ISSN: 2664-9640

Design and implementation of smart campus environment monitoring based on digital twin technology

Yuhang Rui, Haiying Jian, Xiaolong Zhuo, Yi Yuan and Tianhe Duan

[1]School of Wuzi University, Beijing, China;

[2] School of XinXi, WuZi University, China

Abstract

With the development of Internet of Things technology and digital twin technology, the construction of smart campus continues to deepen, campus environment monitoring has gradually become one of the important aspects of school management. In view of many problems existing in the traditional campus environment monitoring method, such as low monitoring accuracy, poor real-time data, etc., digital twin technology and Internet of Things technology are introduced to design and realize the smart campus environment monitoring system, which is composed of Virtualization Engine The system can help carry out comprehensive real-time monitoring and fine analysis of the campus environment, and achieve the purpose of supporting the school administrators to realize the intelligent management and decision-making of the campus environment.

Keywords

Digital twin technology, smart campus, environmental monitoring, system design, data visualization and interaction.

1. Introduction

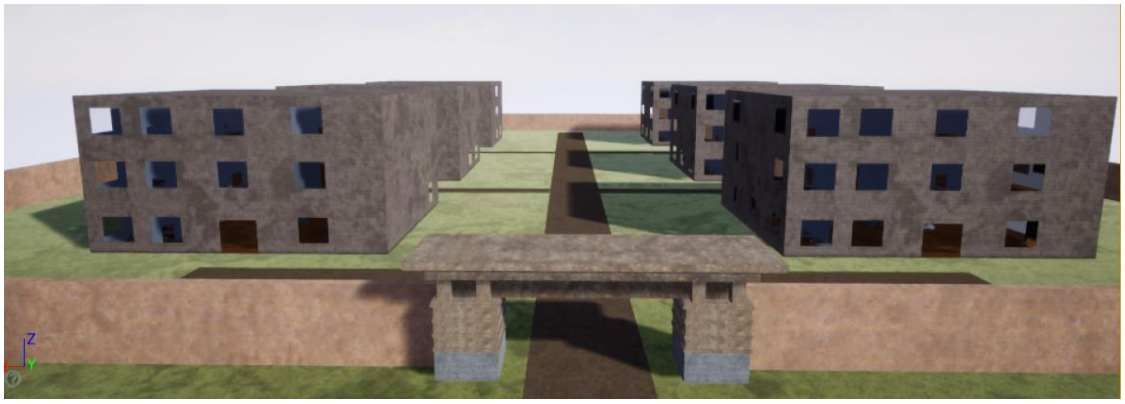
Under the background of education digitization, which aims to improve the quality and efficiency of education through digital transformation through information technology, the combination and development of Internet of Things technology, digital twin technology and artificial intelligence technology has brought a new concept of "smart campus", and to create an intelligent and information campus is inseparable from the real-time monitoring and analysis management of campus environment. The design of " smart campus" takes improving the safety, comfort and sustainable development of the campus environment as the principle, in order to promote the correct and intelligent campus management decisions as the goal, and takes the Internet of Things, digital twin, cloud computing, 5G technology as the technical support to optimize and upgrade the problems of traditional campus environment management. The focus is on building a sustainable high-level and excellent structure of the smart campus environment management system to promote the development and progress of education digitization.

2. Basic theories and concepts

Digital twin refers to the creation of a virtual model corresponding to an actual physical system or process through digital technology and analog modeling. Such models can accurately reflect the structure, behavior and performance of the physical system, and can be updated and interact with the real system in realtime. Digital twins can be used to predict and optimize the operation of the system, provide decision support, conduct fault diagnosis and maintenance planning, and conduct virtual simulations and experiments, among other applications. A digital twin is a digital mapping system made up of one or more important, interdependent equipment systems. With

ISSN: 2664-9640

digital twins, we can better understand and manage actual systems, increase efficiency, reduce costs, and drive innovation and continuous improvement. Digital twin technology collects all kinds of data of campus environment in realtime, and reflects it into the digital model, so that the digital model can highly restore the physical environment, so as to more accurately reflect the actual environment, and provide better data support for environmental monitoring. Through the simulation and analysis of the virtual model, thesystem can realize the prediction and optimization of the campus environment. In order to more effectively control environmental pollution, energy conservation and other issues, improve the quality and sustainability of the campus environment, but also to achieve all kinds of security risks and emergencies forecast and response, so as to effectively improve the campus security management and emergency rescue capabilities. At the same time, the rapid and vigorous development of Internet of Things technology has also laid a solid foundation for the application of digital twin technology in various fields, and the combination of Internet of Things technology and digital twin technology has laid a foundation for the analysis and optimization of physical information and the realization of effective seamless connection between data, which has important application value and significance for intelligence and digitalization.



