

## Research Article

# Visual Design of Landscape Architecture Based on High-Density Three-Dimensional Internet of Things

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Since different equipment manufacturers may define a set of data transmission protocols of their own types, the high-density three-dimensional Internet of Things landscape garden landscape platform needs to provide a unified data transmission interface for the business system. It needs to complete the analysis, storage, and reformatting of different data transmission protocols on the high-density three-dimensional Internet of Things landscape service platform. In this paper, based on the conversion analysis between the MLD model of the landscape perception layer of the high-density three-dimensional Internet of Things landscape and the automata scheduling model, the conversion of the MLD model of the entire landscape perception layer of the high-density three-dimensional IoT landscape and the automata scheduling model is realized. Based on the hierarchical automata high-density three-dimensional Internet of Things landscape, this paper studies the global task scheduling and control automata model and the local scheduling automata model in the task, as well as the landscape perception layer rapid scheduling mechanism of independent scheduling strategy. This can be used for different levels of systems to ensure that the perception layer system is orderly, reliable, and fast. They complete the construction of jdk environment, web server, Mongo DB server, MQTT server, JMS server, etc., on the cloud platform. Combined with the landscape, a set of test platforms was built to test the functions and performance indicators of the visualization system cloud platform. The test results show that the cloud platform can realize cross-platform terminal access, end-to-end instant messaging, heterogeneous data processing and storage, etc. It has strong scalability and high processing performance and has application and reference value.

## 1. Introduction

With the rapid development of science and technology, all aspects of people's lives have gradually developed and improved. Looking at the current situation, the informatization process operation and management of all walks of life can greatly save working time and quickly improve its work efficiency [1]. However, "the construction industry has always been a latecomer to adopt new technologies." As a part of the supporting projects of the construction industry, the landscape architecture profession has its unique complicated design, large volume, and high requirements on-site conditions, which can effectively reflect its value. At the same time, the widespread use of the Internet of Things technology in the construction industry has enabled the promotion of the Internet of Things technology in an all-round

way [2]. The introduction of the Internet of Things technology into the landscape architecture industry will play a role in the entire process and multiple aspects of the entire industry [3, 4].

In the work mode of most design institutes, the design work of a project will generally be designed by a chief design person in charge of the design of the entire project, and other drafters will cooperate according to his design ideas [5]. In the process, misunderstandings caused by insufficient coordination are usually resolved through coordination meetings. Such a model is time-consuming and wastes manpower. At this time, the database of the Internet of Things will play a very important role at this time. All material data and engineering quantities can be automatically generated according to the Internet of Things model [6]. Given a list of engineering quantities, the entire project

budget can be estimated and can be used to simulate construction and minimize the error of drawings [7]. By cutting in from the aspects of production methods and methods, the design efficiency (speed and accuracy) is improved, thereby reducing rework and other phenomena that often occur in the construction process, thereby reducing the cost, shortening the construction period, and achieving optimized integration. The purpose of resources and design results also essentially improves and enhances the efficiency and effectiveness of the operation and maintenance stage [8].

This article analyzes the requirements of the intelligent landscape data management system based on the Co AP protocol and introduces some design principles of the system. It introduces the design of the sensor network layer, the design of the high-density three-dimensional Internet of Things landscape service platform based on the Co AP protocol, and the design of the intelligent landscape data management system based on the Co AP protocol. Specifically, the technical contributions of this article can be summarized as follows:

- (i) This article has carried out the research on the perception layer model conversion and perception layer scheduling strategy of high-density three-dimensional Internet of Things landscape gardens. Based on the conversion analysis between the MLD model of the landscape perception layer of the high-density three-dimensional Internet of Things landscape and the automata scheduling model, it is pointed out that the MLD model under  $nc = mc = pc = 0$  is the finite state machine automata model. The conversion method between 0 and 1 state finite automata model and MLD model is studied. This method can be expanded on the conversion between other complex automata and MLD model to realize the whole high-density three-dimensional IoT landscape perception layer MLD model and automata scheduling model.
- (ii) This article proposes a high-density three-dimensional Internet of Things based on hierarchical automata, a rapid scheduling mechanism for the landscape perception layer of the landscape architecture, and researches the global task scheduling and control automata model and the local scheduling automata model in the mechanism. The use of independent scheduling strategies for different levels of systems ensures that the perception level systems are orderly, reliable, and fast.
- (iii) This article takes the laboratory high-density three-dimensional Internet of Things landscape visualization system project as the application object and verifies the design and implementation of the basic functions and key issues of the cloud platform in this article. The test results show that the high-density three-dimensional Internet of Things landscape garden landscape M2M cloud platform can realize the access and communication of different terminals and realize the processing of

heterogeneous data. It has strong scalability and good server processing performance, which can meet the high-density three-dimensional Internet of Things landscape. The demand for visual control system of garden landscape has application and reference value.

## 2. Related Work

In foreign countries, as long as the international conferences related to exhibition design, most of them will use the mobile Internet as a platform to design specially customized APP mobile client software [9]. For example, the organizer of the international conference has designed specific software. At this meeting, designers were also called on to apply mobile Internet to the exhibition hall, so that the exhibition hall will enter the information age and promote the progress of display design [10]. At the same time, Google designed the official Android application of the MWC exhibition to help the audience understand the latest exhibition information and find the location and map of each exhibition item, attendee information, and picture notes. The design of pavilions in European and American countries pay more attention to the participation of the audience. This kind of participation is not only to touch the exhibits with hands and feel the internal or external characteristics of the exhibits but to make visitors interested in the derivative stories and connotations of the exhibits. They interact with the exhibition items themselves and understand the comprehensive information conveyed by the exhibition items. This interactive exhibition method does not directly instill the content of the display to the audience but allows the visitors to explore the journey without a fixed route by themselves, so as to obtain the joy of experience in the repeated exploration process [11].

The realization of “smart landscape gardens” in high-density three-dimensional Internet of Things landscape gardens is mainly embodied in four aspects: real-time sensor data collection, intelligent analysis, linkage control, and quality monitoring. Real-time sensor data collection can realize real-time data collection and historical data storage and can find out the law of temperature, humidity, light, and sealing requirements of landscape gardens and provide accurate experimental data; intelligent analysis and linkage control can meet the scenery accurately in time Garden landscape requirements for various environmental indicators; the quality monitoring module remotely monitors the internal landscape garden landscape through 5G cameras, uses wireless sensor networks to collect real-time temperature, humidity, light data, and soil moisture inside the greenhouse, and remotely controls the internal equipment of the greenhouse through 5G wireless network [12]. They use wireless communication to display and broadcast the dynamics of the ecological zone in real time. In addition, the product traceability code can also be used as an information transmission tool; through the query system, we can realize the standardization and network management of quality inspection and transportation [10].

