Using Virtual Reality Technology to Visualize Management of College Assets in the Internet of Things Environment

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ABSTRACT This article studies the visual management of college assets under the changing environment of the Internet of Things, uses virtual reality technology to discuss the mechanism of its visualization, and studies the technical selection from the aspects of system architecture, database, and message middleware to provide reliable colleges and universities asset management, provide a complete authority distribution management mechanism, have a safe and reliable data storage mechanism and good scalability. And according to this goal, the overall architecture of the system is designed. Under this architecture, the main modules of the college asset management system divided into college asset information management, information release management, and other modules. To meet these functional modules, related diagrams are designed. The diagram creates a data table corresponding to it. The emphasis is on the systematic analysis of system performance and uses case modeling, static model, and dynamic model based on UML. The overall design of a three-tier logical structure including presentation layer, business logic layer, and data access layer, six functional modules including business process management, platform visualization management, application management, data storage, data processing, and data asset security control. Using the MySQL database and the database design method based on the E-R model, the definition of data entities was completed and the table structure design was carried out. It proved that the functions of the platform are in line with actual needs, and the performance can also meet the business requirements of the visualized management of college assets. It can manage data assets well and has high practical application value.

INDEX TERMS Virtual reality technology, Internet of Things, college assets, visual management.

I. INTRODUCTION

With the rapid development of mobile Internet, cloud computing, and the Internet of Things (IoT), global data has shown an explosive growth trend [1]. Big data, as one of the current mainstreams, is having a huge impact on the operation management, business process, and marketing of enterprises, and it is also changing the way enterprises make decisions [2]. Data assets have become the core competitiveness of enterprises. How to build a big data ecosystem around Xi’an Telecom’s data assets, and innovate business models based on user experience. The Internet of Things is an information connection network formed by the cooperation of sensors and the Internet [3]. It can connect terminal equipment, sensors, industrial systems, or other information systems, video surveillance systems, and other equipment assets with “external enablement” through various wired or wireless networks that realize interconnection and application integration [4]. Adopt appropriate communication and safety guarantee mechanisms to realize real-time online monitoring, tracking, and positioning, command linkage, dispatch control, remote maintenance, other management, and service functions. The rapid development of the Internet of Things technology has made it increasingly an important force to promote the development of science and technology in various countries. Information visualization in data visualization refers to a
technology that expresses a large amount of abstract data in concrete forms such as graphs and charts [5]. Through visual processing, complex and obscure data information can be made simple, clear, and easy to understand [6]. With the development of sensor technology, computer technology, and network transmission technology, data, and status monitoring methods in the field of the Internet of Things are becoming more abundant [7]. Use visualization technology to visually present data in front of users, so that the value of data can be truly utilized. Visualization technology is the key to opening the “last mile” of the Internet of Things [8]. Use the Internet of Things technology to form an information exchange network for equipment, sensors, and monitoring systems through wired or wireless connections, and use visualization techniques to visually display the real-time status of the equipment, and key parameter values in front of users to achieve real-time monitoring of the status of the field equipment and remote operation to achieve the purpose of automatic control of civil air defense equipment [9].

Lee H et al. proposed a whitelisting technology to identify unauthorized IoT devices [10]. This technology extracts 334 features related to TTL in TCP/IP session streams and uses random forest machine learning methods to identify unauthorized devices that are not included in the whitelist [11]. Yuan SN et al. proposed a system DIOT that effectively detects damaged IoT devices [12]. Habibzadeh H used a novel self-learning method to classify devices into device types, establishes a normal communication mode for each device according to the device type, and then detect abnormal deviations in the communication mode [13]. This method can cope with the emergence of new device types and new attacks [14]. Kumar PM and others also proposed the application of machine learning algorithms in network traffic data to accurately identify Internet of Things devices connected to the network [15]. In this paper, network feature extractors are used to extract source and destination addresses, SYN and FIN port numbers, and other layers of the network [16]. Samih H et al. proposed an IoT device model that uses machine learning to identify malicious behaviors in corporate networks, extracted the IP header data characteristics of network traffic, and used three classification algorithms: random forest, Bayesian, and gradient boosting [17]. The results show that random forest and gradient boosting algorithms have high recall and accuracy, while Bayesian performance is the worst [18]. This method identifies the infected device but does not classify the device model [19]. For the simple solution of deploying supervised machine learning algorithms in a centralized location in the network, Thangavelu V and others can neither expand well nor identify new devices [20]. They proposed a distributed fingerprint solution DEFT to solve the problem of intelligent common device identification problems in-home and corporate networks [21]. Milosavljević A et al. proposed an automatic device model identification model, which first identifies devices newly connected to the network, secondly performs vulnerability assessments on the devices, and finally restricts the communication of the devices based on the assessment results [22]. In the device identification part, the traffic characteristics of the communication settings when the device is connected to the network are extracted, and the device identification is performed by the classification method of the random forest [23]. Elmqademi N et al. designed an anomaly detection method based on behavior patterns to detect the medical smartphone network (MSN) and judge the credibility of the node by identifying the difference in Euclidean distance between two behavior characteristics [24]. Papanastasiou G et al. proposed IoT, a system for detecting infected IoT devices [25]. Compared with previous work, IoT uses a novel self-learning method to classify devices into device types and establish a normal communication configuration for each device, which can then be used to detect abnormal deviations in the communication mode [26]. IoT is fully autonomous and can be trained in a distributed crowdsourcing manner without manual intervention or labeled training data [27]. Therefore, IoT can cope with the emergence of new device types and new attacks [28].

