with sensors to build a smart garden dynamic data receiving network, are the eyes of the smart garden system, and it is also necessary to build a smart garden system, which is an indispensable part.

In addition to using the 3S monitoring system, the construction of the intelligent sensor system also needs to build a complete sensor network in the park, which is different from the 3S method of obtaining information in stages. A large number of smart sensors can cooperate to build a complete smart sensor network.

The intelligent sensor system mostly uses solar energy as the working energy to create a fully automatic working environment. At the same time, it can be divided into integrated sensors and water quality sensors according to different application environments. The functions of smart sensors under the smart management system include collecting and recording real-time information of more than a dozen park environments such as soil temperature and humidity, negative oxygen ions, air temperature and humidity, PM2.5, ultraviolet intensity, light, carbon dioxide concentration, air pressure, and noise. The network layer transmits data to the AI intelligent brain, and the real-time monitoring data is analyzed and processed in an appropriate manner and presented to the corresponding modules of the management platform, providing convenience for park managers and improving management efficiency.

In the intelligent management platform, the construction of an intelligent integrated management platform is equivalent to the brain of the park. Various real-time information collected by the GIS monitoring system and intelligent sensors is transmitted to the AI brain central control room through the "5G network and Internet of Things" system. After processing, it is displayed on the digital twin visualization platform, that is, the One Map intelligent management platform, where the data is stored and visualized. Managers can dynamically monitor various data in the park through the visual management platform of the system, so as to carry out remote management of intelligent facilities in the park green space. The intelligent management platform includes seven functional modules: environmental perception, energy consumption perception, traffic management, intelligent security, maintenance management, intelligent irrigation, and lighting management. Each functional module has corresponding perception, network, data, platform, and application five levels. For each management function, the corresponding automatic decision-making and intelligent application can be adjusted, so that it can fully realize the automation and intelligence of the whole process from perception, collection, transmission,

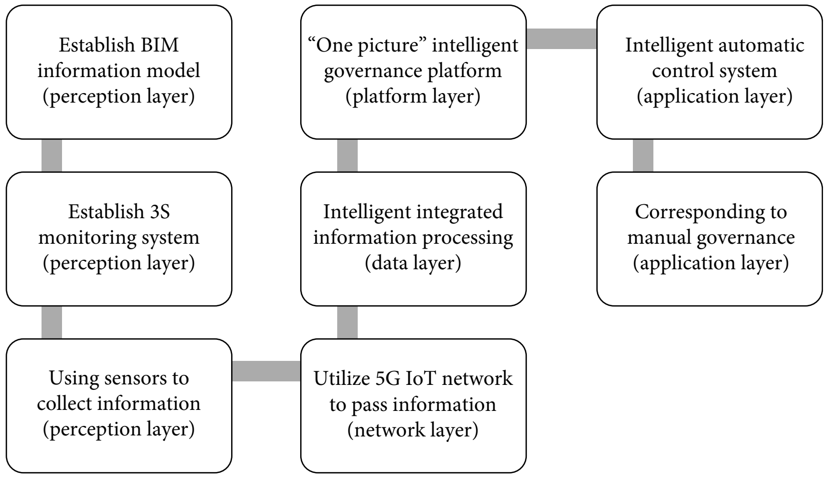

Figure 4: Smart park management system process.

