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Exploration of the Construction of Smart Laboratories in Universities

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***Abstract*—The "Internet +" strategy promotes the evolution of campus informatization construction in colleges and universities to the stage of smart laboratory. According to the actual needs of campus information environment construction, combined with the development status of a new generation of information technology, the concept of smart laboratory is defined and analyzed, the connotation of smart laboratory is expounded, the problems existing in the construction of smart laboratories in domestic universities are summarized, the relevant technical architecture of smart laboratories and the services they can provide are proposed, the basic construction needs of sensing equipment, connected equipment and application systems are analyzed, and the functional modules and key technologies of smart laboratories are elaborated in combination with current cases. It is described from the aspects of smart laboratory management, smart teaching and learning, and smart laboratory life. It provides a reference for the construction and deployment of smart laboratories, and looks forward to the application prospects of smart laboratories.**

***Index Terms*—Smart Lab; Universities; Experimental Construction**

I. Introduction

In recent years, the new generation of information technology represented by mobile Internet, Internet of Things, cloud computing, big data, virtual reality, artificial intelligence, and blockchain has developed rapidly, profoundly affecting all aspects of China's society. "Internet +" promotes the continuous evolution of economic forms and drives rapid social development. "Internet +" is not simply superimposed on "Internet" and various traditional industries, but creates a new economic development ecology through the deep integration of a new generation of information and communication technology and traditional industries.

The development of the information campus has gradually experienced networking, digitalization and informatization, and the smart laboratory is currently its latest stage. Universities have taken the lead in proposing the concept of smart laboratories, and more and more enterprises have also invested in the development and production of smart laboratory related products. However, due to various reasons, the current construction of smart laboratories has more or less some problems: technology and products lack of openness and compatibility, multiple information systems cannot be fully and effectively linked, there is no unified technical standard, the product function is single, does not have a perception function, the degree of intelligence of information exchange between different platforms is low, and the security system is not perfect.

Based on the construction practice of a smart laboratory project in a school, this paper designs a smart laboratory design scheme based on a new generation of information technology.

II. The Definition and Connotation of a Smart Lab

Smart Lab is a higher stage of digital campus development and a specific practice of a new generation of information technology in the campus ecological environment. It integrates the school's teachers, students, venues, equipment and other resources, as well as teaching, scientific research, management, service and other functions, with information technology, based on the idea of integration and intelligence, optimizes various resources on campus, and achieves the goal of improving the efficiency of the school's work. The connotation of smart lab is described from the following dimensions:

(1) Processing and analysis of massive data. The "wisdom" of the smart laboratory is reflected in its powerful ability to collect, store, process and analyze data. Through cloud computing and big data technology, it realizes effective storage and efficient analysis of massive heterogeneous data, and provides data support for intelligent management services.

(2) All-round environmental perception. A large number of perception terminals are arranged on campus, and various information data in the campus environment are captured through GPS, RFID, wireless sensor network, infrared, video recognition, mobile phone positioning and other technologies, and access to the network. Environmental perception is the foundation and premise for realizing intelligent campus management and improving management quality.

(3) Intelligent management services. That is, based on big data and artificial intelligence technology, it provides a comprehensive information service platform for the campus and a data statistics and analysis auxiliary decision-making system for the school.

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III. CURRENT PROBLEMS

At present, there are some common shortcomings in the construction of smart laboratories, mainly including the following problems:

(1) Construction-leading issues. Smart Lab is a completely new concept with many participants, usually involving governments, education authorities, schools, communication operators, equipment vendors, etc. Different subjects understand and interpret this from different angles. Smart Labs require deep-seated, accurate strategies that take into account all aspects of institutional construction. The planning of this strategy must be led by universities, and cannot rely on relevant communication operators and equipment vendors to lead and promote, and other subjects can be supported and participated as important technical forces.

(2) Data fusion problems. The smart laboratory involves many technologies, integrated equipment and manufacturers, follows different standards, and data formats are very different, and if there is no unified standard and data interface, it is not convenient for efficient management and centralized control. Therefore, overall planning in this area should be strengthened, so that perceived data can be shared and combined to improve the level of control.

(3) Backward compatibility issues. At present, various schools have more or less deployed information processing systems. The newly built smart laboratory management platform must consider the compatibility and connection with the original information system, integrate various digital resources, avoid duplicate investment and waste of resources, and reduce development costs.

(4) Team building issues. To build an effective smart laboratory, we must have a strong construction team. In reality, most colleges and universities lack professionals in the construction of smart laboratories, and most of them are teachers in school network centers. These teachers have insufficient practical experience and do not have a good understanding of smart laboratories, and it is difficult to effectively solve the overall grasp of smart laboratory construction and some difficult problems.