3. Design of digital twin campus environment monitoring system

The design of digital twin campus environment monitoring system is a system for real-time monitoring of campus environment. The following is the design scheme of a basic virtual engine:

3.1. Sensor network

By placing sensors in the campus environment, such as temperature sensors, humidity sensors, CO2 sensors, etc., for real-time monitoring of environmental parameters. Sensor data can be

ISSN: 2664-9640

transmitted to the model through the Internet of Things technology. This project checks the environmental data of the teaching building by placing XX sensor in the teaching building.

3.2. Data acquisition and transmission

Data acquisition is to collect and send electrical signals or non-electrical signals to the computer through the sensor. The Internet of Things technology and data acquisition system are used to collect, integrate and store the data collected by the sensor. Data, including environmental data, equipment condition data, energy consumption, etc., can be used for subsequent analysis and modeling.

3.3. Digital twin modeling

The establishment of digital twin modeling requires proper analysis of the collected data and the actual situation of the campus environment. The model can include campus buildings, facilities, energy system, etc., such as temperature, humidity, light and other campus environmental factors. This project uses Unreal Engine to build a teaching building model. Unreal Engine can provide highly realistic graphics rendering and lighting effects, making the teaching building model look more real and vivid.

3.4. Central server

The server provides the function of data storage, protecting the security of data and allowing users to access and process it at anytime. In this project, the server is also a key, it is the steward of the whole system, supervise the storage and transfer of information.

3.5. Data processing and analysis

The central server processes and analyzes the received data, extracts the key information, and generates reports based on temperature changes, equipment data and other information. By analyzing the data in the digital twin model, the operating status and trend of the campus environment can be obtained.

3.6. Visual interface

The system can provide a visual interface for campus administrators and students to view real-time environmental data and reports. Through the visual interface and interactive operation, the results of the digital twin model can be displayed to users. Through the interface, users can view the status and data of the campus environment in real time and perform operations, adjust equipment Settings, view historical data, etc.

3.7. Early warning and notification

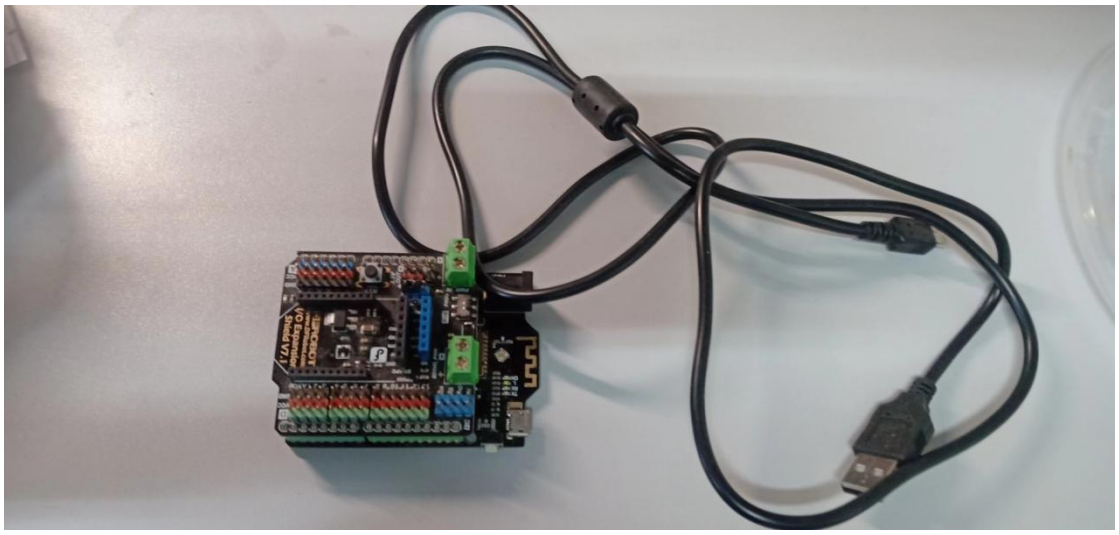
The system can compare the digital twin model with real-time data to realize real-time monitoring and early warning of the campus environment. Campus management personnel can set the safety value, when the detected environmental parameters exceed the set threshold, the system can automatically send an early warning signal to remind the relevant personnel to take corresponding measures.