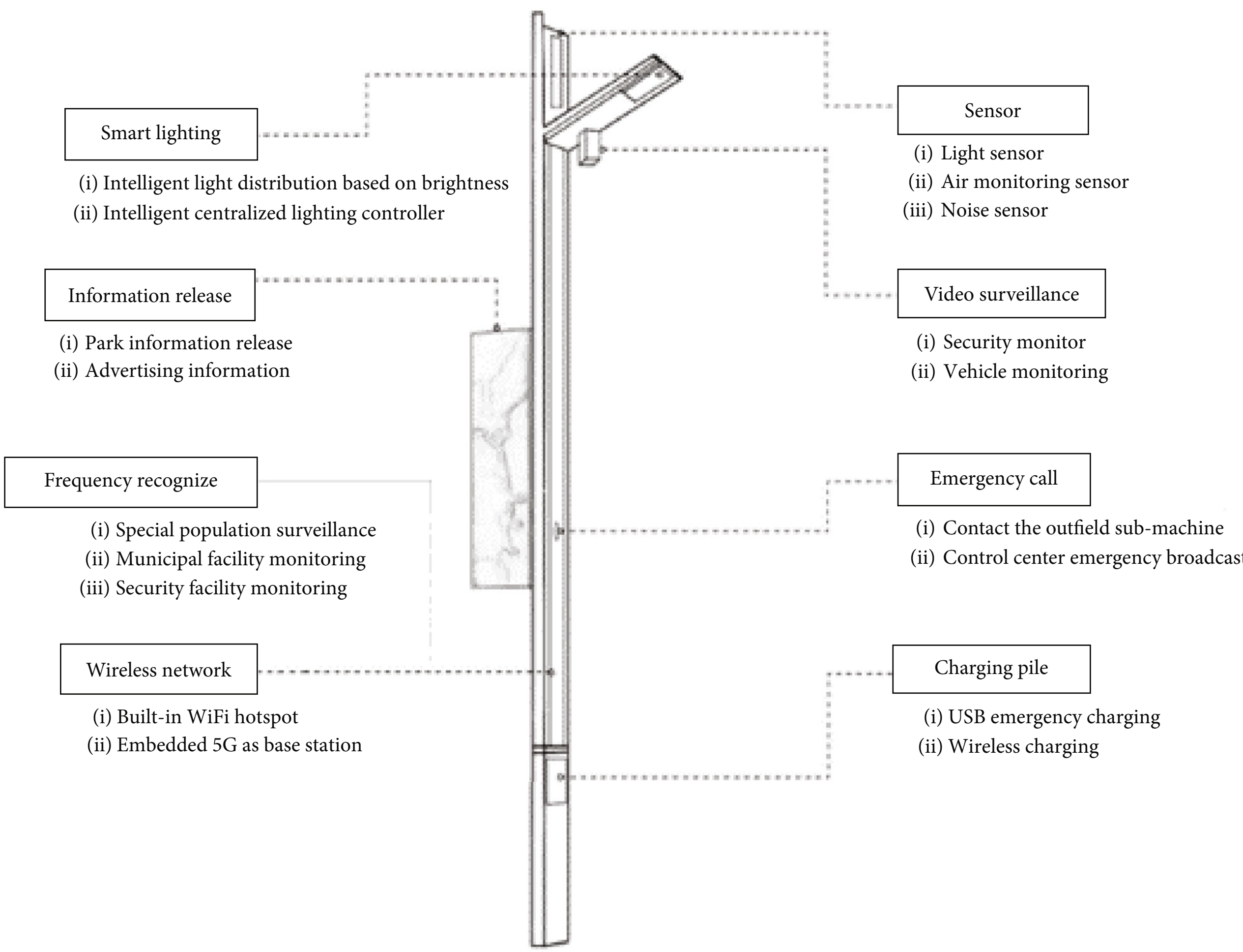

Figure 5: Smart streetlights.

decision-making, and application. Managers can also monitor, collect, analyze, and process various information data such as the environment, 12 traffic, and plants in the park through the platform and report problems to the security personnel in the park in a timely manner to realize the linkage between intelligent management and security personnel.

4. Application Analysis of Smart Garden System

4.1. Infrastructure Lighting. The integrity construction of the smart park system is based on the construction of information infrastructure in the park. Smart streetlights are an important basic node for building a smart network in parks.

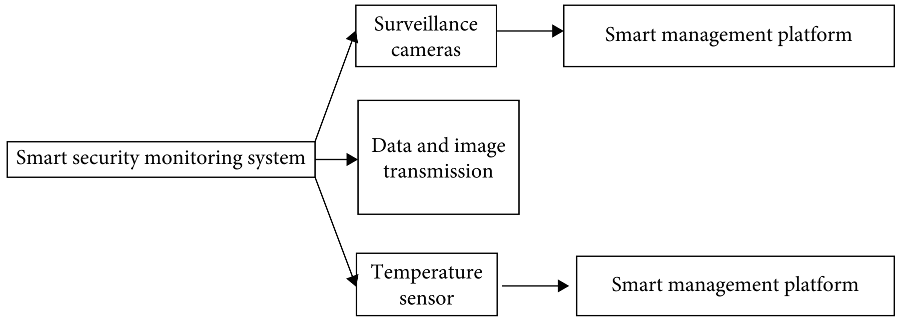

Figure 6: Smart monitoring system.

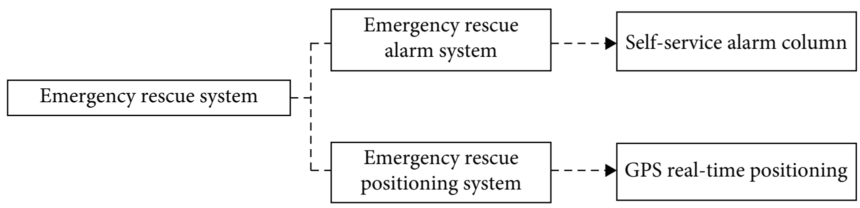

Figure 7: Emergency rescue system.