Through the above literature review, it can be found that predecessors have made many important research results in related fields. However, due to the complexity of the Internet of Things security threats and other reasons, the existing device identification technology requires many features or complex signal processing technologies. These methods require the device to have strong computing capabilities, which is a challenge for resource-constrained IoT devices. Some methods just classify the device abstractly and cannot identify the specific device model, and there is no device identification and abnormality. The response mechanism after discovery is elaborated. After studying the web-side system, I learned about the specific design process and implementation methods, combined with Hadoop and other related technologies and deployment knowledge, conducted a survey and analysis of the market, and studied how data providers use data assets and make them monetize.

To better run the system and make it run reliably and securely, the environment deployment system was first created, and then the platform performance and system functions were tested to verify the actual use-value of the platform and system. Through specific practice and testing, the functions of the platform system are in line with actual requirements, and the functions are comprehensive. In terms of performance, it also meets the needs of university asset management, can be well applied to actual situations, can well manage data assets, process data, manage users, etc., and have high practical application value.

II. VIRTUAL REALITY TECHNOLOGY FOR THE VISUAL DESIGN OF ASSETS
A. OPTIMIZED VIRTUAL REALITY TECHNOLOGY ALGORITHM
In the virtual reality all-in-one machine, single or multiple images are used to calculate the distortion parameters in the nonlinear distortion model after lens distortion. The
self-calibration method is different from the Kang calibration method in that it usually uses a set of images taken from multiple viewing angles to estimate the imaging model of the camera [29]. The Kang calibration method requires a camera to take multiple images of the black and white checkerboard calibration board, and the distance between the black and white calibration boards must be known [30]. The self-calibration method does not require a fixed black and white checkerboard calibration board for calibration. It only needs to use the scene content in the image to construct its model through geometric characteristics and then solve the distortion parameters through numerical optimization. Common methods include bending according to the distortion curve Features, use ellipsoid surface model, spherical coordinate projection model, and arc surface mapping model to approximate and fit; use the collinear constraint of the center of the curve formed after the linear distortion, use the linear distortion feature and the geometric invariance of the linear projection, etc. In numerical optimization methods for solving distortion parameters, linear solutions, exhaustive methods, and least squares methods can be used. Most commonly, the least squares method is used to optimize the distortion parameters, and the use of the least squares method usually requires the establishment of an error function. A common way to establish the error function is to use the distance between the image features and the fitted model, usually requires the establishment of an error function. A least squares method can be used. Most active methods, and least squares methods can be used. Most

The result shows that after the distortion model is modeled, the straight-line segment in the three-dimensional world is deformed into a circle by the lens distortion, and the distortion center P is located at the origin of the image coordinate system [33]. This is a geometric characteristic of the straight-line segment after being distorted, and this method is to use this characteristic to solve the distortion parameter. Suppose the coordinates of the distortion center P are \((x_0, y_0)\), and the coordinates of the image origin are \((0, 0)\).

\[
(x_d - x_0)^2 + (y_d - y_0)^2 + \frac{1}{\lambda} = 0
\]  
(8)

Simplified:

\[
x_d^2 + y_d^2 - 2(x_d x_0 + y_d y_0) + x_0^2 + y_0^2 = 0
\]  
(9)

Abbreviated as:

\[
\begin{align*}
A &= \frac{k}{b\alpha} - 2x_0 \\
A &= -\frac{1}{b\alpha} - 2y_0 \\
C &= x_0^2 + y_0^2 + \frac{1}{\lambda}
\end{align*}
\]  
(10)

The straight line is fitted into a circle by formula, and the values of parameters \(A, B\) can be obtained at the same time, and the distortion center point \((x_0, y_0)\) is constrained by the formula between \(A, B\) at the same time, and the distortion coefficient \(\lambda\) can be solved. Therefore, only need to extract two straight lines from the image to get two sets of equations about \((A_i, B_i)\), then the distortion center point \(P(x_0, y_0)\) can be calculated. The equations are as follows:

\[
\begin{align*}
(A_1 - A_2)x_0 + (B_1 - B_2)y_0 &= 0 \\
(A_1 - A_3)x_0 + (B_1 - B_3)y_0 &= 0
\end{align*}
\]  
(11)

Calculated the parameters \(A, B\) by extracting feature points from the straight-line segment, assuming that the extracted feature points are \((x_i, y_i)\), then:

\[
(x_i, y_i, 1) \begin{bmatrix} A \\ B \\ 1 \end{bmatrix} = -(x_i^2 + y_i^2)
\]  
(12)

After selecting \(M\) feature points, it can be simplified to:

\[
H \begin{bmatrix} A \\ B \\ 1 \end{bmatrix} = M
\]  
(13)

Among them, \(M\) is an \(M \times 3\) matrix; \(b\) is an \(M \times 1\) matrix. Use the least square method to get:

\[
(A, B)^T = (M^T M)^{-1} M^T b
\]  
(14)
Substituting \((x_0, y_0)\) into the formula, the parameters of radial distortion can be obtained as:

\[
\frac{1}{\alpha} = x_0^2 + y_0^2 = Ax_0 + By_0
\]  

(15)

For shorter arcs, to perform accurate circle fitting and improve the robustness of the algorithm, the equation of the circle can be set as:

\[
a_1(x_0^2 + y_0^2) + a_2x + a_3y + a_4 = 0
\]  

(16)

The correction of image distortion requires two parts of correction: the correction of pixel coordinates, the coordinates of the pixels on the distorted image are obtained according to the mapping relationship, and the coordinates of the distorted pixels can be geometrically transformed to perform coordinate correction; image pixel restoration. The pixels of the distorted image can be calculated and corrected using interpolation algorithms.