3.8. Data storage and analysis

The system can store historical data and use it to generate trend charts and predictive models to help campus administrators make decisions.

In general, a smart campus environment based on digital twin technology can enable real-time monitoring, data analysis, optimized decision making and interactive operations to improve the efficiency, sustainability and user experience of the campus environment. The digital twin campus environment monitoring system is designed to provide real-time and accurate campus environment data, help campus administrators monitor and improve the quality of the campus environment, and improve the quality of life and work of students and employees.

ISSN: 2664-9640



4. Visual interaction can be achieved in the following ways

4.1. 3D model display

Visual interaction can present the campus environment in the form of a 3D model, and users can navigate through the virtual reality device or the controller on the computer screen. In this way, users can freely move and browse the campus environment, view the detection data of different areas, and interact with the model.

4.2. Data visualization

The data in the digital twin is presented in the form of charts, graphs or heat maps to help users analyze and understand the distribution, trends and associations of the data.

Through visual interaction, the system can display the real-time data of campus environment monitoring in the form of graphs, charts or animations. For example, a virtual map can be used to display the temperature, humidity, air quality and other data in each area of the campus, and users can select the data of different areas or time periods to view through interactive means

4.3. Real-time monitoring and early warning

the digital twin model can be compared and updated in real time with the data of the actual system, and users can monitor the status and performance of the system in real time through the visual interface. When the system is abnormal or reaches the warning threshold, the visual interface can remind the user in time and display the corresponding alarm information.

4.4. Data analysis and decision support

Through visual interaction, the system can analyze and display campus environment detection data to help users better understand data trends and correlations. Users can choose different data dimensions, time periods or regions for analysis through interactive means to support campus environment management and decision making.

In general, visual interaction in the digital twin campus environment detection system can achieve real-time data display, three-dimensional environment navigation, alarm and early warning system, data analysis and decision support and other functions. These functions can improve users' perception and understanding of the state of the campus environment and help them make corresponding management and decisions.

ISSN: 2664-9640

5. Conclusion

In this paper, we study the smart campus environment test based on digital twin technology, and get some important research results. Through the application of digital twin technology, we successfully set up a virtual model of simulated campus environment, and conducted a comprehensive test and analysis on it.

Our research results show that digital twin technology has great potential in smart campus environment testing. It can help schools and educational institutions better understand how the campus environment operates, optimize resource allocation, and enhance the experience of students and staff.

However, we are also aware that digital twin technology still has some challenges and limitations in the smart campus environment test. For example, the complexity of data collection and processing, accuracy of model building and other aspects still need further research and improvement.

Therefore, we suggest that future research can focus on the following aspects: First, further improve the construction methods of digital twins to improve the accuracy and reliability of the models. Secondly, strengthen the collection and processing technology of campus environmental data to improve the quality and availability of data. Finally, explore the wider application of digital twin technology in smart campus management, such as campus security monitoring, energy management and other fields.

In conclusion, the research of this paper provides the basic theory and reality for the smart campus environment test based on digital twin technology, and provides some useful viewpoints for research and future use. We believe that in the near future, digital twin technology will play an increasingly important role in the construction of smart campuses and contribute to improving the education level and the effectiveness of school management.

References

[1] Wang Wuying, Wei Linjing. Design and implementation of intelligent agricultural environment monitoring system based on digital twin.

[2] 3D visualization network simulation platform based on digital twin technology.