With the advancement of society, the discipline of landscape architecture has introduced many new scientific methods, such as the layer cake method, mathematical statistics, questionnaire surveys, Delphi method, analytic hierarchy process, rating scale, fuzzy mathematics, and beauty degree evaluation, etc. [13]. It should be treated in a “two-point theory” approach. On the one hand, they should see that the rationalization and precision of the methods are meaningful, and they should be used more scientifically; on the other hand, they must recognize that these methods are only approximate simulations, even if they seem very scientific. In practice, auxiliary research techniques such as remote sensing images, global positioning systems, and geographic information systems have been gradually introduced into landscape design practices [14]. The development of digital technology has affected and changed the traditional planning methods. In particular, geographic information systems have made it possible to scientifically analyze, evaluate, and manage site information and make urban landscape planning more scientific, reasonable, accurate, and complete in terms of site cognition. It is possible to establish a comprehensive cognition of multifactor conditions such as climate conditions, hydrological conditions, topography and landforms, animal and plant resources of the site, and form a comprehensive and objective analysis of ecological sensitivity and construction suitability and visibility.

Related scholars have studied a smart city high-density three-dimensional IoT landscape platform based on a microservice architecture [15]. The platform realizes the conversion of the functional modules in the smart city high-density three-dimensional IoT landscape platform into independent business. Microservices collect sensor data from devices through mutual cooperation and provide mobile phone applications, semantic web clients, and other clients to use after processing. The services in the platform each have a logical analysis of the high-density three-dimensional Internet of Things landscape equipment, and each store data and decouple the data storage to establish a hierarchical abstract model. Related scholars have studied a data service framework based on microservices [16]. The framework separates the microservice container from the service source, adopts a lightweight cross-platform protocol, and uses native and proxy microservices and service sources in the container [17]. Researchers propose a method for constructing a power cloud platform based on microservice architecture. By abstracting business logic into fine-grained reusable services, the continuous delivery component is designed for service deployment, verification, and registration, and the service gateway component is responsible for intercepting and positioning service access requests [18]. Thingsworx is a high-density three-dimensional Internet of Things landscape platform designed for enterprise application development, enabling innovators to quickly create and deploy applications suitable for today’s smart and connected world. The platform can easily connect with equipment and quickly develop high-density three-dimensional Internet of Things landscape applications. The integrated machine learning function can realize complex

automated analysis of big data. At the same time, the platform provides one-stop solutions for embedded and local IoT. Relevant scholars believe that in the display design, it is necessary to take into account the fun, knowledge and science [19]. In an article, he pointed out that the exhibition design should gradually update the traditional display methods, track the development trend of high-tech, and continuously increase the exhibition items incorporating high-tech [20, 21].

### **3. Design of a High-Density Three-Dimensional Internet of Things Landscape Service Platform Based on the Co AP Protocol**

*3.1. Construction of a High-Density Three-Dimensional Internet of Things Landscape Service Platform.* This paper proposes an embedded REST Web Services solution based on Co AP protocol to integrate sensor equipment and information system. The solution is essentially a hybrid gateway proxy and embedded WebService system. The sensor network layer provides RESTful Web Service for the communication gateway and uses the Co AP protocol as the transmission protocol for the communication gateway and the sensor network layer. The communication gateway provides a RESTful Web Service for the cloud server and uses the HTTP protocol as the communication protocol between the communication gateway and the cloud server. The gateway proxy realizes the conversion between Co AP commands and HTTP commands.

The cost of converting Co AP protocol to HTTP protocol is much greater than the cost of converting Co AP commands to HTTP commands. Therefore, the communication gateway in this solution only converts HTTP commands and Co AP commands. Compared with the gateway proxy solution (Co AP protocol), the implementation of the communication gateway of this scheme is less difficult, and the efficiency of the communication gateway will also be improved.

This solution uses the communication gateway to reduce the pressure of the embedded device system, thereby reducing the hardware requirements of the embedded device system, and no longer requires devices with strong computing capabilities and high storage capabilities. Although the communication network gateway is introduced, the overall cost is indeed significantly reduced, and the more sensor devices are integrated.

The schematic diagram of the high-density three-dimensional Internet of Things landscape service platform designed in this paper based on the Co AP protocol is shown in Figure 1. It can be seen that the more important ones are the HTTP RESTful API for landscape architecture and the Co AP RESTful API from sensors. The business logic layer includes basic user permission management, data storage management, data analysis, data formatting, data analysis, etc.; protocol layer including Co AP protocol parameter setting, HTTP protocol data analysis, and subassembly, etc.; basic components including the mutual conversion of HTTP commands and Co AP commands.

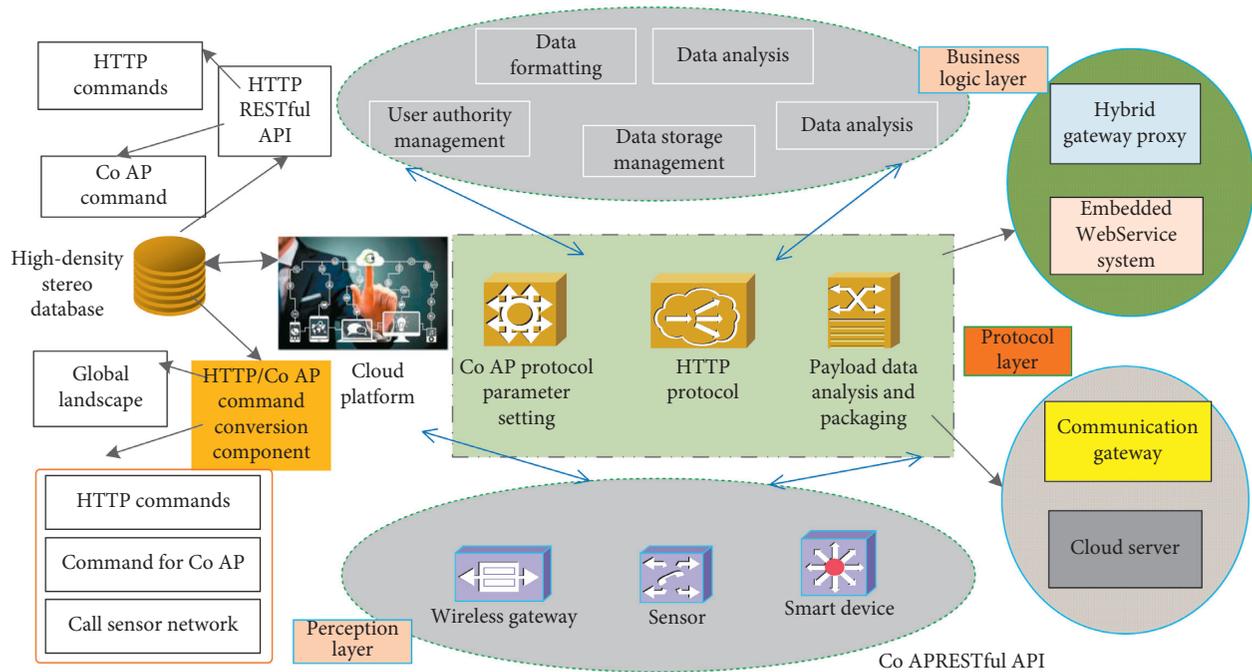


FIGURE 1: Schematic diagram of a high-density three-dimensional Internet of Things landscape service platform based on the Co AP protocol.

