International Journal of Smart Home
Vol.10, No.12 (2016), pp.213-220
http://dx.doi.org/10.14257/ijsh.2016.10.12.20

Research on Smart Campus Based on the Internet of Things and Virtual Reality

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Abstract

Smart campus is an inevitable trend in the development of digital campus construction. With the development of the Internet of Things (IoT) and Virtual Reality (VR) technology, these technologies become the key to the construction of smart campus. The major objective of this study put forward a smart campus system prototype based on Internet technology. This paper firstly introduces the definition and characteristics of the IoT and VR technology. Secondly, presents the architecture and implementation methodology of the system prototype, and analyzes the core idea of smart campus. Finally, discuss the problems should be noticed in the smart campus construction.

Keywords*: Internet of Things, Virtual Reality, Smart Campus*

1. Introduction

Smart campus is an intelligent and smart environment of teaching, learning and living, which is based on the Internet technology and application services. It consists of teaching, research, management and campus life [1]. Smart campus is an inevitable trend in the development of digital campus construction. It is a new development stage of educational information, and it is a long-term systematic process [2]. A number of studies have been conducted during the construction of smart campus in recent years. At present, the construction of smart campus still in exploration and innovation stage, in practice still faces many problems. A great variety of new things come with the constant development of the Internet. In recent years, with the continuous development of the Internet of Things (IoT) and Virtual Reality (VR) technology, the techniques are being applied almost everywhere [3]. People's lives and therefore more and more comfortable and convenient.

1.1. The Internet of Things

The IoT represents one of the most significant disruptive technologies in this century, consisting of an emerging global Internet-based technical architecture [4-5]. The concept of the IoT is proposed in the Auto-ID Center at the Massachusetts Institute of Technology in 1999 [6]. There is no universal definition for the IoT, the Auto-ID Center envisions a world in which all electronic devices are networked and every object, whether physical or electronic, is electronically tagged with information pertinent to that object. The core concept is that everyday objects can be equipped with identifying, sensing, networking and processing capabilities that will allow them to communicate with one another and with other devices and services over the Internet to achieve some useful objective. So far,

ISSN: 1975-4094 IJSH

the IoT has been launched as demonstration applications in different fields, including intelligent industry, intelligent agriculture, smart grid, environmental protection [7], security protection, intelligent medical care, smart home, and smart cities [8-9].

1.2. Virtual Reality

VR, also known as computer-simulated reality or immersive multimedia [10], is a computer technology that replicates an environment, real or imagined, and simulates a user's physical presence that environment in a way that allows the user to interact with it. VR creates sensory experience, which can include sight, touch, hearing, and smell. Recent decades, VR technique develops rapidly and has been applied in several fields such as military applications, aerospace application, medical service, and the like [11]. As an important application area of VR technology, smart campus has gradually been valued by many colleges and universities [12].

In this paper, we describe a smart campus system prototype for effective management education. The aim of our study was to design and development a smart campus system prototype based on IoT and VR technology. The remaining of the paper is organized as follows. We first review the characters and applications of the IoT and VR in various disciplines in Section 1. Then, we present the smart campus system prototype design specifications in Section 2. Experiments and results are reported in Section 3, followed by discussion and conclusions in Section 4 and Section 5, respectively.

2. Methodology and Implementation

2.1. Objective

The overall objective of this study is to create a smart campus system model for efficient management, using IoT and VR technology. The system prototype should adhere to the following principles.

- ✧ Principle of high-efficiency responsiveness
- ✧ Principle of reliability
- ✧ Principle of standardization
- ✧ Principle of the compatible scalability
- ✧ Principle of friendly interface

2.2. Key Techniques

The construction of smart campus is a complicated project. It requires interdisciplinary technology, including computer, communication, electronics, material engineering, etc. Radio frequency identification (RFID) [13] and electronic product code (EPC) is necessary [14]. In system model through the EPC and RFID stores information, the data automatically submit to the central information system through a wireless communication network. Sensor technology will play a key role in connecting the actual physical world and virtual computing world, network technology achieves barrier free communication and data transmission.

2.3. System Prototype

According to the principle of the construction of smart campus and the IoT, smart campus system prototype architecture is proposed, include sensor layer, network layer, control layer and application layer. Figure 1 shows smart campus system prototype structure diagram.

