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Research Article

Application of Internet of Things and Data Optimization in the Design of Smart Medical Park

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The ecological development of industrial parks has become a concern in current urban planning. The traditional development model and development ideas of pharmaceutical industrial parks need to be changed urgently, not only to improve their own functions but also to use land more effectively and save resource costs. Aiming at the problems existing in the construction of the park, this paper studies the use of the Internet of Things technology to build a smart park platform to realize the access of intelligent systems and equipment in the park. First of all, starting from the background of the combination of smart parks and the Internet of Things, by analyzing the architecture of the Internet of Things, it studies the requirements for the combination of smart parks and the Internet of Things technology. Second, according to the results of the demand analysis, we conducted a research on the construction plan of the smart park in the Internet of Things era, including the construction of the smart park platform using the Internet of Things technology, the ideas and access methods of the intelligent system access platforms in the smart park, and the research on the construction of the intelligent park platform architecture based on the Internet of Things and decision tree technology. Finally, the specific implementation process of its access to the smart campus platform is studied through simulation tests, and the feasibility of the access method is verified.

1. Introduction

With the extensive construction of the park, it has become an important part of urban construction and an important driving force for urban development, as well as an important pillar of economic construction and a special industrial form [1, 2]. Under the new situation of the transformation of the economic growth mode, the industrial park has begun to upgrade its industrial structure, and the development of the park has shown a new trend. On the one hand, the park economy has changed to an ecological one, and it has begun to pay attention to the ecologicalization of the industry and the coordinated development of production, life, and ecology [3–5]. The transformation of enterprises in the park to high tech is through technological innovation, from the original manufacturing enterprises to innovative enterprises [6]. On the other hand, the management of the park has changed to intelligence. In 2008, IBM puts forward the concept of "Smarter Earth." Since then, there has been a global upsurge in the construction of smart cities. As an important part of smart city construction, parks have become an inevitable trend in order to meet the increasingly complex needs of social functions [7, 8].

Due to the differences in the level of economic development, the popularity of new technology applications, management concepts, and management levels in various regions, the construction of various parks is uneven [9, 10]. For more developed areas and parks with strong comprehensive scientific and technological strength, the construction of smart parks has already begun. The relatively backward parks are still in the initial stage of informatization construction, and are building or even planning basic office informatization management systems and websites [11, 12]. Cooke and Feldman believe that the biomedical park has attracted many enterprises due to its unique advantages [13, 14]. In addition, with the concentration of enterprises, elements such as professional talents with relevant knowledge and capital are also constantly gathering [15]. The park proposes to use the venture capital invested every year for R&D and the number of Internet of Things technology companies and life scientists. At the same time, the annual funds used by large pharmaceutical companies for Internet of Things technology research and development can be used for the development of biomedical industry clusters. If the enterprises in the industrial cluster want to improve their comprehensive competitiveness, they need to be as symmetrical as possible. Therefore, interactivity is a very important premise. The relationship between the enterprises in the cluster is delicate, and there is both competition and cooperation among them. Scholars such as Martha Prevezer in [16] pointed out that the biopharmaceutical industry is a technology- and knowledge-intensive industry that relies heavily on basic research. If enterprises in a cluster want to develop more efficiently, they need to cooperate with universities, laboratories, and research institutes, or cooperate closely with other types of scientific research institutions [17–19].

We use the Internet of Things technology to improve the quality, integration, and safety of the park and its buildings and realize the intelligent development of the park. This is the current concern of many park managers and park economic researchers, and it is also the development direction of park construction [20–22]. Based on the results of the demand analysis, we conducted a research on the construction plan of the smart park in the era of the Internet of Things, including the use of the Internet of Things technology to build the platform of the smart park, and the ideas and access methods of the intelligent systems in the smart park to access the platform. We will describe the relevant background and technical overview of the smart medical park in Chapter 2. The third chapter describes the key technologies and their applications based on the Internet of Things and studies the requirements for the combination of smart parks and Internet of Things technologies. The fourth chapter describes the problems existing in the construction of smart parks, studies the ideas and methods of using Internet of Things technology to build a smart park platform, researches the ideas and methods of the intelligent system access platform in the park, and studies the construction of the Internet of Things platform for smart parks based on M2M (machine to machine) technology.