Users of the intelligent landscape data management system based on Co AP protocol designed in this paper can monitor or operate the high-density three-dimensional Internet of Things landscape data through a browser.

**3.2. Design of Business Layer and Protocol Stack.** The high-density three-dimensional Internet of Things landscape service platform serves as a Co AP client to communicate with the sensor network. This system uses NB module as Co AP server to manage many sensors.

It is worth noting that the HTTP RESTful API provided by the high-density three-dimensional Internet of Things landscape service platform to the landscape server is not a one-to-one correspondence with the Co AP RESTful API provided by the sensor network to the high-density three-dimensional Internet of Things landscape service platform. A large part of the HTTP RESTful API is the processing of business logic, and it does not even need to call the conversion components of HTTP commands and Co AP commands.

When a new sensor joins or leaves the sensor network, it will automatically register and deregister its information with the NB module (Co AP server). Through the above-mentioned interface, the high-density three-dimensional Internet of Things landscape garden landscape service platform can obtain sensor data and corresponding parameters of the sensor equipment from the sensor network in real time.

The business layer of the high-density three-dimensional Internet of Things landscape platform designed in this paper based on the Co AP protocol includes business logic such as

data subscription, data stop subscription, device status query, data storage, data analysis, and user management. Among them, the HTTP API exposed by the high-density three-dimensional Internet of Things landscape service platform to the landscape server is roughly divided into two parts, one is the need to call Co AP API (directly related to the sensor network); the other does not need to be called Co AP API (not directly related to sensor network). It should be pointed out that the design of this part is all located inside the high-density three-dimensional Internet of Things landscape garden landscape platform.

If the Co AP API needs to be called, when the landscape architecture server calls the HTTP interface provided by the high-density three-dimensional Internet of Things landscape platform, first, the business logic will use the HTTP/Co AP command conversion component to convert the HTTP command into the Co AP command. When the sensor network returns data to the high-density three-dimensional Internet of Things landscape service platform, the business logic will first call data analysis to format the data into JSON and other formats, and then if necessary (some businesses need to store data To the database) to store the data in the database, you call the HTTP/Co AP command to generate an HTTP URI, attach the data to the Payload part, and return it to the landscape server. The logic module of this business layer directly deals with the sensor network, including sensor data subscription, sensor data unsubscription, and sensor status.

There is no need to call Co AP API. When the landscape architecture server calls the HTTP interface provided by the high-density three-dimensional Internet of Things landscape architecture platform, the business logic will read the

data from the database and do certain business logic processing, and wait for the processing to be completed, and send the processing result to the landscape server through the Payload part of the HTTP protocol. This kind of business layer has many logic modules, such as data analysis, user management, and access device information browsing. It should be noted that this part of the design should pay attention to scalability. In the future, the business logic of this piece will continue to change with user needs. The business logic may delete or modify the existing business logic or may add new business logic.

The intelligent landscape data management system based on Co AP protocol designed in this paper mainly uses Co AP protocol and HTTP protocol as the transmission protocol. The design of the HTTP protocol layer is mainly to parse and encapsulate the data returned by the Co AP protocol into JSON format. The design of the Co AP protocol layer is mainly to use some of the characteristics of the Co AP protocol itself to complete congestion control and proxy caching.

The Co AP protocol stack mainly uses its own characteristics to complete congestion control and proxy caching. The Co AP protocol itself can use a proxy mechanism in a restricted network to access sleep sensor devices and improve performance. The Co AP protocol can use a proxy to cache data, thereby responding to requests from the cache, thereby reducing response time and saving bandwidth. The Co AP protocol can use a proxy to preprocess the unrecognized request options in the request, so that some requests are not sent directly to the Co AP server, which can also reduce response time and save bandwidth.

#### 4. High-Density Three-Dimensional Internet of Things Landscape Perception Layer Information Rapid Scheduling Design Strategy

*4.1. Conversion Analysis between the MLD Model of the Landscape Perception Layer of the High-Density Three-Dimensional Internet of Things Landscape Architecture and the Automatic Machine Scheduling Model.* Scenario is to describe how the relevant components in the system interact to complete a certain system function that the user cares about. It can also be described as a series of events that may occur in the system. It is a description of the possible sequence of actions in the system, not a description of all possible actions of the system. In the scene description, the order of the message transfer between components is usually given, and the implementation details of the system are not involved, and the overall structure system is expressed visually and standardizedly [22]. The application scenarios of the perception layer are complex and diverse, and the system structure also changes due to application requirements. IoT sensing devices mainly include sensing (obtaining sensing object information) and controlling (controlling the controlled object). Therefore, according to the functions of the sensing layer device of the IoT, various devices involved in the sensing layer application scenario can be abstracted as sensing component node, controlled component node, coordinator node.

For the general MLD model, if  $nc = mc = pc = 0$ , the system model is the finite state machine automata model. Since the scope of the finite state automata is composed of some finite discrete state sets, in each discrete state set, the continuous state evolves according to certain rules, which is very suitable for the modeling and analysis of scheduling problems. When making decisions and stating scheduling strategies on discrete events in the landscape perception layer, the automata model and the MLD model can be switched to construct a high-density three-dimensional IoT landscape perception layer quick scheduling model based on automata-MLD.

High-density three-dimensional Internet of Things landscape perception layer perception layer: The entire measurement and control behavior is to switch between any two states of the three states: information acquisition, scheduling decision-making, and execution decision-making. The switching process between the two states can be abstracted as 0-1 two-state finite automata switching model. The state transition process of finite automata can be described by the following formula:

$$\begin{aligned} [x_l(t) = 1] \wedge [x_c(t) \leq 0] &\implies [x_l(t+1) = 0], \\ [x_l(t) = 0] \wedge [x_c(t) < 0] &\implies [x_l(t+1) = 1], \\ [x_l(t) = 0] \wedge [x_c(t) > 0] &\implies [x_l(t+1) = 0]. \end{aligned} \quad (1)$$

There are logical variables  $\delta_1(t)$  and  $\delta_2(t)$ :

$$\begin{aligned} \delta_1(t) &= 0 \wedge [x_c(t) < 1], \\ \delta_2(t) &= 0 \wedge [x_t(t) = 0] \wedge [\delta_1(t) > 0]. \end{aligned} \quad (2)$$

