



# The Research on Architecture and Key Technology in Constructing Digital Twin Campus in Education Metaverse

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**Abstract.** At present, as the most cutting-edge concept in the development of information technology, Metaverse has comprehensively applied advanced technologies such as 5G communication, XR mixed reality, and digital twin to build a virtual digital world that meets the future needs of mankind. In the application scenarios of the Metaverse, the Education Metaverse can effectively utilize the characteristics of the immersive experience of the Metaverse, bringing a new user experience to the teaching process and students' use. This paper aims to explore the introduction of advanced technology to build a digital twin campus on the basis of traditional smart campuses, so as to provide new ideas and references for university display and new assistance for publicity and promotion in the process of school selection.

**Keywords:** education metaverse · digital twin campus · key technologies

## 1 Introduction

In the current construction and development process of vocational colleges, the campus is no longer just a physical carrier for the activities of teachers and students, but an integrated digital space that combines the virtual information world. Using the carrier of the metaverse, integrating artificial intelligence, virtual reality, digital twins and other technologies to provide learners with rich information resources as a carrier, so that students can carry out cognitive architecture and innovation on this basis, which is the current development of education metaverse. The trend of. Based on this trend, it is particularly critical to build a new smart campus model that can cover all campus scenarios and fully assist all staff, the whole process, and the implementation of all-round education. This paper aims to explore the realization of this goal through digital twin technology. Study the architecture that should be followed in the implementation process and the key technologies required.

## 2 Introduction to Educational Metaverse Scenarios

Through research, the author believes that the metaverse, as a new digital space carrier, has the following three characteristics: the root is in the data, formation lies in

the acquisition and presentation lies in the virtual. The education metaverse and the new applications generated by the integration of education in the development of the metaverse, through the structure of the metaverse, build a new learning environment for students and teachers, and allow teachers and students to participate in a new way through immersive experience. During the learning process [2–4]. On the one hand, the construction of the teaching metaverse is rooted in the classroom, and the teaching environment is innovated through technologies such as virtual reality, so that teachers and students can teach in different teaching environments, from the perception environment, information environment, psychological environment, cultural environment. Innovating the teaching process of traditional classrooms on multiple levels, thereby effectively improving the efficiency of modern teaching and student learning; on the other hand, it is the innovation of the construction of traditional smart campuses. Through the construction of metaverse scenarios, smart campuses will no longer stay. At the level of traditional hardware upgrades, it is to truly achieve intelligent upgrades, so that smart campuses can truly serve teaching [5].

### **3 Architecture and Key Technologies of Digital Twin Campus**

#### **3.1 Characteristics of Digital Twin Technology**

The digital twin technology, which originated in aerospace and advanced manufacturing, is gradually being combined with educational applications as the education field pays more and more attention to information technology [6].

Digital twin technology is a technology that uses virtual modeling technology combined with IoT sensors to collect relevant data of physical entities, and comprehensively performs simulation modeling of physical entities based on historical data accumulation. It has real-time synchronization, twin mapping, faithful restoration, etc. Characteristic is a technical means to establish a connection and feedback mechanism between the physical world entity and the virtual world model. As the mirror image of the virtual world to the physical entity, it reflects the entire evolution process of the corresponding physical entity [7].