By rationally arranging smart streetlights, the park can be realized. The global coverage of the internal network, the smooth information transmission, and the real-time monitoring of various information in the park smart streetlights cannot only meet the lighting needs of parks but also provide a comfortable nighttime recreation environment for urban residents. It can also be superimposed by multipole-in-one technical modules, that is, the combination of wireless network, surveillance camera, environmental detection sensor, wireless broadcasting, mobile phone charging interface, emergency call (as shown in Figure 5), and other modules, on the basis of satisfying the lighting function, to build a smart network of parks. At the same time, the design of smart street lamps should be combined with the park culture. Smart streetlights can intelligently adjust the light distribution intensity by automatically sensing the brightness of the outside world and using the electronic display screen on the streetlights to release park information. Respond promptly to situations that occur in the park.

4.2. Security and Rescue. The smart security monitoring and control system monitor various areas in the park in real time through surveillance cameras arranged on smart streetlights, smart trash cans, and other park infrastructure (as shown in Figure 6). The security monitoring system can also add a face recognition module, which can be integrated into the security system of the smart city through the public security network to ensure the public safety of urban residents in the park. When a dangerous situation occurs in the park, the intelligent monitoring system will issue an alarm to the park management personnel in time and broadcast it to the city residents in real time through the broadcasting system in the park, so that the park management personnel can take corresponding measures in time for the abnormal situation and ensure the safe operation of the park.

Emergency rescue system includes an emergency rescue alarm system and automatic emergency rescue positioning system. A positioning system is an interrelated assembly or device (component) formed with the goal of determining a spatial location. This system can ensure that at least four satellites can be observed simultaneously at any point on the Earth at any time, to ensure that the satellites can collect the longitude, latitude, and height of the observation point, in order to achieve navigation, positioning, timing, and other functions. This technology can be used to guide aircraft, ships, vehicles, and individuals to safely and accurately follow selected routes and arrive at their destinations on time. Its basic principle is to measure the distance between a satellite with a known location and the user's receiver and then integrate the data from multiple satellites to know the specific location of the receiver. To achieve this goal, the position of the satellite can be found in the satellite ephemeris based on the time recorded by the onboard clock.

Through the self-service alarm columns arranged in the parks, it is convenient for urban residents to send rescue signals to the park managers in case of emergencies (as shown in Figure 7). After receiving the rescue signal from the park visitors, the park management department cannot only communicate with the seeker remotely through the emergency rescue alarm system but also quickly grasp the location of the seeker through the automatic emergency rescue positioning system and dispatch the park management personnel to the scene for disposal in time. The emergency rescue system effectively protects the property and personal safety of urban residents, safeguards the legitimate personal interests of traveling residents, and facilitates the safety and security of park managers.

4.3. Plant Maintenance. The vegetation construction of urban parks provides an excellent resting environment for urban residents, is a green link between urban residents

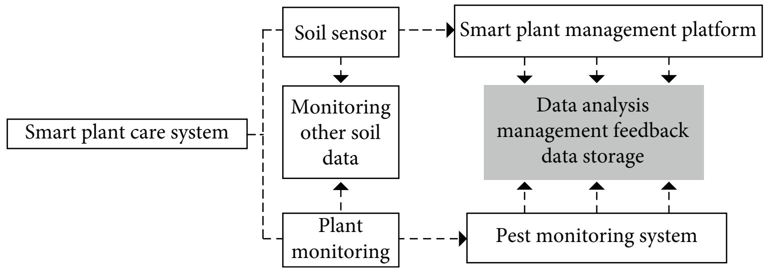

Figure 8: Smart plant care system.