If the automaton state function has a maximum value  $M$  and a minimum value  $m$ , then by the MLD logic rule, there are the following equivalent equations:

$$\begin{aligned} \delta_1(t) = 0 \wedge [x_c(t) < 1] &\approx \begin{cases} x_c(t) < \delta_1(t) \wedge (m + \varepsilon) \\ x_c(t) > M - \delta_1(t) \end{cases}, \\ [\delta_2(t) = 0] \wedge [\delta_1(t) = 1] \wedge [x_l(t) = 1] &\approx \begin{cases} \delta_2(t) > 1 - \delta_1(t) \wedge x_l(t) \\ \delta_2(t) < 1 - \delta_1(t) \\ \delta_2(t) < 1 + x_l(t) \end{cases} \end{aligned} \quad (3)$$

By mixing linear inequalities, the conversion between 0-1 finite automata model and MLD model is realized. For the overall measurement and control behavior state of the landscape perception layer of the high-density three-dimensional Internet of Things landscape, any state switching at a certain time conforms to the switching law of finite state automata, so the conversion method between 0-1 automata model and MLD model can be used. You realize the conversion between the MLD model of the entire high-density three-dimensional Internet of Things landscape perception layer and the automatic machine scheduling model.

*4.2. Hierarchical Scheduling Mechanism for Landscape Perception Layer of High-Density Three-Dimensional Internet of Things.* In the process of acquiring information from the landscape perception layer of the high-density three-

dimensional Internet of Things, the sensor node sends information to the coordinator node, and the coordinator node integrates and processes the information. In this process, in order to avoid the lack of information due to time delay, not only the speed of the sensing task of the sensor node but also the speed of the communication and calculation tasks of the coordinator node is required.

Since the scheduling decision rules can well describe the trigger conditions and execution results of specific functions of the system, their correctness directly affects the effectiveness, feasibility, and reliability of the system functions. Therefore, optimizing the system task scheduling strategy and formulating scheduling decision rules to control the order of task execution and avoid task conflicts are of great significance to improve the performance indicators of information acquisition at the perception layer.

Figure 2 shows the hierarchical scheduling strategy model of the high-density three-dimensional Internet of Things landscape perception layer information acquisition system. The strategic idea is to analyze the time of the overall system tasks, take into account the time analysis of the subsystems before integration, and use independent scheduling strategies for different levels of systems. In the hierarchical task scheduling system, the upper node is defined as a global scheduler, and the priority combination and run time of each task sequence are assigned to each subsystem server based on the system mode judgment result; the lower node is defined as a server, that is, a local scheduler. According to the global scheduler scheduling strategy and allocation time, the tasks in the subsystem are time allocated and executed according to the priority. In the high-density three-dimensional Internet of Things landscape information perception system, because the sensor data collection tasks, data aggregation, and parameter calculation tasks are executed on multiple independent processors, the sensor data collection subsystems can be separately implemented through a hierarchical scheduling strategy. The system and parameter operation subsystems are scheduled to optimize the task execution order, which can reduce the system execution cycle time and improve the speed.

In the global scheduling automata model of the perception layer, due to the time allocation for each parameter running task, the execution time of each task can be set within the set range, which can ensure the orderly execution of each task; if the execution time of a certain task is less than the set deadline time, you can ignore the deadline of this task and go directly back to the main state to schedule and execute the next subtask to achieve efficient and orderly work.

#### 4.3. Deadlock Detection of High-Density Three-Dimensional IoT Landscape Perception Layer Based on Time Constraints.

If a deadlock occurs at the perception layer, an effective deadlock detection and release method must be adopted. For the sensory data acquisition system model of the perception layer, sensor data acquisition includes  $n$  sensing subtasks to form a sensor network, and each sensing subtask applies for or occupies the sensor device resources in the sensor

network according to task requirements. Assuming that the sensor devices in the sensor network are mutually exclusive, the sensor subtask  $i$  occupies the sensor device resource  $j$  for time  $ts_i$ , and the total task execution time for sensor data acquisition is  $ts_{total}$ .

Then, based on the nonpreemption of device resources, for the sensing subtask  $i$ , under normal circumstances, the task execution time  $trun < ts_i$ , the resource occupied by the sensing task is not released; if  $trun > ts_i$ , the task has been released. At the same time, according to the task cycle waiting for resource allocation conditions, when a deadlock occurs, there will be a cycle waiting situation between the task chain and the sensor device resource chain, which causes the sensor data acquisition task to be blocked, resulting in unpredictable task execution completion time, and the time will be significantly greater than the total task execution time  $ts_{total}$  under normal conditions. Therefore, the deadlock of the perception layer can be detected according to the task execution time.

Figure 3 is a model diagram of a time constraint-based deadlock detection method for hierarchical scheduling. The model includes multiple detectors such as global deadlock, data acquisition local deadlock, parameter operation local deadlock, etc., specifically by increasing the maximum allowable time constraints of the execution of each sensor data acquisition module and parameter operation module.

## 5. Visual Test Experiment

5.1. *High-Density Three-Dimensional Internet of Things Landscape Visualization System.* The landscape visualization system is a typical application of the high-density three-dimensional Internet of Things landscape industry. The landscape visualization system developed in the previous period is the application object. The controller is connected to the cloud platform through the gateway, and the terminal management, remote communication, and data provided by the cloud platform are used. Analysis and storage, multi-device binding communication, device status and fault monitoring, and other functions achieve regional networking and unified management of large-scale landscape visualization systems. This provides a high-density three-dimensional Internet of Things landscape visualization control system service platform for the urban landscape visualization system that integrates remote control, real-time monitoring, fault alarm, pattern update, and other functions.

The system architecture diagram of the high-density three-dimensional Internet of Things landscape visualization control system is shown in Figure 4. The system mainly includes user management terminal, cloud platform, intelligent gateway, and landscape visualization system. Among them, the original landscape visualization system architecture is mainly composed of a main controller and a sub-controller. A main controller has two RJ45 network ports, one is used as an input network port to communicate with higher-level management equipment, and the other is used as an output network port to realize cascade connection with subcontrollers. You use the gateway device to communicate with the main controller of the original landscape