B. DESIGN OF VISUALIZATION SYSTEM OF UNIVERSITY ASSETS

Publishing information in real time is always like having a window open, allowing more teachers, students, and parents to understand the style of the school. In daily promotion and teaching, there is a need to transmit a large amount of information within the school such as curriculum-related courseware, teaching information, curriculum information and instructional management. Smart school information dissemination systems face different audiences on different occasions, at different times, with different content, and can integrate and manage education-related policies, news, school profiles, and enrollment information [34]. Publish school teaching and related information in a new way. While demonstrating the strength of the school’s hardware facilities to the outside world, it is also necessary to show the school’s soft power, such as the school’s history, celebrity allusions, centennial anniversary, alumni style, campus construction and development, and other information, which can be displayed in the public area of the campus for digital. The campus provides timely, comprehensive, high-quality, and efficient information services. There are mainly the following three aspects: (1) the need for multi-level information transmission; (2) the need for unified management of grades and permissions; (3) the need for campus digital and information construction.

The system hardware is based on the cloud edge router. The northbound communicates with the cloud platform through 4G or wired network, and the southbound communicates with hardware devices through WIFI, LORA, RS232, RS485, or LAN networks. The system platform level is mainly divided into IaaS cloud infrastructure, PaaS cloud management architecture, and SaaS application layer [35]. IaaS is a basic environment construction and all services depend on it; the PaaS platform manages the hardware,
network, storage, and strategy of the system layer. User-specific applications are based on the SaaS platform for demand development to meet the needs of different applications. The summary design architecture is shown in Figure 2.

The cloud edge router is an interactive portal between front-end hardware devices and the cloud platform. It has a strong processing performance. It takes the core board as the center, runs the Linux operating system, expands the STM32 expansion board, and leads to UART, USB, LoRa, 4G, WIFI and LAN. And other interfaces to facilitate the access of various hardware devices. The system is compatible with common protocols such as MQTT, CoAP, and Http, and can be quickly connected to the platform.

The teacher-side management system is mainly divided into hardware equipment status queries, equipment control, access control authorization, teaching course arrangement, alarm push, and class card system, and other modules. Hardware equipment status query and equipment control can monitor the on-site status in real-time, and solve problems remotely and in time when the abnormality occurs; access authorization can grant access control permissions to students of designated classes according to the teaching curriculum; the class card system will cloud platform information and necessary equipment information or student information is pushed and displayed to facilitate the teaching management of teachers. The student-side management system is mainly divided into hardware equipment status query, equipment control, authorization application, course information display, alarm push, and class card system and other modules. The course information can be displayed according to the teaching arrangement of the teacher, and the course progress can be tracked in real-time.

The Cloud Edge Router and Management Platform Interaction Protocol should run over TCP/IP or other protocols to provide an orderly, reliable, and bi-directional connection to the upper layer. The application layer uses the lightweight message queuing telemetry transport protocol MQTT, based on a publish/subscribe message model, to provide one-to-many messaging and release application coupling. The message body in MQTT uses a lightweight, programming language-independent text format JSON as the data exchange format. Its interactive functions should include multiple aspects such as device management, application management, and business interaction. Device management should cover the full life cycle management of cloud edge routers, including device registration, device upgrades, device configuration, device control, device monitoring, and credibility measurement. Application management should include application control, application status monitoring, application event reporting, and sub-device management. Business interaction should include functions such as object model distribution and data interaction.

The embedded software of the cloud edge router adopts the built-in edge intelligent operating system RTOS, the application is based on container technology and provides basic APP operating environment and edge computing support components on the edge side. Each profession can develop and deploy professional APP applications according to their
needs and can be remotely managed, to promote rapid iteration of application functions. The equipment collects terminal data information uniformly and uses standard Internet of Things protocol to report to the management platform. The management platform provides standardized data interfaces and services to the corporate headquarters or various business systems. The embedded software of the cloud edge router adopts the built-in edge intelligent operating system RTOS, the application is based on container technology and provides basic APP operating environment and edge computing support components on the edge side. Each profession can develop and deploy professional APP applications according to their needs and can be remotely managed, remote monitoring, remote upgrades, to promote rapid iteration of application functions. The equipment collects terminal data information uniformly and uses standard Internet of Things protocol to report to the management platform. The management platform provides standardized data interfaces and services to the corporate headquarters or various business systems.

The cloud platform and the cloud edge router use the MQTT+Json data format for communication. The cloud edge router and hardware devices use Modbus RTU for acquisition and control. In particular, the camera encodes the image data in H265 data and then pushes it through the RTSP stream. The cloud platform and APP client use MQTT to publish and subscribe and the web client uses HTTP to send request and response modes.

### III. DESIGN AND ANALYSIS OF UNIVERSITY ASSET DATA IN THE INTERNET OF THINGS ENVIRONMENT

#### A. IoT ENVIRONMENT DESIGN

The system uses MySQL as the database for back-end services. The database has the characteristics of open source, simple structure, support for multiple platforms, simple deployment, and fast execution speed. The Java application in this system is connected to the MySQL database through the JDBC driver, and the corresponding data table is added to the store, classify, and manage the system data. According to the design requirements of the system, the database is divided into a user module, equipment data module, student management module, and teacher management module. The user module is mainly to add, delete, modify and check user registration information; the device data module is used to manage and store front-end hardware device data; the student management module associates student account information with teaching courses and other information; the teacher module is used to associate students course and field equipment status.