2. IOT Technology and Its Exploitable Applications in the Park

The Internet of Things technology is not a new technology. It is an extension of traditional modern scientific information technology. It is an application model that integrates all existing and various types of sensing equipment and network facilities [23]. Sensing devices include sensors and electronic tags, and network facilities include the Internet and sensor networks, and they have been widely used. Electronic product codes, networks, cloud computing, and other technologies are becoming more and more mature. We need to make full and reasonable use of mature electronic devices to better connect human society with the physical world and improve the level of information intelligence in the whole society [24]. Various useful information in the park, including temperature, humidity, and luminance, can be obtained by sensor technology. After the sensor technology obtains this information, it converts them into corresponding output signals, so that people can better control them. The environment in which one lives and works can eventually make the park intelligent [25]. The unified security identity authentication system is mainly responsible for the user's permission to log in to the application platform of the park according to the user information and provides a unified authentication platform for the park [26, 27]. By applying the software technology of the Internet of Things, it is possible to set up suitable software for each operating system in the park, and the park can develop corresponding functions on the open middleware software platform according to the needs of the personnel in the park, so as to realize the diversified services and satisfaction of the park. The individual needs of enterprises settled in the park.

3. Demand Analysis of the Combination of Smart Park and IOT Technology

The significance of the combination of Internet of Things technology and smart park construction is to cater to the development of the times and meet the requirements of social development and park construction, thereby promoting social and economic development by driving the development of related industries [28, 29]. This section mainly analyzes and researches the requirements from the functional requirements of the park and the problems existing in the current park construction combined with the Internet of Things technology.

If there is a building equipment monitoring or management system in the park, the running status of each equipment in the park can be monitored. The system can display the operating parameters, accumulated operating time, maintenance times, and maintenance status of each equipment. However, the management system of the general park is set up independently in each building, so it is necessary to upload the collected operation data of the relevant park equipment to the park management platform [30]. The application of the Internet of Things technology can realize the collection of data such as the operating status parameters of various electromechanical equipment in the park. Through the analysis and processing of the collected data, the remote monitoring and fault diagnosis of the park equipment can be realized. Upload equipment data such as equipment operation status and operation records, or upload on-site video signals through cameras monitoring the equipment site, to provide equipment operation status monitoring and query for park property managers and equipment manufacturers.

Energy monitoring and management are an important part of building energy conservation in the park. Through the collection and analysis of the energy consumption data of each building in the park, the energy consumption status of the building and the energy consumption efficiency of the equipment can be determined, so as to provide optimization measures for the energy management of each building in the park, so that the building can provide people with an energy-saving and environmentally friendly environment. The energy management application in the park can monitor and measure the consumption of heating, heating, electricity, and natural gas of each building in the park. Figure 1 shows the relationship between IOT architecture and energy management.

The energy management platform can record, count, and analyze various data. The smart park energy management system is set up in each building in the park where energy consumption monitoring is required and is integrated into the IOT service platform in the park. It can collect and process the energy consumption data in the park and has network communication functions. The monitored energy consumption data are saved, and the monitored energy consumption can be monitored according to the requirements of the energy management system. The IOT energy management platform develops various applications and services based on the data collected by the perception layer and the data after energy management statistics and analysis, including remote monitoring, control, and management of energy-consuming equipment in each building in the park.

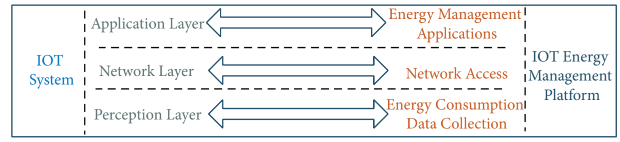

Figure 1: The relationship between the architecture of the Internet of Things and energy management.

4. Construction of IOT Platform in Smart Park

This section is about overall structure of the park, data optimization scheme, and model simulation test results.

4.1. Overall Structure of the Park. The perception layer of the smart park is mainly to meet the requirements for the construction of the smart park. The sensing module is used to monitor the environment of the park and to perceive the operation status of various electromechanical equipment in the smart park, and the activities of people and vehicles. The perception module of the perception layer is the foundation of the wisdom of the park, and the perception layer realizes a thorough perception of the park. It includes various sensors, sensor network monitors, RFID (radio-frequency identification) readers, GPS (global positioning system) receivers, intelligent mobile terminals, and other information collection equipment throughout the park. The collection of information such as production sites and production sites provides a broad and solid data foundation for the smart application of smart parks. Figure 2 depicts the schematic diagram of the perception layer architecture of the smart medical park.