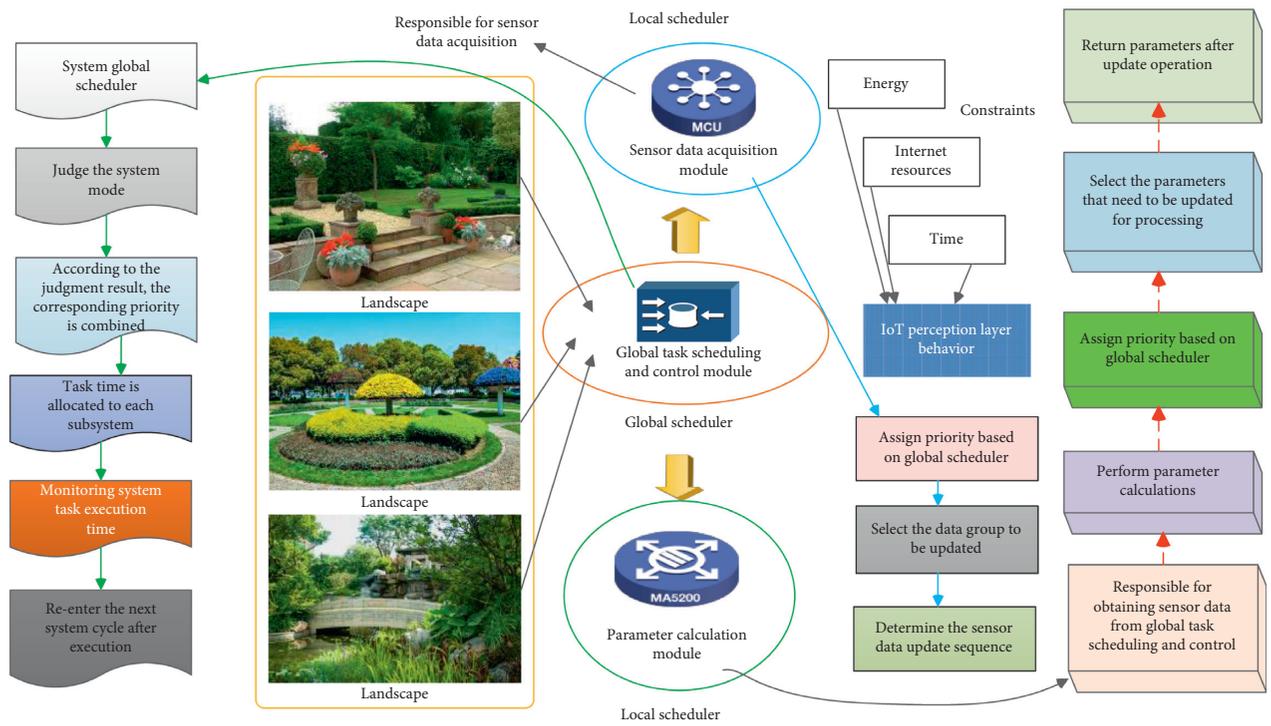


FIGURE 2: Hierarchical scheduling model of high-density three-dimensional Internet of Things landscape perception layer information acquisition system.

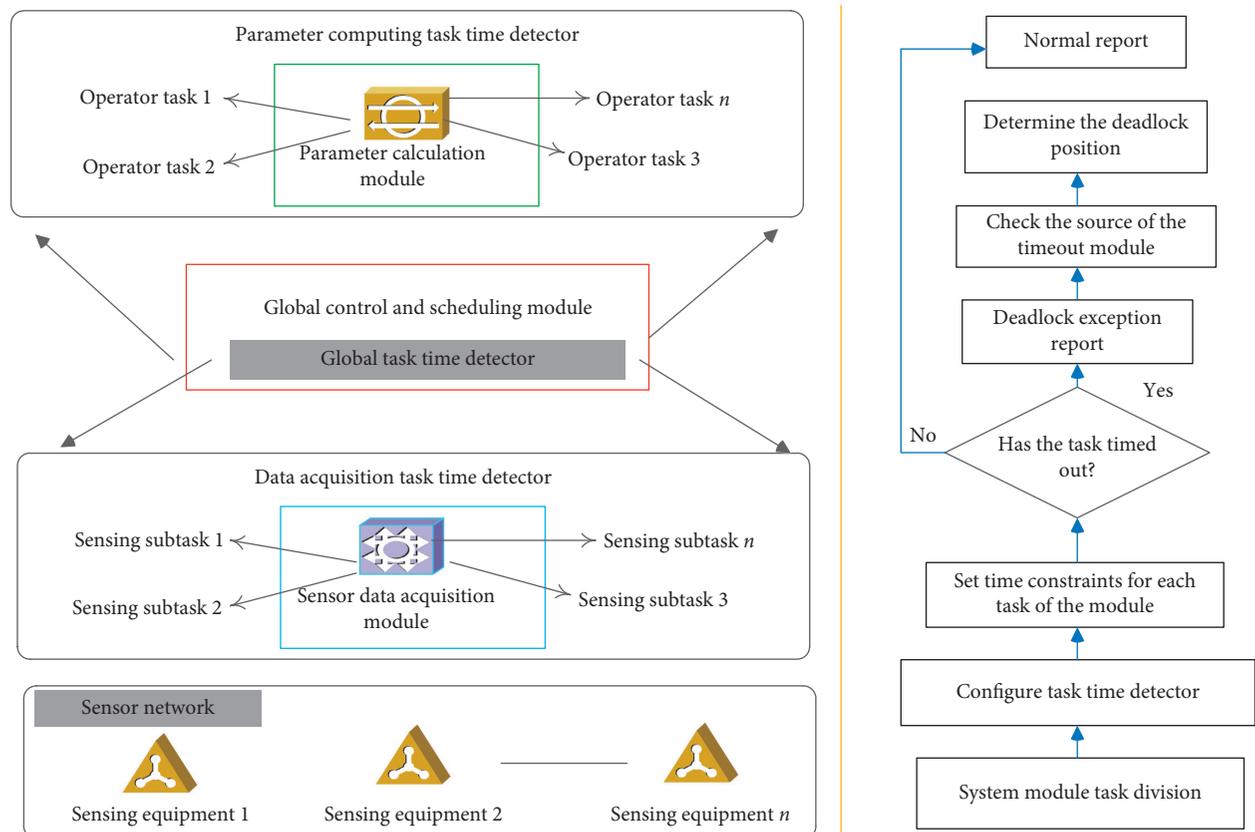


FIGURE 3: Model diagram of deadlock detection method for hierarchical scheduling system based on time constraints.