The system is built with cloud edge routers as the core, and hardware devices are connected in the south direction and the platform is connected in the north direction. The communication methods of the southbound interface mainly include WIFI, wired LAN, LORA, RS232, and RS485, etc., and the northbound interface mainly includes a 4G or wired network. Due to the large data bandwidth, the camera needs to use WIFI or wired network for docking; gas equipment and other environmental monitoring equipment, the amount of data transmission is small, the real-time requirement is not high, the number of equipment is large, considering the difficulty of installation, the LORA wireless communication method is adopted access; equipment such as access control equipment and air conditioning controllers have high real-time requirements and can be accessed in RS485 mode, as shown in Table 1.

Sensors are the tentacles of the security object, security resource terminal, and every corner of the security location of the college asset security Internet of Things. It is the forefront of perception information and the source of college asset security Internet of Things information. The sensor can be set independently, or it can exist in a network with other devices. Sensors are embedded in college assets and various security resources to monitor their status and are distributed on the battlefield to perceive battlefield information. The information is the basic information of the college asset security Internet of Things and the basis for the operation of the college asset security Internet of Things.

Sensors installed on college assets or security equipment are generally divided into two categories: one is internal state sensors, and the other is external state sensors. Internal state sensors are mainly used to detect, perceive, and control the state of college assets themselves, for automatic control, servo systems, etc. External state sensors are mainly used to detect and perceive college assets, to ensure the existence and application of the external environment of resources. Compared with civilian sensors, sensors have special requirements such as special variety and structure, harsh use environment, high technical indicators, high-quality levels, high stability, and reliability. In recent years, driven by high-tech technologies such as microelectronics technology, micro-machining technology, nanotechnology, and new material science, increased miniaturization, multi-functionalization, digitization, intelligence, systemization, and networked sensors can be used. Applied in the field of college asset protection Internet of Things. The sensors used in the asset

| Equipment name       | Values | Access method |
|----------------------|--------|---------------|
| camera               | 3      | WIFI/LAN      |
| Smoke/combustible gas/Co gas, etc. | 3      | LORA          |
| Air conditioning controller | 4      | RS485         |
| thermometer         | 3      | LORA          |
| Door sensor detection | 2      | LORA          |
| Lighting control     | 2      | RS485         |
| Curtain control      | 3      | RS485         |
| Access control equipment | 4      | RS485         |
protection of colleges and universities mainly include the following types: the measured displacement is within a very small range of 0.1pm to 10pm. This type of sensor can measure the technical status of college assets. According to different working principles and measurement parameters, they are divided into thermal speed sensors, capacitive speed sensors, etc. These sensors are used to measure the operating status of college assets. Including piezoresistive accelerometers, force balance accelerometers, and capacitive accelerometers, etc., these sensors are used to measure the operating status of college assets. The measurement range is 1~500mN, and the accuracy is 1mN. This type of sensor is used to measure damage to college assets. Including integrated thermal diodes, integrated thermal transistors, etc., which can be used to measure the operating status of college assets. It is mainly the satellite positioning device, which is used to monitor the location information of college assets and college asset protection resources.

There are many network nodes for asset protection in colleges and universities, and sensors are installed and deployed on each node. These nodes have two functions: one is to perceive information, to monitor and perceive the status information of the battlefield environment, weapon platforms, and equipment. The second is to transmit information, which not only transmits the information data perceived by the node itself but also forwards the data of other nodes and finally uploads it to the control server through the sink node. Sensor networks are divided into two types: wired and wireless. Short-distance, low-power wireless sensor networks are more suitable for the use of college asset protection IoT. Wireless sensor network technology has multiple independent application directions but compared to college asset protection applications, a single technology is difficult to meet the requirements. To realize the interconnection and intercommunication of information between college assets and guarantee resources, a wireless self-organizing network needs to be constructed. Based on the application of asset protection for colleges and universities in peacetime and wartime, the Internet of college assets guarantee has put forward higher requirements on the communication distance, transmission bandwidth, security, and confidentiality of wireless ad hoc networks.

The general communication distance must reach several kilometers, and the transmission bandwidth to reach the level of Mb/s or higher. Based on the above index requirements, this paper studies and designs a wireless transmission network dedicated to the asset protection of colleges and universities, and realizes the automatic networking between various terminals and the high-speed and reliable transmission of related information, as shown in Figure 3.

The star network is simple in structure and easy to implement, but because the transmission distance is relatively short, it is generally used in networks with nodes close to base stations and small coverage areas. Mesh networks have low power and small capacity and are generally used in networks with a small number of users and a small range of activities. The hybrid network structure has the advantages of simple, easy-to-control, multi-hop, self-healing, and so on. The establishment and maintenance of the network are simple and efficient. The hierarchical network structure is a typical hybrid network. The entire sensor network forms a hierarchical structure. The network divides the sensor nodes into different clusters according to certain rules. Each cluster has a node as the cluster head. Control each node in the cluster, on the other hand, collect and summarize the data information collected by the sensors of each node, and forward it to the base station in the network after integration processing. The hierarchical network structure manages the network hierarchically through clusters and all nodes in each cluster exchange information with the base station through the cluster head. The hierarchical network structure has three advantages: first, the network structure is simpler, which is convenient for construction and maintenance; second, it reduces the information interaction between nodes and base stations, and reduces the overall energy consumption of the network; third, the cluster head pair. The information collected by each node in the cluster is integrated and processed and then transmitted centrally, which reduces the information flow and reduces the transmission overhead of network routing. Based on the above characteristics, the hierarchical network structure is very suitable for university asset wireless sensor networks with many network nodes and wide coverage.