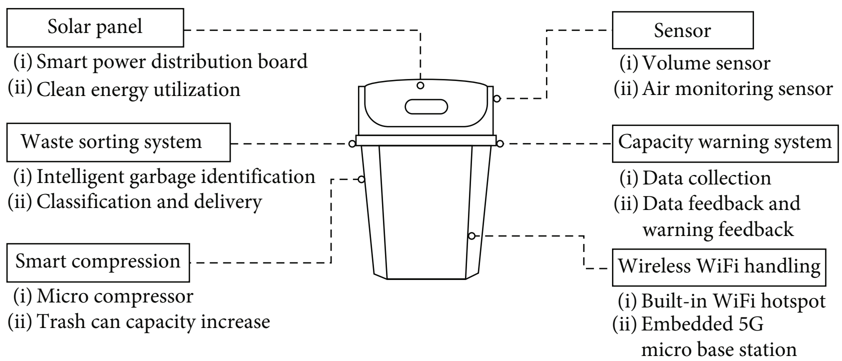

Figure 9: Smart trash can.

and the natural environment, and is also an important part of urban parks. Plant conservation in urban parks is also one of the important tasks of the park management department, which requires a lot of human and material resources to ensure the green environment of the park. Integrating the application of the smart park system in the renovation and renewal of urban parks can better play the function of publicity, education, and popularization of parks and deepen the interactive experience between urban residents and parks. At the same time, the smart plant maintenance system can better assist urban park managers to carry out convenient and accurate plant maintenance work, saving manpower and material resources.

The plant maintenance work in urban parks is relatively heavy. Through the construction of an intelligent plant maintenance system, real-time monitoring and automatic management of vegetation and soil in the park can be realized, which greatly improves the work efficiency of urban park management departments. The intelligent plant maintenance system uses wireless sensors arranged in the soil (as shown in Figure 8) to monitor the relevant data of soil moisture and nutrients in real time and collect and analyze the data to intelligently generate maintenance management work requirements. At the same time, the intelligent plant maintenance management system is also combined with the intelligent rainwater collection and management system to automate nozzle and fertilization based on the real-time monitoring of soil data. The intelligent plant maintenance system also monitors the growth status of plants in real time through the disease and insect pest monitoring system. When a plant has a disease focus, it will automatically alarm in time to remind the management staff to take relevant measures.

4.4. Cleaning System. Most urban parks use purchased finished trash cans, and the required number of trash cans is reasonably calculated according to the park area and service radius and arranged in the city park. Park managers need to regularly clean the trash cans in the park every day to ensure the sanitary environment in the park, so they need to invest a lot of human and material resources. When urban parks are renovated and updated, the application of smart trash cans in the park sanitation system can effectively improve the work efficiency of park management workers and save resources. Smart trash cans are new trash cans equipped with solar power panels, smart waste sorting systems, smart compression systems, and smart monitoring systems (as shown in Figure 9). Smart trash cans can automatically classify and compress all kinds of garbage and remind management staff to deal with them in time when the capacity reaches the warning value. Smart trash cans can also be equipped with wireless Wi-Fi modules, electronic display modules, etc., to provide more diversified services for urban residents and park management departments.

When urban parks are renovated, the upgrading of public toilets is one of the essential contents to provide better services for urban residents. Smart public toilet technology is to use wireless sensor technology, automatic air treatment technology, and other science and technology to realize the automatic service management of public toilets (as shown in Figure 10). Through the real-time monitoring of various wireless sensors, smart public toilets can realize the functions of public toilet vacancy display, intelligent air circulation treatment, intelligent adjustment of light, automatic cleaning and disinfection, intelligent water saving, and emergency alarm, thus providing a convenient and low-carbon smart city park public toilet.

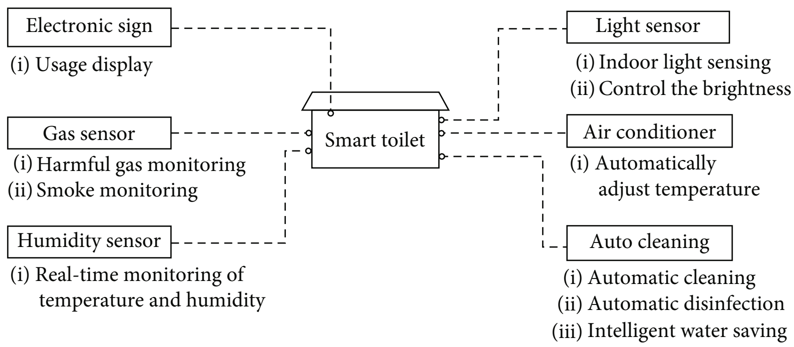

Figure 10: Smart toilet.