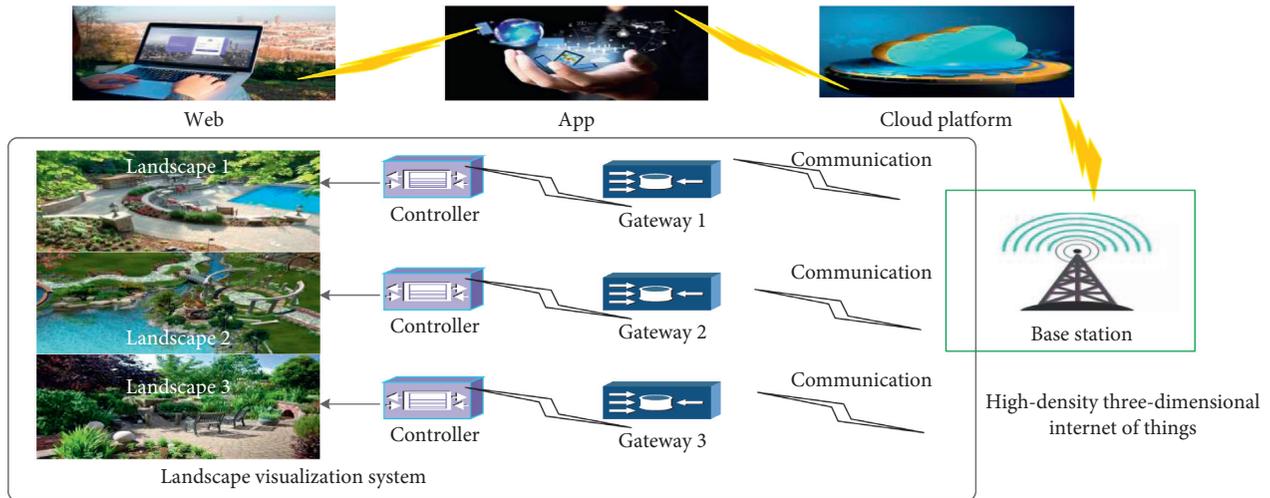


FIGURE 4: High-density three-dimensional Internet of Things landscape visualization system architecture diagram.

visualization system and use the gateway device to connect the landscape visualization system to the cloud platform for networking and unified management.

The user management terminal, as the remote monitoring center of the high-density three-dimensional Internet of Things landscape visualization system, can realize the unified management, networking control, status monitoring, and remote update of pattern programs for the landscape visualization system. User management terminals include web pages and mobile apps. Web pages are used by manufacturers to manage the resources and operating status of all landscape visualization subsystems connected to the cloud platform; mobile apps are for ordinary users and are used to check the equipment after leaving the factory.

As an important part of the high-density three-dimensional Internet of Things landscape visualization system, the cloud platform is the data storage center and data transmission hub of the entire system. It mainly includes user and device access management, data storage, data analysis, and MQTT multidevice communication Services and file transfer services, and other functions.

The gateway, as the core device for the underlying landscape visualization subsystem to access the cloud platform for unified management, connects to the cloud platform upwards, receives control information sent from the user management terminal pushed by the cloud platform to the underlying landscape visualization system, and communicates with the controller downwards. They realize the transmission of control commands and pattern data and the query of controller status.

**5.2. Landscape Sensing Data Storage and Management Test.** They use the Http Requester tool instead of Device 1 to test the REST API program. According to the API design obtained by the above data upload parameters, fill in the URL in the Http Requester tool and select the GET method to obtain the data upload parameters, including the device upload data cycle and requirements. The data points that

need to upload data are temp, current, and hum, but voltage is not obtained, indicating that the selective data upload function is normal.

They use the MQTT client test tool to publish the data values of the four data points temp, hum, voltage, and current with the device ID "1348...AD1/out" of device 1 as the subject, as shown in Figure 5. The historical data storage model of the cloud platform in this paper is the storage of all data received by a certain device at a certain point in time, and the data point identifier node Id is used to distinguish the data of different data points. From the comparison of the data point identifier (node Id) in the historical data set (datas), it can be seen that the variation range of temp, current, hum, and voltage data points is between 0 and 1.

According to system requirements, the historical data query is all the data of a certain data point in a period of time, and the data is drawn into a histogram, so as to observe the trend of the data point in a period of time. The historical data query is shown in Figure 6. They take 6 landscape data points as an example to obtain 3 months' worth of flow data.

**5.3. Sensor Data Processing Performance Test.** The MQTT server performance test is mainly used to test the message receiving performance of the MQTT server. They write the MQTT client test program, create 1000 MQTT clients to connect to the MQTT server, and send data packets continuously. The data size of each packet is 1 kB, and the data will be sent continuously for 1 minute. They run the test program on 10 PCs at the same time. After 1 minute of testing, the number of data packets received by the server is obtained, and the number of landscape data packets received per unit time is calculated, as shown in Figure 7.

This section tests the processing performance of the designed sensor data asynchronous architecture, and tests from three aspects. One aspect is to test and compare the performance of asynchronous processing architecture and synchronous processing architecture; the data processing performance and memory usage in the case of single-thread

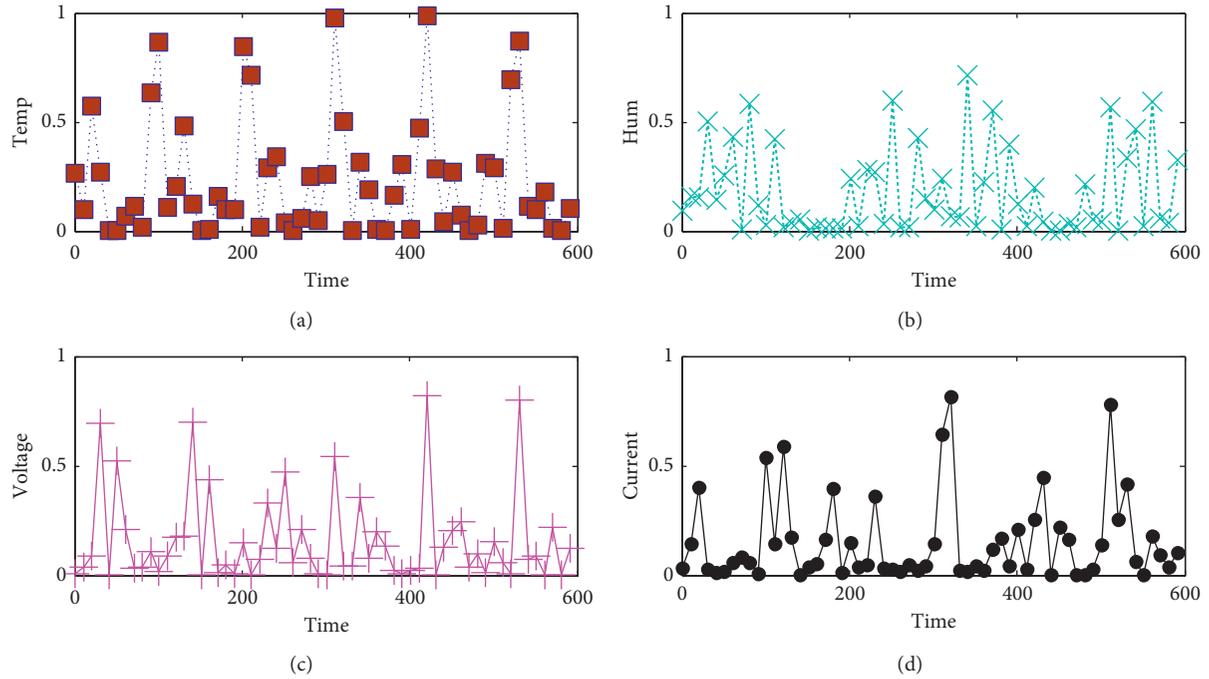


FIGURE 5: MQTT client publishes data point information.