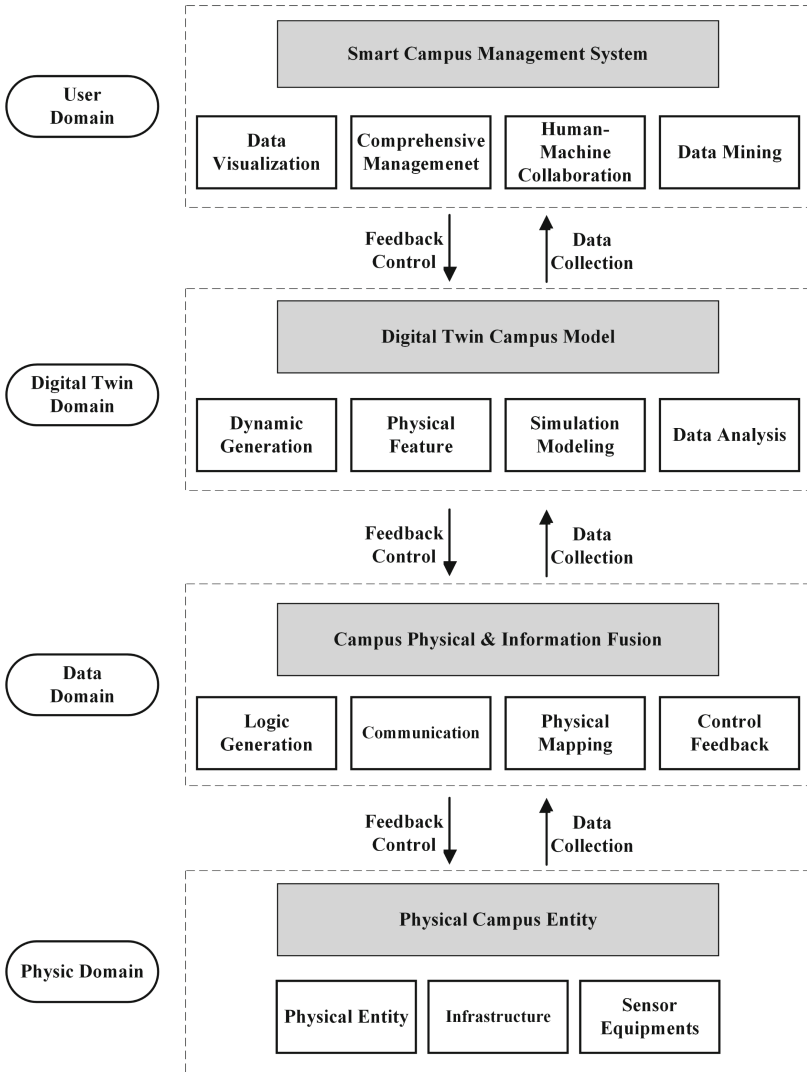
#### **3.2 Architecture of Digital Twin Campus**

The core of the construction is to build a digital twin campus model with comprehensive information perception, effective data collection, effective decision fusion, and real-time control. According to the typical digital twin model architecture, this paper divides the digital twin campus model into four layers, from top to bottom. The following are the campus intelligent management platform, digital twin campus model, campus physical information fusion, and campus physical entities, as shown in the Fig. 1 [8].

#### **3.3 Key Technologies of Digital Twin Campus**

##### **3.3.1 IoT Technology**

At the bottom layer of the digital twin campus model, various sensors need to be used to collect and upload the logistics, power, flow of people, access control and other states



**Fig. 1.** Architecture of the digital twin campus

during the operation of the campus. Smart devices are connected to realize human-machine interconnection and machine interconnection, forming an information network covering the entire physical entity level. Relying on the Internet of Things technology, comprehensive perception of campus operation information and access to smart devices can be realized, so that the digital twin campus can display the actual situation of the campus and realize related control of the campus.

In the research, the research team used a IoT modified campus as reference. The IoT modification includes smart sensors and controllers in classroom, behavior-analysis and security camera, classroom smart monitor and face recognition smart access control. The

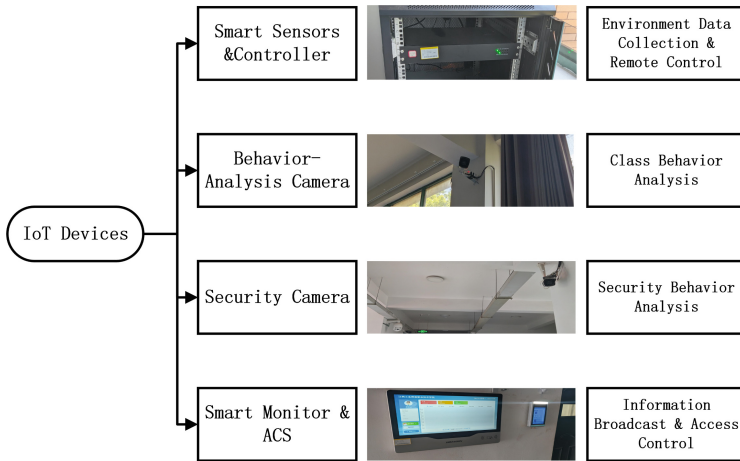


Fig. 2. IoT devices in digital twin campus

smart sensors can automatically collect environment data such as luminosity, temperature, humidity and so on. The smart controller can link to center sever and be controlled via internet. The behavior-analysis camera is capable of analyzing both teacher and student behavior during classes, which will provide information for campus teaching management. The smart monitor can display both course and teacher information for students’ viewing, and could act as attendance machine for classes [9] (Fig. 2).