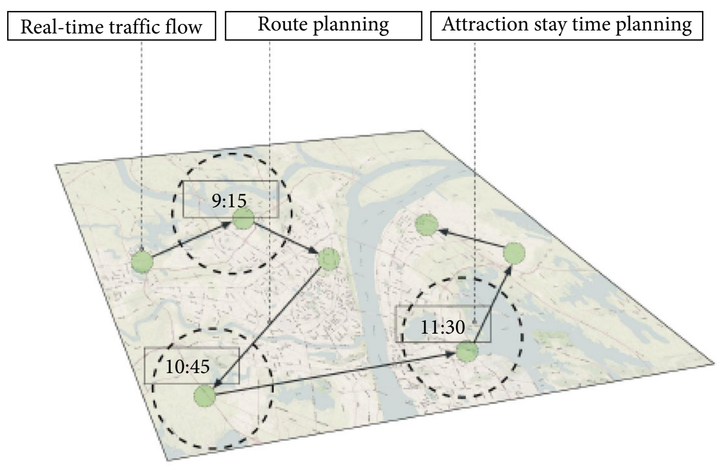

Figure 11: Intelligent route planning system.

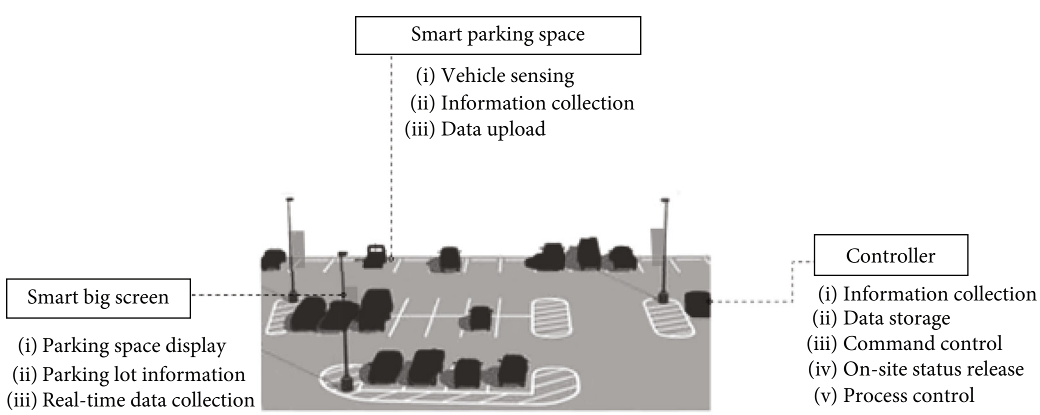

Figure 12: Smart parking lot.

4.5. Public Services. Traditional maps are arranged at park entrances and exits, important landscape nodes, and park road intersections. The park information provided by them is relatively simple and lacks interaction with urban residents. An electronic map is a digital display of information, using electronic interactive displays or smartphone apps to present information about the park. The updated electronic map during the renovation of the urban park cannot only display the introduction of the park, the instructions for tourists, and the park map (as shown in Figure 11) but also allow urban residents to have a good interaction with the park, so that they can know their location in real time and every detail during the park tour. The detailed information of each landscape node can better plan travel activities.

Parking social vehicles are prohibited in the city park, and independent public parking lots will be provided near the main entrances and exits within the urban park area to provide parking services for residents of the park city or residents around the park. With the rapid development of society and the economy, the number of vehicles per capita in cities is also increasing rapidly, and the public parking lots in many urban parks can no longer meet the needs of citizens. At the same time, due to the increase in the number of vehicles, the workload of the park management department has also increased, and the travel experience of urban residents has also been affected. In the process of renovation and renewal of urban parks, it is necessary to renew the parking lots of existing urban parks according to the current conditions such as park area, service radius, and traffic conditions around the park. At the same time, the introduction of a smart parking system can make the parking process more efficient. The functions of the smart parking system mainly include real-time monitoring of vehicle information, vehicle parking guidance, data collection and storage analysis, and command control (as shown in Figure 12). The smart parking system implements traffic management by collecting real-time vehicle information and parking space information through the cooperation of wireless sensing technology and cloud computing. Through the command control after data collection and processing, the information display in the smart parking lot can display the number of remaining parking spaces in real time and guide the driver to find the parking location conveniently and efficiently through the indicator lights in the parking lot, saving parking time. The intelligent monitoring and feedback system of the smart parking lot also greatly facilitates the management of the parking lot by the park managers and can better serve the urban residents.