B. SYSTEM INDEX EVALUATION DESIGN

The fundamental purpose of designing system test cases is to carry out unit testing for the software function to find out its shortcomings. But nowadays, when multiple users use the system on the Web site at the same time, the speed of the system slows down. Therefore, it is necessary to use test tools to detect the concurrency problem of the system, and improve the hardware or optimize the software system based on the detection results. To fundamentally solve the problem. In the process of system test verification, test cases can be used, which can ensure the validity of the test. Before testing, first, take a certain kind of software as the object, and then set a target, then simulate the actual possible problems, set the constraints and factors, and then conduct the test, analyze the results obtained, and then compare the predicted value and the test value. For comparison, you can judge whether the requirements are met by comparing the results. Test the sub-module role management in the user management to verify whether the function can be used normally; second, you need to log in to the system and perform specific operations on the user management role page; third, you need to check the role management function to ensure that there are no problems.

According to the introduction of platform functions, the platform data model is designed, and the platform data storage adopts multiple modes and hierarchical storage, and the system core library, resource configuration library, and file content are stored in different types of databases. Ensure the security of core data, the flexibility of configuration data, and multiple backups of resource data. Among them, remote
sensing image data such as the planting area needs to be stored in non-relational data, and structured data such as numbers and symbols need to be stored in the MySQL database. The following is a detailed introduction to the design of the agricultural product price prediction database in the business system.

As shown in Figure 4, it can be seen from the E-R that there are four main bodies including basic market information, basic product information, daily prices, and basic production information.

In the process of system development, the study of functional requirements is very critical, but the data interaction and data objects between the functional modules are also essential. When developing the database, the system data objects can be researched one by one, and the attributes and relationships of each entity object can be determined one by one, which lays the foundation for building the system data model. Figure 4 describes the attributes and relationships of multiple entities involved in this system, such as users, permissions, roles, tasks, projects, data applications, and data sources. Data table structure design the design of the data table is completed based on the E-R diagram. A clear and familiar design of the data table in the system will determine whether the system can efficiently process the interaction of business data. For system development, determining the core key fields, types, and other constraints of each entity is the most basic requirement, and it also reflects the development experience and capabilities of the development team. Of course, the precise definition of the specific primary key and foreign key information in the table is the top priority of the database table design. In this paper, a total of 39 database tables are designed based on the required application functions, combined with the concept of the E-R model and the system application, which can realize different functions of the system. Next, a few main database tables will be introduced.

Taking from the overall design of each functional module of the system to the brief design of each functional module, and then to the end of the detailed design of each functional module, a total of business process management module, platform visualization management module, application management module, a data storage module, and data processing are completed. Six modules including module and
data asset security control module. In the detailed design stage, the important sub-function modules of the six functional modules are mainly elaborated. In the business process management module, the function of business management is explained in detail, and the process is analyzed in detail. Some commonly used management functions are included in the visual management module. Also, in the process of detailed design and analysis of the system, users and roles are analyzed. For the data application sharing process, the focus is on the data application management module, and the data application sub-functions are also explained. In the basic data module, including the data processing module, and the data storage module, the process of data processing and storage is explained in detail. In the data security control module, a set of programs to ensure the safe operation of the system is designed, and the control steps for data security are described in detail, thereby providing a guarantee for data security.

IV. RESULTS ANALYSIS
A. ANALYSIS OF SYSTEM PERFORMANCE RESULTS

In the simulation process, we simulated the tree network and the mesh network respectively. The number of nodes in the tree network is 64, 80, 100, 128, and the number of nodes in the mesh network is 64, 81, 100, 121, respectively. The ratios of the temperature and light intensity sensor nodes of the two networks are 1:3, 1:2, 1:1,2:1, and 3:1. In these cases, the nodes are set not to be aggregated, and simulations are performed according to N:1, N:2, and N:3 aggregation. Suppose that in a cycle, all sensor nodes stay dormant most of the time, and each node has a data generated in a cycle and sent to the destination node through the routing algorithm.

Based on the above assumptions, we will simulate and compare the proposed routing algorithm based on data aggregation and the non-aggregated routing algorithm. The simulation results are described as follows: Figure 5 respectively describes the average remaining energy of the tree and lattice network algorithms at 5 different sensor node ratios. It can be seen that in the case of non-aggregation, the average remaining energy of the network nodes is much greater than the three cases of aggregation, indicating that when most of the nodes have a lot of remaining energy, the life of the network has ended, and all collected data is sent to the destination node causes the nodes near the destination node to be overloaded, and each cycle has to transmit a large amount of data to consume energy, and most of these data may be redundant data. Therefore, no data aggregation will seriously affect the performance of the network.

In the case of aggregation, the higher the degree of aggregation, the more remaining energy in the network. This is because the higher the degree of aggregation, the less the amount of data transmitted by the node, and the corresponding reduction in its energy consumption, so the remaining energy will be at the same time because the network is heterogeneous when the temperature sensor and the light intensity sensor transmit different types of data, the energy consumed is different, so the ratio of the two sensor nodes also has a certain impact on the average remaining energy of the network.

For the algorithm, the maximum number of stations that can be associated with APs is set to 3 and 5 respectively, and the results are represented by JORS (1) and JORS (2). At each time step, the system throughput rate (the sum of the throughput rates of all stations) and the queue length (the sum of the buffer queue lengths of each station) under each algorithm are shown in Figure 6.