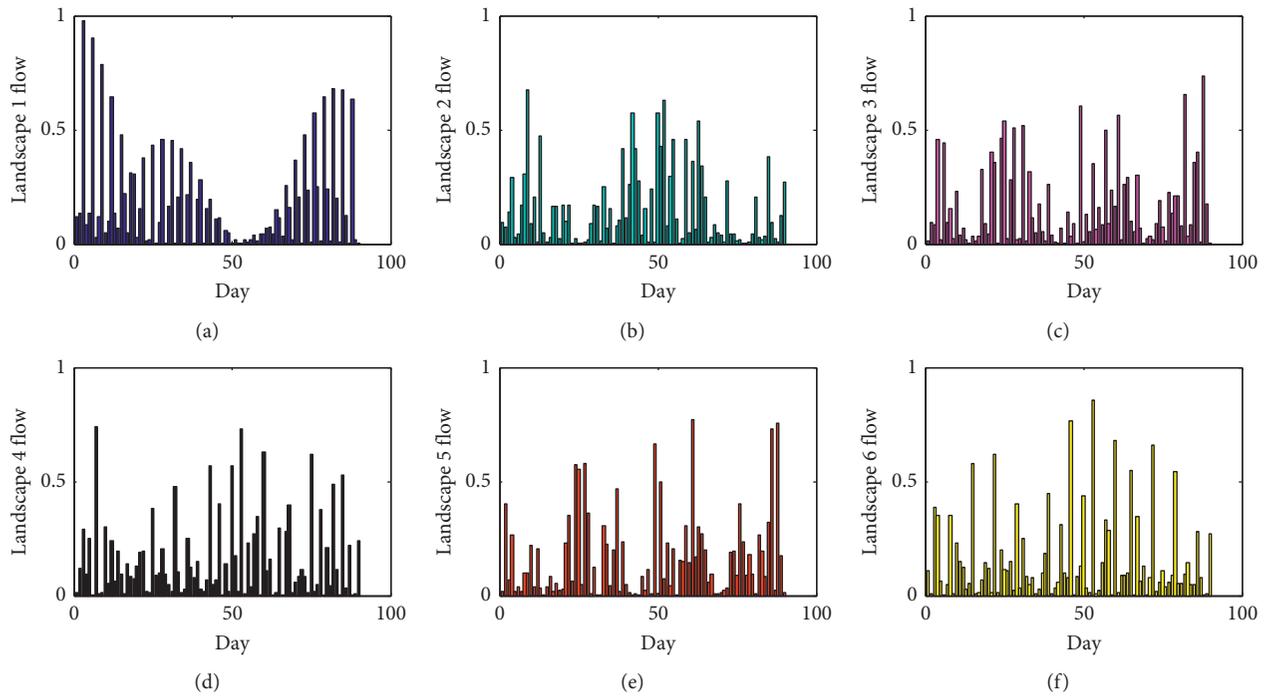


FIGURE 6: The data query and test of historical flow data of 6 landscape gardens.

and multithread are compared. In order to avoid the influence of other factors in the MQTT communication process on the test result, the program of the MQTT client part is shielded in the test in this section, and data is directly generated in the main function for testing.

Here is a comparison between the synchronous processing architecture and the data processing performance in

the consumer single-threaded mode. In the program running result, output the time when the message is generated and the time when the storage is completed, subtract the two times and calculate how many pieces of data can be processed in 1 second, and judge the data processing performance based on the number of data processing pieces per unit time. Here, the subject is set to "134\*\*\*/in" formed by

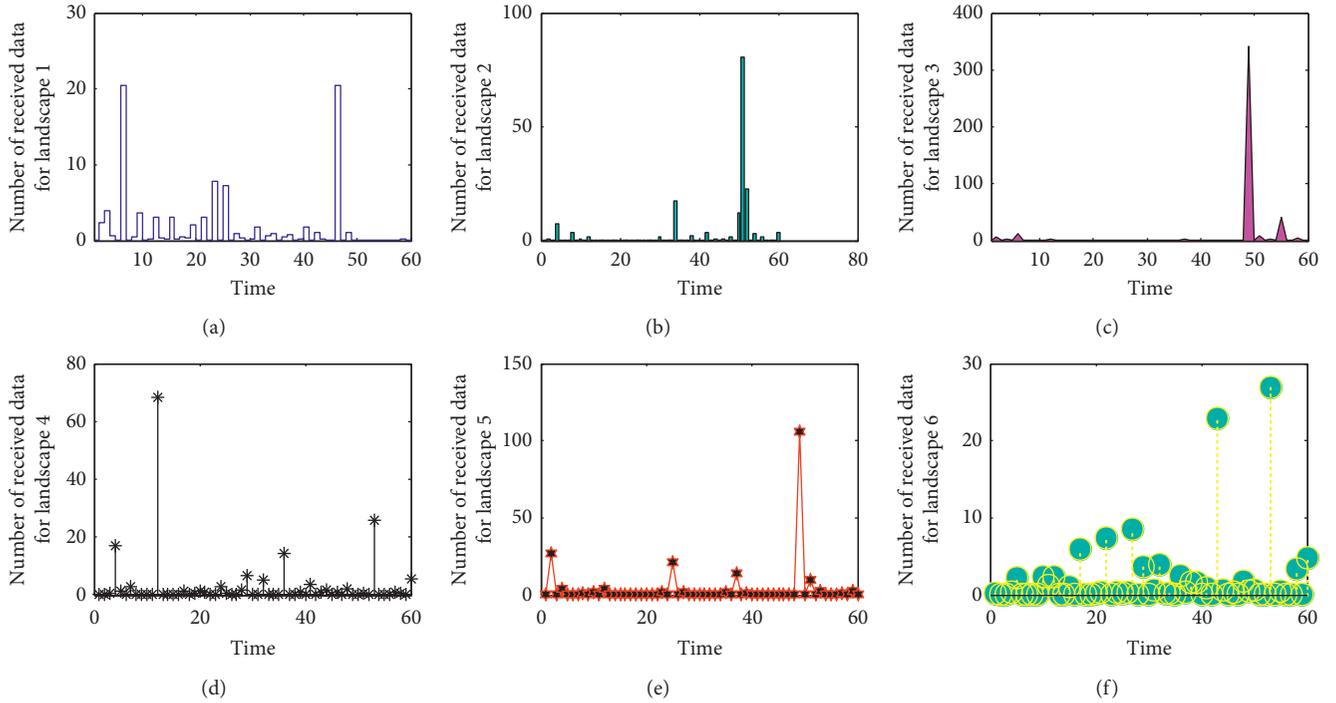


FIGURE 7: Statistics and visualization of data received by 6 landscape IoT servers.

the device ID of device 1, the message content is fixed to the data value of the temp data point, and the number of data sent at one time in the main function is changed to test the data processing performance. Under the same conditions, the peak efficiency of single-threaded data processing in the asynchronous architecture is about 4000 records/s, while the peak data processing efficiency in the synchronous architecture is about 1100 records/s. The processing performance of the asynchronous architecture is 300% higher than that of the synchronous architecture. Processing performance has been significantly improved.