The smart campus network layer is mainly responsible for the secure transmission, processing, and control of the data information sensed in the smart campus perception layer and finally provides application services to the smart campus. At the same time, because the switch of providers is only required through software settings, users in the park can easily and efficiently choose the network provider they need. The network layer also provides the storage and processing functions of perception data, which is the infrastructure and environment required for the operation of smart services. Figure 3 shows a schematic diagram of the network layer topology of the smart medical campus.

The network layer of the smart campus includes the core layer, the aggregation layer, and the access layer. The core layer is the center of the entire campus network layer, responsible for a large number of communications in the entire network, the connection between various departments in the park, providing office automation, data information services, and providing high performance for the campus data center server, cloud computing center, application server, etc. The core switch in the core layer can simultaneously access the data of three different network providers, namely Telecom, China Mobile, and China Unicom. Through the WLAN mode, users can freely choose the services of the network provider, instead of switching providers through physical links. Upload equipment data such as equipment operation status and operation records, or upload on-site video signals through cameras monitoring the equipment site, to provide equipment operation status monitoring and query for park property managers and equipment manufacturers. At the same time, because the switch of providers is only required through software settings, users in the park can easily and efficiently choose the network provider they need. Figure 4 depicts a schematic diagram of the application platform architecture of the smart medical park.

The smart campus application platform includes a unified security authentication system, integrated business components, and business architecture/portal support platform. The unified security identity authentication system is mainly responsible for the user's permission to log in to the application platform of the park according to the user information and provides a unified authentication platform for the park. The integrated business components provide platform support services such as development aids, rapid customization, geographic information services, rights management, data presentation, and mining for applications in various industries in the park, including development tools, workflow/rule engines, content management, decision-making aids, information exchange center, data maintenance, and intelligent retrieval.

4.2. Data Optimization Scheme. In the construction of the energy management platform in the park, through the establishment of the public building energy consumption database, the park administrator can clearly understand the actual operation of the energy consumption of each building in the park, which is convenient for the administrator to analyze the energy consumption of public buildings and

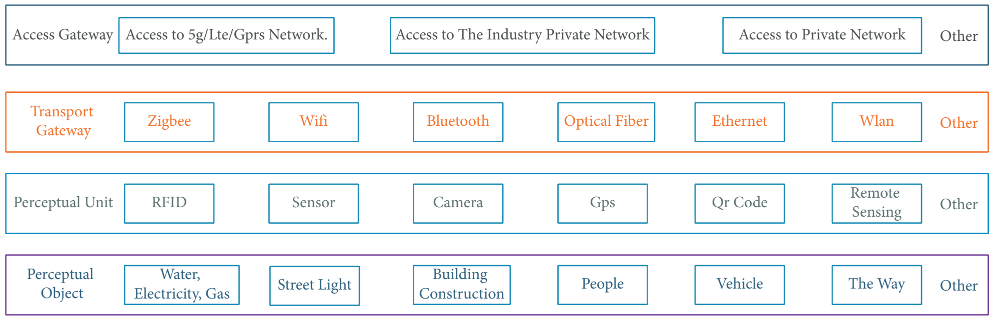

FIGURE 2: Schematic diagram of the perception layer architecture of the smart medical park.

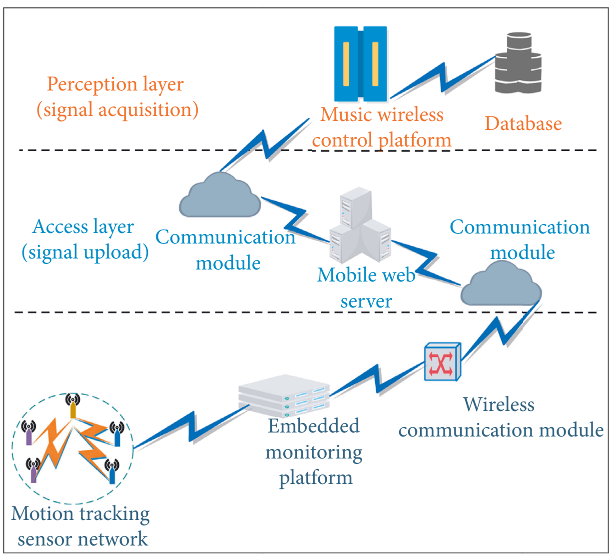

FIGURE 3: Schematic diagram of network layer topology of smart medical park.