At each time step, compared to the other two algorithms, the JORS algorithm can effectively improve the system throughput and ease the system queue length. Compared with the static allocation method, the adaptive spectrum allocation algorithm does not consider the correlation between APs, and each station has a limited improvement in system performance. At the 4th and 10th time steps, the two have similar performance. The maximum number of stations that can be associated with APs is determined by after increasing from 3 to 5, more stations can choose the closest AP to associate with themselves, instead of being "forced" to associate with
The result of characteristic fingerprint adjustment is generally higher inaccuracy. In the result of the method before adjustment, the recognition accuracy of each device is quite different. Among them, the recognition accuracy of a few devices is below 50%, but there are also many devices with a recognition rate of 100%. In comparison, the method in this paper is more stable. The reason for the improved accuracy is the adjustment of characteristic fingerprints, such as removing the IP options feature that cannot effectively reflect the difference, and then selecting the frequency of IP address conversion as part of the fingerprint, and converting the packet length feature to a decimal within 10. To avoid that the data size difference between each pixel of the fingerprint is too large to affect the classification effect. The method of feature construction of fingerprints will affect the accuracy of classification. In the following research, we will further analyze and compare the impact of different fingerprint construction processes on accuracy, as shown in Figure 7.

When the device is connected to the network, the gateway records communication data packets during the device setup stage to construct a characteristic fingerprint. To determine the value of the number of data packets, the number of data packets is 6, 8, 10, 12, and 14 respectively. In the case of 16, the recognition accuracy comparison experiment was carried out, and the experimental results are shown in Figure 8.

It can be seen from Figure 8 that the horizontal axis represents the number of selected data packets, and the vertical axis represents the detection accuracy rate. When the number of data packets reaches 12, the accuracy rate reaches 0.97, and the accuracy rate changes after increasing the number of data packets. It tends to be stable, so select 12 as the number of data packets in the final characteristic fingerprint. After testing, the average time for equipment identification training and testing is 2.5ms, which meets actual needs. After saving the completed task, if you need to modify the information, you can click the edit button to modify it. After the task is created, just submit it directly. It should be noted here that if the task has been submitted, the modification operation cannot be performed. After submitting the task, you need to wait for the review, that is, the system will review the specific situation of the user. If the review is passed, the task is passed, if not, it will be rejected. When the user’s task is rejected, the user can make further modifications to it, that is, the status can be changed. There are two types of task execution status, one is the task is completed, and the other is in execution. If the user needs to query it, just check it.

B. VISUALIZATION RESULT ANALYSIS
Figure 9 compares the remaining energy standard deviations of the tree and trellis network algorithms at 5 different sensor node ratios. The data is aggregated and transmitted, which reduces the load of sensors near the destination node, reduces the corresponding energy consumption, and balances the energy consumption of the entire network node to a certain extent. Therefore, the remaining energy standard deviation in the case of aggregation is much lower than that in the case of non-aggregation. Besides, due to the different sensor parameters, the sensor ratio also has a certain impact on this index.

In this experiment, we chose an 8×8 grid map to simulate the display content of the VR device. As shown in Figure 10 below, if the optical design is perfect and there is no distortion, then each red dot should perfectly fall on the intersection of the grid. In the case of setting the same lens distortion rate, compare the picture corrected by our optimization algorithm
with the picture corrected by the anti-distortion processing algorithm stripped from the Oculus display algorithm. We use the distortion rate as a quantitative criterion to evaluate the distortion of an image. The distortion rate is in percentage. If a pixel is placed at a distance of 100 pixels from the center of distortion, but the lens looks at a distance of 110 (that is, after lens distortion, the pixel falls to 110 pixels from the center of distortion), then the distortion rate of this point is \((110 - 100)/100 = 10\%\). The distortion rate of the \(8 \times 8\) grid map after distortion and the distortion rate corrected by our optimization algorithm and the Oculus anti. The distortion rate comparison after the distortion processing algorithm corrected is shown in Figure 10, which is the distortion rate comparison data of the 7 grid points in the first row of the grid map.

From Figure 10, we can see that the distortion rate of the grid map that has not been optimized by the algorithm is very high. Although the distortion rate of the grid map optimized by the Oculus anti-distortion algorithm has decreased significantly, the distortion rate still exists. It shows that there is still slight distortion in the grid graph, and the grid graph optimized and corrected by our algorithm, the distortion rate has been reduced to 0\%, which shows that our algorithm has higher correction accuracy and better correction effect.

In this part, we perform anti-distortion processing on selected 10 different scene pictures. These 10 scenes can cover the scenes we see in daily life, such as streets, buildings, and people. Some scenes contain straight lines and arcs in these 10 pictures, and some scenes do not. Figure 11 shows the correction effect of our algorithm. The left image is the original image of different scenes, the middle image is the image corrected by the Oculus anti-distortion algorithm, and the right image is the image corrected by the correction algorithm we proposed. From the experimental results, we can see that our algorithm can accurately correct the image to a very good effect regardless of whether the scene contains feature points such as straight lines and arcs. Oculus anti-
distortion algorithm has a good effect in correcting landscape and portrait scenes, and when there are a large number of straight-line segments in the scene, it can be seen that there are still a lot of poor correction effects in the scene, and there is insufficient restoration, distortion has not been eliminated. This shows that our algorithm can have a good correction effect when dealing with different scenes.