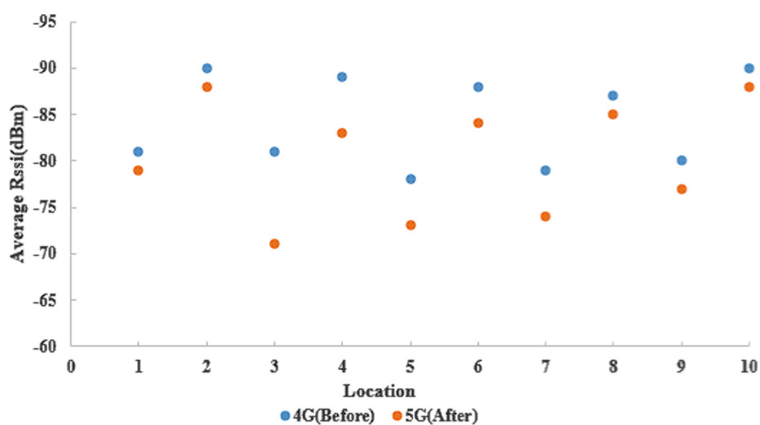
### 3.3.2 Extended Reality Technology

In the campus intelligent management platform, the process of data display should be real-time, immersive, and intuitive. At this time, the failures that traditional plane 3D modeling can provide is very limited, but relying on extended reality technology for display can greatly enrich The dimension and depth of data display allows users to experience the actual utility of the digital twin campus more deeply when using the platform. At the same time, in the teaching process, expanding reality technology is also an important boost to the current information-based teaching reform, which enables teachers and students to experience the actual work process more intuitively and truly master some technical skills in specific work scenarios.

In this research, the whole campus has already been photographed and constructed as a virtual campus. The virtual reality interface provides a comprehensive overview of the entire campus, which makes it possible to show different information about the running status of the campus.

### 3.3.3 5G Communication Technology

In the process of digital twin modeling, uninterrupted data transmission and information exchange are required between the twin model and the underlying sensing and control equipment to ensure the real-time performance of the twin model. In the campus environment, the coverage of traditional Ethernet and wireless local area networks is insufficient,



**Fig. 3.** The analysis of average signal strength in different campus locations

and simple fieldbus or Zigbee and other wireless sensor network technologies have limited ability to transmit a large amount of data to devices such as high-definition cameras. Therefore, 5G mobile communication is used. Technology can effectively enable communication between smart devices and twin model platforms where needed on campus. At the same time, compared with 4G mobile communication, the high capacity and low latency characteristics brought by 5G are also more suitable for the data requirements of the digital twin model.

In the campus, 5G network of China Telecom is available, thus multiple sensors and security camera around campus was upgraded from 4G to 5G. By analyzing the data of average signal strength from ten different locations within the campus, it is clear to see that 5G tech has significantly increased the availability of network (Fig. 3).

### 3.3.4 Artificial Intelligence Technology

In the digital twin campus, in addition to the physical modeling of the campus environment, it also includes related modeling of the campus operation and teaching implementation. With the expansion of the campus scale, the campus operation and course teaching process are clarified purely by manual methods. The problems existing in the system require excessive energy and financial resources. The introduction of artificial intelligence technology to analyze the teaching situation, environmental information, equipment operation, etc. can effectively improve the practical application effect of the twin model and create favorable conditions for campus operation.

## 4 Conclusion

With the continuous development of information technology, the education metaverse has become the development trend of information-based teaching reform, and the construction of digital twin campuses is extremely critical in the process of constructing the education metaverse. Referring to the typical four-layer structure of the digital twin

model, this paper proposes and builds a digital twin campus model, including four layers of campus physical entities, campus physical information fusion, digital twin campus model, and campus intelligent management platform., artificial intelligence, extended display and other technologies have achieved efficiency improvement in the process of campus operation, which can effectively provide effective support for the construction of the education metaverse.

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