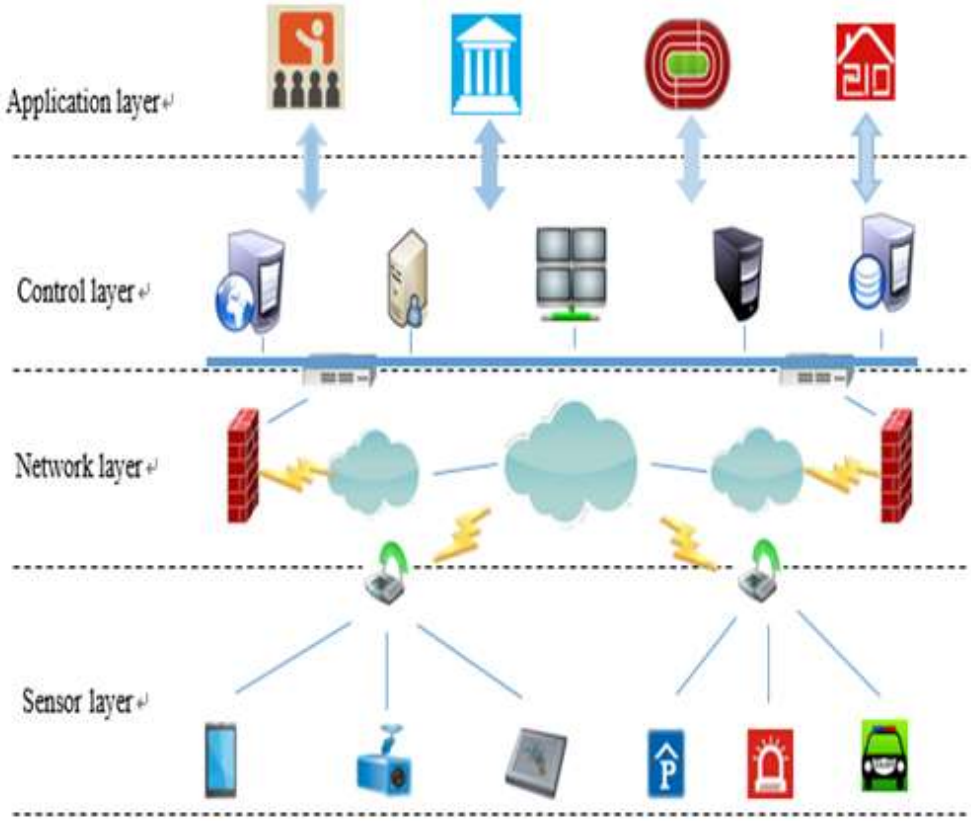

Figure 1. The Smart Campus System Prototype Structure Diagram

2.3.1. Sensor layer: Sensor layer is the core technology of the smart campus, it is the link between the physical world and the information world. Sensor layer includes not only the RFID, wireless sensor and other information automatic generation equipment, also includes a variety of intelligent electronic products used to generate information [15]. It mainly realizes the information collection function. Sensor nodes are deployed in different equipment. They access network layer, to provide database for the entire digital campus.

2.3.2. Network layer: Network layer is the basis of the information of the smart campus. The former is mainly composed of computer network and the communication network; the latter by all kinds of application server composition, main functions include the aggregation of data acquisition, forwarding, analysis, and presents the user with the appropriate distribution and event triggering [16]. Its main function is to perceive the layer of information through the Internet, cable, wireless communication network and other networks, real-time, accurate, safe and reliable delivery. At present, Internet, communication network and other technologies are more mature, basically able to meet the data transmission of the IoT.

2.3.3. Control layer: Control layer is the main function of the network layer to spread the massive data through the cloud computing technology for effective management and storage. In the face of massive information, how to effectively organize and query data is the core issue [17]. It is characteristics is the application of operational research principles, machine learning, data mining and expert system to achieve intelligent.

2.3.4. Application layer: Application layer is located above the entire networking system, but also the development of the system, it is the use of perception after data analysis and processing for the user to provide specific services. Application layer information is applied to the physical world (Wang et al., 2015). The realization of cross industry, cross system between the application. Since the service layer provides an intelligence service, this layer can develop the campus needs of each subsystem, but also can improve the campus network environment.

2.4. Implementation

2.4.1. 3D Model: 3D modeling is an important piece of the smart campus system prototype. There are different tools to generate 3D models and virtual scenes, such as 3ds Max, Maya and Blender. The choice of the modeling system dictates what type of geometry will appear in the system. In this study, the main tools for modeling are 3ds Max 2016 [18]. The specific steps are as follows: 1) obtaining modeling data; 2) determining model structure; 3) carrying visual system model; 4) removing redundant polygons; 5) using texture mapping. The smart campus model can be obtained through the above steps. Figure 2 shows rending effect of two buildings.

Figure 2. Rendering of the Build

2.4.2. Unity 3D: Unity3D is chosen as the platform for smart campus system prototype. Unity3D is one of the most famous virtual reality tools, it is cross-platform game development software [19]. Unity 3D supports three scripting languages: JavaScript, C# and Python. In this study, smart campus models are imported by using the Unity 3D editor. After the campus modeling import to the system, using scripting language to process data collected by sensors.

2.4.3. System Development: The application system prototype of smart campus is a distributed multilayer software and hardware architecture, so the development of the software system should follow the idea of "unified structure, layer by layer management". The smart campus uses the design method of business logic, data, interface display, which is conducive to the analysis and reuse of modules, the use of interfaces between layers of interaction, is conducive to the expansion of the system. Figure 3 shows the system structure diagram.