We propose a method suitable for solving the distortion of the displayed image in VR devices. The algorithm we propose can process any unknown image and video content, without pre-calibration of the VR device, and there is no requirement for the number of sampled pictures in the estimation process, and it is extremely robust and accurate. The comparison experiment with Oculus' anti-distortion algorithm verifies that our algorithm has a more accurate correction effect, and has parameter adaptability, which can have a very accurate correction effect in different images. Therefore, this method is very suitable for application in the display algorithm of the VR all-in-one machine and can solve the distortion problem very robustly and accurately, as shown in Figure 12.

Compared with other network topologies, the lattice network has the following advantages: high efficiency and direct access, and convenient expansion. The lattice network can be expanded at any point. When a certain span fails or is congested, there is no need to change the other spans, just change the current; it can fight against multiple failures. The connectivity of each node in the trellis network is greater than 1, which means that even if some links fail, the network function can still be achieved through other continuity; more effective spare bandwidth utilization efficiency. Due to these advantages, the lattice network is more widely used in real life, and the tree network has the characteristics of easy expansion and easy isolation of obstacles, as shown in Figure 13.

The realization of the functions of the college asset management system based on the Internet of Things technology is based on the Internet of Things technology as the core, and the system hardware is based on the cloud edge router to build a complete college asset management system.

V. CONCLUSION

This article uses virtual reality technology to visually manage assets in the Internet of Things environment. This article focuses on the construction of the Internet of Things in colleges and universities and conducts exploratory research on technology selection, hardware design, network construction, algorithm optimization, and software development. In practice, beneficial attempts have been carried out. In the research process, the university’s asset management visualization system is used to provide a good experimental practice platform for university management to improve their IoT technology application level; at the same time, it provides a scientific research platform for IoT application research through innovation and practice. The training room promotes better scientific research communication between teachers and researchers and provides an intelligent, safe, and visual management platform for teachers, students, and managers. Through the asset management system of colleges and universities, a comprehensive information service platform integrating information integration, collection, transmission, and
release is provided for the teachers and students of the school to realize the digitization, and intelligence of the physical environment, resources, activities, teaching management to improve the campus. The efficiency of management, to realize the comprehensive information of the teaching process, to achieve the purpose of improving the level of teaching management and teaching efficiency.

REFERENCES

[1] C. Gomez, S. Chessa, A. Fleury, G. Roussos, and D. Preuveneers, “Internet of Things for enabling smart environments: A technology-centric perspective,” J. Ambient Intell. Smart Environ., vol. 11, no. 1, pp. 23–43, Jan. 2019.

[2] A. Darwish, A. E. Hassanien, M. Elhoseny, A. K. Sangaiah, and M. Yamin, “Preserving privacy management and teaching efficiency.”

[3] H. Son, S. Ha, R. Kumar, J. M. Chatterjee, and M. Khari, “Collaborative handshaking approaches between Internet of computing and Internet of Things towards a smart world: A review from 2009–2017,” Telecommun. Syst., vol. 70, no. 4, pp. 617–634, Apr. 2019.

[4] A. T. Chatfield and C. G. Reddick, “A framework for Internet of Things-enabled smart government: A case of IoT cybersecurity policies and use cases in U.S. federal government,” Government Inf. Quart., vol. 36, no. 2, pp. 346–357, Apr. 2019.

[5] G. Misra, V. Kumar, A. Agarwal, and K. Agarwal, “Internet of Things (IoT)—A technological analysis and survey on vision, concepts, challenges, innovation directions, technologies, and applications (an upcoming or future generator communication system technology),” Amer. J. Electr. Electron. Eng., vol. 4, no. 1, pp. 23–32, Feb. 2016.

[6] B. Li and Y. Li, “Internet of Things drives supply chain innovation: A research framework,” Int. J. Org. Innov., vol. 9, no. 3, pp. 71–92, Jan. 2017.

[7] C. K. Ng, C. H. Wu, K. L. Yip, and T. Cheung, “A semantic similarity analysis of Internet of Things,” Enterprise Inf. Syst., vol. 12, no. 7, pp. 820–855, Aug. 2018.

[8] C. T. Lai, P. R. Jackson, and W. Jiang, “Shifting paradigm to service–dominant logic via Internet-of-Things with applications in the elevators industry,” J. Manage. Anal., vol. 4, no. 1, pp. 35–54, Jan. 2017.

[9] R. Hassatnab, R. Najafi, and D. G. Armstrong, “Health sensors, smart home devices, and the Internet of medical things: An opportunity for dramatic improvement in care for the lower extremity complications of diabetes,” J. Diabetes Sci. Technol., vol. 12, no. 3, pp. 577–586, May 2018.

[10] H. Lee, O. Na, Y. Kim, and H. Chang, “A study on designing public safety service for Internet of Things environment,” Wireless Pers. Commun., vol. 99, no. 2, pp. 441–459, Mar. 2017.

[11] W. Serrano, “Digital systems in smart city and infrastructure: Digital as a service,” Smart Cities, vol. 1, no. 1, pp. 134–154, Dec. 2018.

[12] S. N. V. Yuan and H. H. S. Ip, “Using virtual reality to train emotional and social skills in children with autism spectrum disorder,” London J. Primary Care, vol. 10, no. 4, pp. 110–112, Jul. 2018.

[13] H. Habibzadeh, K. Dinesh, O. R. Shishvan, A. Boggio-Dandry, G. Sharma, and T. Soyata, “A survey of healthcare Internet of Things (HIoT): A clinical perspective,” IEEE Internet Things J., vol. 7, no. 1, pp. 53–71, Jan. 2020.