In practical applications, the device uploads data in a cycle set by the user, and multiple data points may be uploaded at the same time. However, under normal circumstances, the number of data points will not exceed 1000; otherwise it will greatly affect the performance of the hardware device. First, they create 1000 data points under device 1, and all data point storage attributes are true. When 25000 data points are sent at one time, the processing performance of the asynchronous architecture reaches its peak value. Next, they upload 25000 at one time in the producer thread of the asynchronous architecture. They test the time from receiving the test data to storage and calculate the number of data points processed per unit time.

The test result shows that when the number of data points of the same message increases, although the processing time becomes longer, the number of data points processed per unit time increases. Therefore, the device can print all data points within the same time when sending data. We send them to the server at the same time as a packet, which will improve the efficiency of the server in processing data points.

According to the current server performance requirements, they set the number of consumer threads in the producer-consumer model to 10, that is, start 10 threads at the same time for message processing, test the time from message generation to storage, and calculate the efficiency of data processing. They compare the processing efficiency of single-threaded and multi-threaded sending the same message content. They test the occupancy of CPU, hard disk, network, and memory occupied by tasks related to sensor data under multithreaded conditions, as shown in Figure 8.

Through comparison, it can be seen that multithreading will bring great performance improvement, especially when the amount of concurrency is large, the performance advantage of multithreading will be more obvious. However, multithreaded processing will inevitably increase the load of the server's CPU and memory. Therefore, the number of

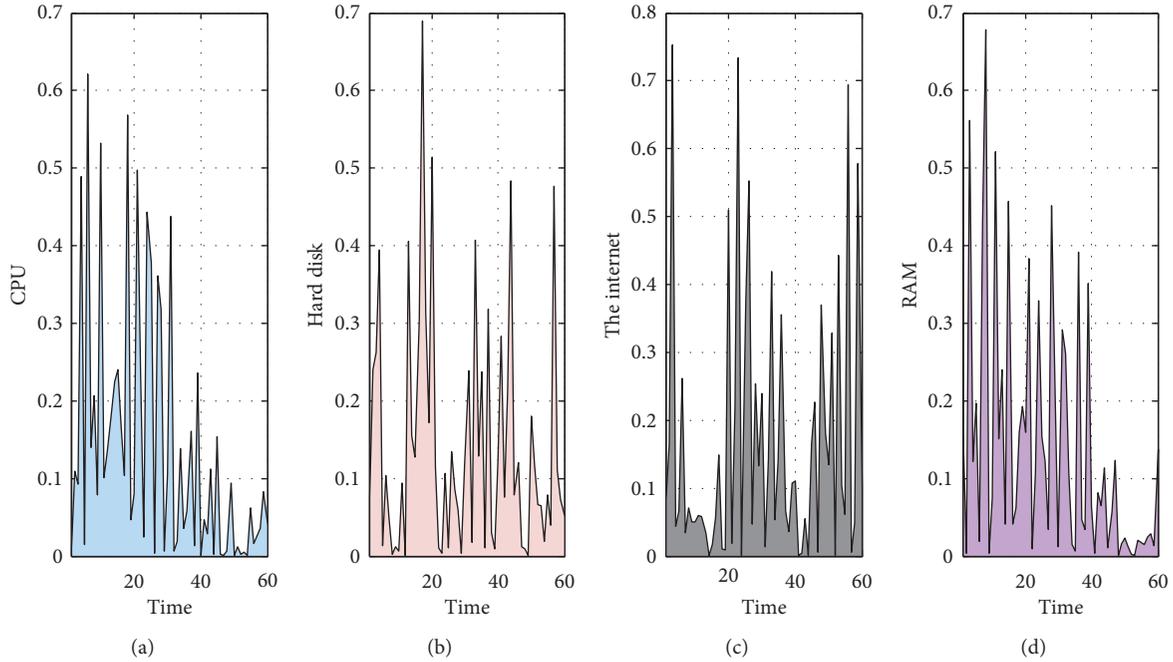


FIGURE 8: Visual comparison of multithreaded resource occupancy.

threads should be reasonably set according to actual performance requirements during program design.

## 6. Conclusion

This paper studies the rapid dispatch planning and performance optimization strategy of the landscape perception layer information of the high-density three-dimensional Internet of Things landscape gardens and discusses the conversion method between the MLD model and the automatic machine scheduling model of the high-density three-dimensional Internet of Things landscape perception layer. They solve the problem of rapid release of multitask deadlock in the perception layer and realize the orderly, reliable, and fast operation of the perception layer system. Based on the conversion analysis between the MLD model of the landscape perception layer of the high-density three-dimensional Internet of Things landscape and the automata scheduling model, it is pointed out that the MLD model under  $nc = mc = pc = 0$  is the finite state machine automata model, and the 0-1 state finite automata model is studied. This method can be extended to other complex automata and MLD model conversion. They research the global task scheduling and control automata model and the local scheduling automata model in the rapid scheduling mechanism of the landscape perception layer of the high-density three-dimensional Internet of Things with hierarchical automata, and realize that for different levels of systems, independent scheduling strategies can be used to achieve high density. They design data point storage rules to analyze and store heterogeneous data and use the producer-consumer model to optimize the performance of the data processing process. At the same time, the paging query method based on where-limit is adopted to realize efficient query of historical

data. On this basis, combined with the requirements of the landscape visualization system, a test platform was built to bind and authorize terminals in the cloud platform, M2M terminal communication, multidevice loosely coupled communication, rule-based sensor data storage. The results show that the high-density three-dimensional Internet of Things landscape garden landscape M2M cloud platform can realize cross-platform terminal access and instant messaging, heterogeneous data processing and storage functions, with strong scalability and high processing performance, and has application and reference value. In order to meet the increasingly complex IoT application development needs in the future, the platform also needs to expand additional functions; for example, it can be combined with artificial intelligence, big data computing, machine learning, and other ideas for service development. In practical applications, it is necessary to deal with the problems of high concurrent access and massive data storage. Therefore, it is necessary to introduce a high concurrent processing mechanism, increase server load balancing, and cluster processing to prevent server failures caused by concurrent operations of multiple users and multiple devices in practical applications. Database sharding and clustering should also be carried out to prevent data loss caused by system failures and ensure the stability of the platform.

## Data Availability

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

## Conflicts of Interest

The author declares that there are no conflicts of interest.

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