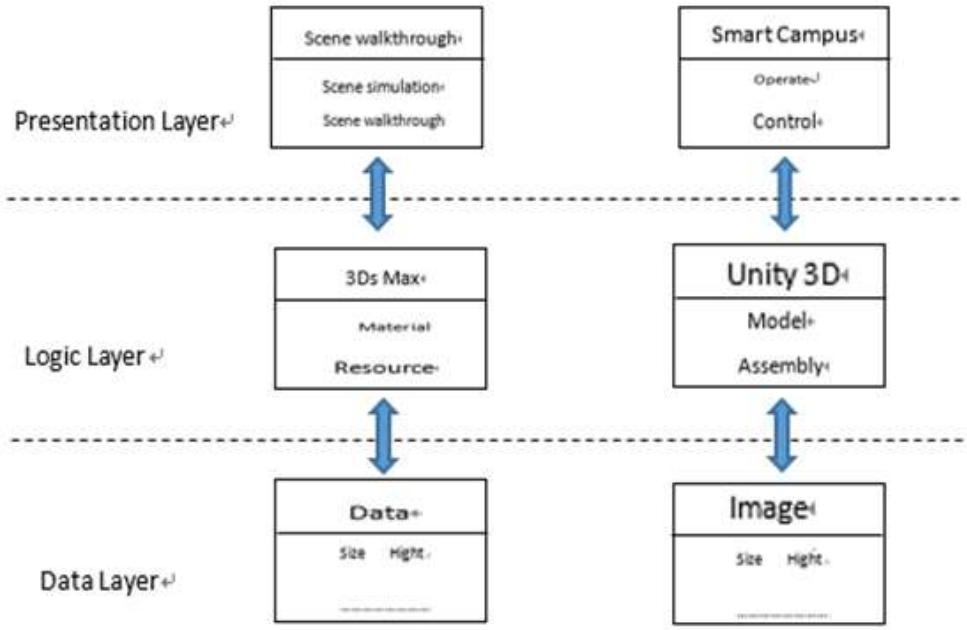

Figure 3. The System Structure Diagram

The system is divided into three layers: data layer, logic layer and presentation layer. In the data layer, the data is divided into raw data and image data. The original data for 3D model of the real data, including a building category, name, size, size, height, distance, location and other, these data and graphic data further to in the smart campus. In the logic layer, the control module is mainly composed of the logical control module to control the interaction between the elements. The construction process of smart campus, including the use of the underlying data for coupling, making the original data and image data has a certain relevance. Provide 3D engine, can add containers and components, write scripts to achieve the control of three-dimensional model. The script includes motion control script, information query script, such as the trajectory, direction, angle of view and so on. In the presentation layer, the main human-computer interaction interface, including the input button, the output interface and other basic functions. Interactive background data and signaling interaction, according to the user request, the logic layer processing results displayed to the screen, three-dimensional display.

3. Experimental Results

According to the above method, we design and develop the smart campus system prototype. Because the IoT application system development involves a variety of hardware and software design elements, so its performance testing is different from other application system complexity and uncertainty, in to test the capability of the system to take into account related to various subjects at different levels and through sufficient scale test objects, comprehensive enough testing sessions were repeated operation and performance evaluation. In order to test our approach and evaluate its potentials, a simple experiment was executed and some results analyzed. At hardware, repeated selection of hardware device of practical use to verify its ability to achieve the expected functionality and performance requirements, involving objects including read card reader to read and write tag stability, fault tolerance and security of, the electronic tag information scalability, wireless communication equipment of the transmission efficiency and

reliability. At software, the roaming function and data visualization function of the system were tested. The hardware consisted of a computer with an Intel Core Quad CPU Q6700, 4GB of RAM, and a GeForce 8800GT and the operate system is Windows 7 SP1 32 bits. At last, the result of the system shows that the method is feasible in this study. The system interface and working effect chart were shown in Figure 5 and Figure 6.

Figure 6. The System Interface

Figure 7. The System Working Effect Chart

4. Discussions

Smart campus is based on the IoT and VR technology. Despite rapid growth, smart campus system prototype is rapidly still its issues. The smart campus system in the early stage of industrial development, the lack of a unified standard system and industrial model, the development of networking technology and industrial diversification and scale. In the process of building a smart campus, Lack of uniform standards hinders the addition of new features on the smart campus. Sensor technology research is still in the initial stage of development, the import equipment's price is higher, concentrate on the minority enterprise. In addition, there is a large amount of information and data in the device. The existence of the risk of data leakage.

5. Conclusions

Smart Campus is an intelligent and smart environment of teaching, learning and living, which is based on the IoT and application services. It consists of teaching, research, management and campus life. Smart campus is an important part of digital campus. In this paper, we describe a smart campus system for effective management education. The aim of our study was to design and development a smart campus based on IoT and VR technology. Through these technologies, the collected data information is displayed through the virtual campus visualization platform. This study is only the preliminary results of our study and test the function of a small part. A complete system requires cross disciplinary knowledge. The next step is to Co-data mining software with the system together, the virtual reality system will possess the sophisticated analysis functions of data analysis when the whole work is finished.

Acknowledgements

Xiaoming Bi and Youliang Huang contributed equally to this work. Xiaoming Bi is Corresponding author This work is supported in part by grants Committee of Security Studies, Beijing Association of Higher Education (2015), and Beijing University of Chinese Medicine (Grant No. 2015-JYB-JSM052).

Conflicts of interest

The authors declare that there is no conflict of interests regarding the publication of thi s paper.

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