[14] S. Balakrishnan, S. S. Rani, and K. C. Ramya, “Design and development of IoT based smart aquaculture system in a cloud environment,” Int. J. Oceans Oceanogr., vol. 13, no. 1, pp. 121–127, Oct. 2019.

[15] P. M. Kumar, U. Gandhi, R. Varatharajan, G. Manogaran, R. Jidhesh, and T. Vadivel, “Intelligent face recognition and navigation system using neural learning for smart security in Internet of Things,” Cluster Comput., vol. 22, no. S4, pp. 773–7744, Jul. 2019.

[16] A. A. A. Sen, F. A. Eassa, K. Jambi, and M. Yamin, “Preserving privacy in Internet of Things: A survey,” Int. J. Inf. Technol., vol. 10, no. 2, pp. 189–200, Jun. 2018.

[17] H. Samih, “Smart cities and Internet of Things,” J. Inf. Technol. Case Appl. Res., vol. 21, no. 1, pp. 3–12, Jan. 2019.

[18] D.-H. Shin, “The role of affordance in the experience of virtual reality learning: Technological and affective affordances in virtual reality,” Telematics Infomat., vol. 34, no. 8, pp. 1826–1836, Dec. 2017.

[19] Y. S. Yoon, H. Zo, M. Choi, D. Lee, and H.-W. Lee, “Exploring the dynamic knowledge structure of studies on the Internet of Things: Keyword analysis,” ETRI J., vol. 40, no. 6, pp. 745–758, Dec. 2018.

[20] C. E. Mora, J. Martín-Gutiérrez, B. Astorbe-Díaz, and A. González-Marrero, “Virtual technologies trends in education,” EURASIA J. Math., Sci. Technol. Educ., vol. 13, no. 2, pp. 469–486, Jan. 2017.

[21] N. Chung, H. Lee, J.-Y. Kim, and C. Koo, “The role of augmented reality for experience-influenced environments: The case of cultural heritage tourism in Korea,” J. Travel Res., vol. 57, no. 5, pp. 627–643, May 2018.

[22] A. Milosavljević, D. Rančić, A. Dimitrijević, B. Predić, and V. Mihajlović, “Integration of GIS and video surveillance,” Int. J. Geograph. Inf. Sci., vol. 30, no. 10, pp. 2089–2107, Oct. 2016.

[23] S. C. H. Li, P. Robinson, and A. Oriade, “Destination marketing: The use of technology since the millennium,” J. Destination Marketing Manage., vol. 6, no. 2, pp. 95–102, Jun. 2017.

[24] N. Elmnaïd, “Augmented reality and virtual reality in education. Myth or reality?” Int. J. Emerg. Technol. Learn., vol. 14, no. 3, pp. 234–242, Feb. 2019.

[25] G. Papastasitaoiu, A. Drigas, C. Skianis, M. Lytras, and E. Papastasiti, “Virtual and augmented reality effects on K-12, higher and tertiary education students’ twenty-first century skills,” Virtual Reality, vol. 23, no. 4, pp. 425–436, Dec. 2019.

[26] M. Brengman, K. Willems, and H. Van Kerrebroeck, “Can’t touch this: The impact of augmented reality versus touch and non-touch interfaces on perceived ownership,” Virtual Reality, vol. 23, no. 3, pp. 269–280, Sep. 2019.

[27] M. Farshid, J. Paschen, T. Eriksson, and J. Kietzmann, “Go boldly!! Explore augmented reality (AR), virtual reality (VR), and mixed reality (MR) for business,” Bus. Horizons, vol. 61, no. 5, pp. 657–663, Sep. 2018.

[28] D. T. Dieck, M. C. T. Dieck, T. Jung, and N. Moorthouse, “Tourists’ virtual reality adoption: An exploratory study from lake district national park,” Leisure Stud., vol. 37, no. 4, pp. 371–383, Jul. 2018.

[29] S. Kang and S. Kang, “The study on the application of virtual reality in adapted physical education,” Cluster Comput., vol. 22, no. S1, pp. 2351–2355, Jan. 2019.

[30] F. Izzo, “Museum customer experience and virtual reality: H BOSCH exhibition case study,” Mod. Economy, vol. 8, no. 4, pp. 531–536, Apr. 2017.

[31] N. M. D’Cunha, D. Nguyen, N. Naumovski, A. J. McKune, J. Kellett, E. N. Georgousopoulou, J. Frost, and S. Isbel, “A mini-review of virtual reality-based interventions to promote well-being for people living with dementia and mild cognitive impairment,” Gerontology, vol. 65, no. 4, pp. 430–440, 2019.

[32] L. Qin, N. Yu, and D. Zhao, “Applying the convolutional neural network deep learning technology to behavioural recognition in intelligent video,” Tehnički Vjesnik, vol. 25, no. 2, pp. 528–535, 2018.

[33] X. Chen and J. Hu, “A review of haptic simulator for oral and maxillofacial surgery based on virtual reality,” Expert Rev. Med. Devices, vol. 15, no. 6, pp. 435–444, Jun. 2018.

[34] J. H. Park, C. Lee, E. Yoo, and Y. Nam, “An analysis of the utilization of Facebook by local Korean governments for tourism development and the network of smart tourism ecosystem,” Int. J. Inf. Manage., vol. 36, no. 6, pp. 1320–1327, Dec. 2016.

[35] P. Buonincontri and R. Micera, “The experience co-creation in smart tourism destinations: A multiple case analysis of European destinations,” Inf. Technol. Tourism, vol. 16, no. 3, pp. 285–315, Sep. 2016.
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