provide information for building energy consumption. Provide a basis for comprehensive and effective management. Here, we take the smart meter as an example to design the data optimization scheme through the decision tree algorithm. Sensing devices include sensors and electronic tags, and network facilities include the Internet and sensor networks, and they have been widely used. Electronic product codes, networks, cloud computing, and other technologies are becoming more and more mature. Decision tree is an algorithm based on a tree structure, which is equivalent to dividing the space into squares. The display of root nodes and leaf nodes is similar to the thinking process of the human brain, so the results are well interpretable and intuitive. After the node is split, the impurity of the node will become lower. Selecting a node is to choose which node can reduce the impurity the most before and after the split.

$$\text{s.t.}\begin{cases}\dfrac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i-1}^{m} v_i x_{ij}} \leq (j = 1, \ldots, n), \\ \\ v_i \geq 0\,(i = 1, \ldots, m),\ u_r \geq 0\,(r = 1, \ldots, s).\end{cases} \quad (1)$$

The algorithm makes full use of the structure of the binary tree and divides the current sample set into two subsample sets each time, so CART will generate a binary tree with a concise structure. If the branch attribute has more than two values, this algorithm will combine the attribute values and choose the best two combinations to branch. Figure 5 shows a conceptual diagram of the decision tree algorithm.

Information gain is an indicator for ID3 algorithm to select feature attributes. Information gain is simply the difference of entropy, where entropy represents the uncertainty of information.

$$\max h_{j0} = \frac{\sum_{r=1}^{n} u_r y_{rj0}}{\sum_{r=1}^{m} v_r x_{rj0}}. \quad (2)$$

Simply using this indicator to select attributes will cause the ID3 algorithm to have two main defects. One is that it tends to select attributes with more values; that is, it tends to be too finely divided, so there will be over fitting only by information gain. Second, it can only handle discrete data, and when encountering continuous data, it must be separated before it can be used.

$$Q = \begin{cases} Y = a_1 x_1 + a_2 x_2 + a_3 x_3 + a_4 x_4 + a_5 x_5, \\ a_1 + a_2 + a_3 + a_4 + a_5 = 1, \\ 0 < a < 1. \end{cases} \quad (3)$$

When using a binary decision tree for classification, each decision node is associated with a threshold, and each leaf node is associated with a classification result. So the decision tree has a threshold vector of length m.

$$t = \frac{1}{\sum_{i=1}^{m} v_i x_{ij}}, \quad w_i = t v_i,\ \mu_r = t u_r. \quad (4)$$

4.3. Model Simulation Test Results. The main task of the smart meter database design is to share the data values of the meters of each building in the park, including voltage, current, electricity consumption, and the time when electricity is collected. The client can analyze and process these data and share the power consumption and power collection time with other terminals. The transformation of enterprises in the park to high-tech is through technological innovation, which occupies an important part of the industrial chain of the park.

In order to verify the role of decision tree in data optimization, we analyzed the communication cost of cloud