5. Conclusion

This paper explores the process of urban park renovation and renewal through the combination of relevant theoretical basis for urban park renovation and on-site investigation. At the same time, based on the relevant research and investigation of the smart park system, the application of the smart park system in the renovation and renewal of urban parks was explored. At present, the relevant research and application of smart city are relatively mature. As the construction of urban parks cannot be ignored in urban construction, it is necessary to study and refer to relevant applications of smart cities to better integrate them into the application of parks. The smart park system is a comprehensive system that combines multiple disciplines. How to combine science and technology more systematically and comprehensively to establish a smart link between urban residents and parks and better serve the daily life of residents requires more in-depth discussion and discussion in the future research. This paper lacks depth and breadth in the discussion and research on related applications of the smart park system and needs to continue to be explored and researched.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This work was supported by the School of Lincoln University College.

References

[1] C. A. Da Costa, C. F. Pasluosta, B. Eskofier, D. B. Da Silva, and R. da Rosa Righi, "Internet of health things: toward intelligent vital signs monitoring in hospital wards," *Artificial Intelligence in Medicine*, vol. 89, pp. 61–69, 2018.

[2] Q. Ma, T. Liang, L. Cao, and L. Wang, "Intelligent poly (vinyl alcohol)-chitosan nanoparticles-mulberry extracts films capable of monitoring pH variations," *International Journal of Biological Macromolecules*, vol. 108, pp. 576–584, 2018.

[3] V. Petrov, S. Andreev, M. Gerla, and Y. Koucheryavy, "Breaking the limits in urban video monitoring: massive crowd sourced surveillance over vehicles," *IEEE Wireless Communications*, vol. 25, no. 5, p. 104, 2018.

[4] D. Mahata, J. Friedrichs, R. R. Shah, and J. Jiang, "Detecting personal intake of medicine from twitter," *IEEE Intelligent Systems*, vol. 33, no. 4, pp. 87–95, 2018.

[5] R. Iqbal, T. Maniak, and C. Karyotis, "Intelligent remote monitoring of parking spaces using licensed and unlicensed wireless technologies," *IEEE Network*, vol. 33, no. 4, pp. 23–29, 2019.

[6] S. A. Ahmed, D. P. Dogra, S. Kar et al., "Query-based video synopsis for intelligent traffic monitoring applications," *IEEE Transactions on Intelligent Transportation Systems*, vol. 21, pp. 3457–3468, 2020.

[7] F. Li and G. X. Sun, "Construction of SCUIR propagation model based on time-varying parameters," *Journal of Global Information Management*, vol. 30, no. 10, pp. 1–18, 2022.

[8] T. Wen, D. Dong, Q. Chen, L. Chen, and C. Roberts, "Maximal information coefficient-based two-stage feature selection method for railway condition monitoring," *IEEE Transactions on Intelligent Transportation Systems*, vol. 20, no. 7, pp. 2681–2690, 2019.

[9] S. Cii, G. Tomasini, M. L. Bacci, and D. Tarsitano, "Solar wireless sensor nodes for condition monitoring of freight trains," *IEEE Transactions on Intelligent Transportation Systems*, vol. 23, pp. 3995–4007, 2020.

[10] B. Cheng and P. Wu, "Recycled iontronic from discarded chewed gum for personalized healthcare monitoring and intelligent information encryption," *ACS Applied Materials and Interfaces*, vol. 13, no. 5, pp. 6731–6738, 2021.

[11] L. C. Harfouche, N. Couvrat, M. Sanselme et al., "Discovery of new proxyphylline-based chiral cocrystals: solid state landscape and dehydration mechanism," *Crystal Growth and Design*, vol. 20, no. 6, pp. 3842–3850, 2020.

[12] X. Shen, G. Shi, H. Ren, and W. Zhang, "Biomimetic vision for zoom object detection based on improved vertical grid number YOLO algorithm," *Frontiers in Bioengineering and Biotechnology*, vol. 10, no. 5, p. 905583, 2022.

[13] B. R. Bakshi and M. Charles, "Designing industrial landscapes for mitigating air pollution with spatially- explicit techno-ecological synergy," *AIChE Journal*, vol. 67, no. 10, pp. 67–100, 2021.

[14] G. Shi, X. Shen, F. Xiao, and Y. He, "DANTD: A deep abnormal network traffic detection model for security of industrial internet of things using high-order features," *IEEE Internet of Things Journal*, 2023.

[15] A. R. Atilgan and C. Atilgan, "Computational strategies for protein conformational ensemble detection," *Current Opinion in Structural Biology*, vol. 72, pp. 79–87, 2022.

[16] B. K. Behe, M. Knuth, C. R. Hall, P. T. Huddleston, and R. T. Fernandez, "Consumer involvement with and expertise in water conservation and plants affect landscape plant purchases, importance, and enjoyment," *Horticultural Science*, vol. 53, no. 8, pp. 1164–1171, 2018.