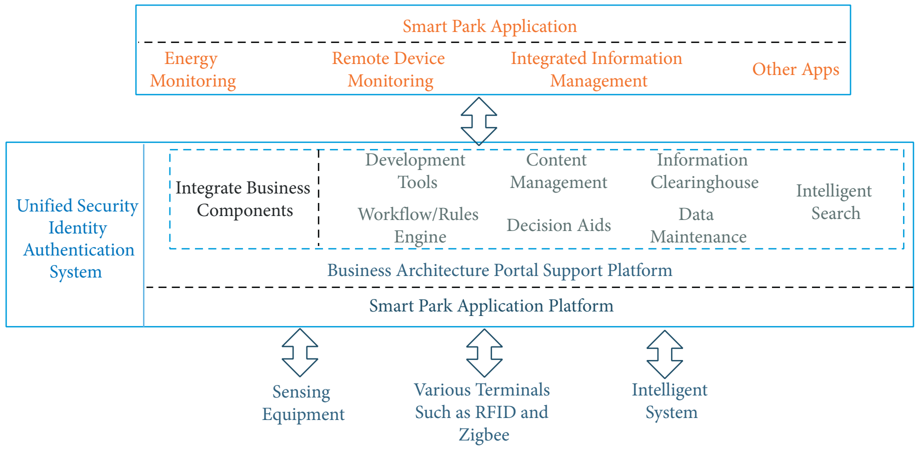

FIGURE 4: Schematic diagram of the application platform architecture of the smart medical park.

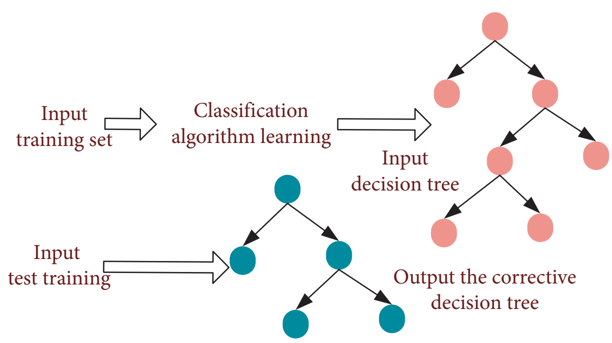

FIGURE 5: Schematic diagram of the decision tree algorithm concept.

TABLE 1: Smart campus customer traffic (KB).

Data set	Feature encryption	The result is reconstructed.	Total
Heart disease	0.43	0.81	1.24
Credit screening	0.32	1.61	1.93
Breast cancer	0.19	23.36	23.55
Housing	0.29	756.13	756.42
Spam base	2.32.	12642.31	12644.63

server in smart campus. The communication cost of the cloud server is mainly caused by the secure multiplication invocation in feature selection, the comparison process of decision nodes, and the transmission of secret shared shares when the classification result is generated. In most cases, the communication cost is less than 1 MB. Even for the largest decision tree, it only takes 12.249 MB, which is very efficient in resource-rich cloud computing. Table 1 shows the smart campus customer traffic results. Table 2 describes the smart campus server traffic.

These data are then analyzed and processed through the client and finally displayed to the user in the form of a chart, so that the administrators and users of the park can intuitively understand a certain electricity department and each electricity department in the park during a certain period of time. For the more developed areas and the parks with strong comprehensive scientific and technological strength, the construction of intelligent parks has already begun, while the more backward parks are still in the primary stage of information construction and are under construction or even planning basic office information management. The energy consumption collection system in the park uploads the collected data to the system database through the energy consumption collection equipment, and users can query the energy consumption monitoring situation in real time. The client of the energy management platform analyzes and processes the uploaded energy consumption data. Finally, it is displayed to the user in the form of a chart, so that the user can intuitively see the consumption of various energy sources in the park.

Table 2: Smart campus server traffic (KB).

Data set	Feature selection	Node comparison	Classification generation	Total.
Heart disease	0.23	0.19	0.32	0.74
Credit screening	0.36	0.41	0.79	1.56
Breast cancer	5.86	6.40	11.43	23.69
Housing	135.50	187.92	327.56	650.98
Spam base	3018.30	3162.80	6172.26	12353.36

5. Conclusion

The smart park platform constructed by the Internet of Things technology has scalable business configuration management functions, through which it can provide diverse services to different users such as households, enterprises, park managers, and system maintainers and can meet the individual needs of users. Under the new situation of the transformation of the economic growth mode, the industrial park has begun to upgrade its industrial structure, and the development of the park has shown a new trend. The research in this paper has practical significance for the construction of smart parks and plays a positive role in promoting the development and construction of smart cities. The construction of a smart park is a systematic project, which involves many industries and takes a long time to build. Therefore, while paying attention to the technical solutions of the smart park, we should also consider the feasibility of its business model, because only the development of the park can be promoted only after its business model is considered mature. Due to the limitation of the working time of the thesis and the current knowledge and technology, the research and exploration of the construction of smart parks in this paper are still in its infancy. There are still many in-depth and challenging works to be carried out in the future.

Data Availability

The data for the article are included in the body.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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