IV. SMART EXPERIMENT CONSTRUCTION

The establishment of an efficient Internet of Things technology solution to obtain laboratory education big data has opened an era of intelligent interconnection of all things, marking the arrival of intelligent interconnection. The Smart Lab will cooperate with pioneers in the artificial intelligence industry to jointly develop robot teaching assistants. These robots will realize natural language interaction mode, be able to answer questions during experiments, provide the necessary professional knowledge and valuable experience accumulated by industry experts or teachers, and use artificial intelligence to help experimental teaching. In the smart laboratory, laboratory education big data not only includes a professional experimental knowledge base, but also includes "three-dimensional data" such as students' learning behavior and language interaction in the laboratory, rather than traditional "flat data" such as basic grades, attendance, and experimental reports. Through machine vision analysis and deep learning and other technologies, it is possible to analyze students' learning behavior, experimental process, experimental data, number of hours, reference data, experimental reports and other learning data, accumulate a large amount of student learning data, and build a student ability cultivation intelligent guidance system and comprehensive ability digital portrait system. These systems can provide personalized and precise solutions for the development and assessment of students' abilities. The smart lab uses advanced technologies such as fusion technology, real-time audio and video communication, AI recognition, AR interaction, and edge computing to provide teachers and students with a set of remote end-to-end teaching solutions based on AI+AR smart glasses. [6] discussed that according to the observations in this paper, an existing mathematical model of banking capital dynamics should be tweaked. First-order ordinary differential equations with a "predator-pray" structure make up the model, and the indicators are competitive. Numerical realisations of the model are required to account for three distinct sets of initial parameter values. It is demonstrated that a wide range of banking capital dynamics can be produced by altering the starting parameters. One of the three options is selected, and the other two are eliminated. The model is generalized taking into account fractional derivatives of the bank indicators for time, reflecting the rate of their change. Based on numerical calculations, it is established that reduction of the order of derivatives from units leads to a delay of banking capital dynamics. It is shown, that the less the order of derivatives from the unit, the more delay of dynamics of indicators. In all analyzed variants indicators at large times reach their equilibrium values. [5] examined the development and refinement of possible mathematical models for the intellectual system of career guidance. Mathematical modeling of knowledge expression in the career guidance system, Combined method of eliminating uncertainties, Chris-Naylor method in the expert information system of career guidance, Shortliff and Buchanan model in the expert information system of career guidance and DempsterSchafer in the expert information system of career guidance method has been studied. The algorithms of the above methods have been developed.

The smart lab uses digital methods to realize the copy and virtual simulation of laboratories and instruments and equipment. To this end, it is necessary to synchronize the laboratory and instrument equipment, that is, build a corresponding model in the virtual laboratory system based on the real laboratory and instrument equipment. This requires 3D modeling of every piece of equipment in a real lab and placing it into a virtual scene. This enables one-to-one correspondence between real and virtual labs and synchronizes data. Through network communication connection technology, real-time linkage between real equipment and virtual equipment is realized, so as to monitor the laboratory in real time. This is an important driver in the project to promote the digital, networked and intelligent transformation of laboratory systems. The smart lab will use

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holographic technology and network video interaction to build an experimental live classroom system to display the experimental process and experimental results in an all-round way. At the same time, abstract theories can be dynamically demonstrated, so that students can get an immersive experimental teaching experience. This will be a completely new experimental teaching method with great potential to greatly improve students' experimental skills and experimental understanding ability.

The smart lab will build a virtual simulation experiment teaching platform. This platform will allow students to experience and learn from cognitive, practical and applied perspectives, allowing them to experience real experimental scenarios in a virtual environment. On the one hand, this platform can complete experiments that cannot be completed in traditional laboratories, on the other hand, it can increase the understanding of theory and instruments and equipment, combine theory and practice, and effectively improve students' interest and efficiency in learning. This is a very promising educational technology that may have a wide range of applications in the field of education in the future.

V. Application of Smart Lab

By reforming the teaching path, form and method, expanding the teaching space and improving the teaching quality, artificial intelligence technology can be implanted in teaching. Using artificial intelligence robots as teaching assistants, they are customized and developed through a series of functions, can charge and move by themselves, provide students with laboratory navigation, answer questions for students' learning, and collect feedback and other functions, which can strengthen the guidance of students' value orientation in practical courses. Interesting images and informal forms make it easier to attract students' attention, make students willing to seek questions and give commands or chat for robot teaching assistants, forming a good interactive teaching and adding vitality to the classroom. This teaching method will be a major feature of experimental teaching in the future.

Taking students as the center, design a method of collecting students' information and data without feeling, including students' learning process, grades, classroom performance, clubs, socialization, innovation, consumption, communication, scientific research, training, internship, social services, etc., and then carry out big data cluster analysis, especially for labeling and visualizing key contents such as students' learning ability, learning habits, knowledge system defects, scientific research inquiry, innovation ability, organizational ability, psychological and physical health.

These experimental education big data cooperate with the smart laboratory to further guide and standardize the daily learning process of students and realize the subtle learning of learning. Platform users can display the entire operation process of the device user in real time through computers, tablets, mobile phones, AR glasses and other devices. Equipment management personnel can know the on-site situation from a first-person perspective and confirm the operation accuracy of equipment users in real time through AR annotation and frozen screen annotation. By wearing AR smart glasses, device users can obtain real-time information guidance from equipment management personnel, so as to realize interactive equipment operation and serve teaching and research activities more efficiently. With a 3D visualization of a virtual lab, you can get a clearer picture of what's really going on in your lab. In terms of equipment management, the entire laboratory equipment health is clear at a glance. The system will visually represent the problematic instruments or parts through 3D visualization, which is very convenient for troubleshooting hidden dangers; The system can integrate the experimental resource consumption of the entire laboratory, so that managers can more conveniently and efficiently realize the management of experimental resources.

VI. Conclusion

Through the construction of smart laboratories, establish efficient Internet of Things technology solutions to obtain laboratory education big data. Laboratory education big data is not limited to traditional "flat data", but focuses more on "three-dimensional data" such as students' learning behavior and language interaction in the laboratory. Relying on laboratory education big data, establish an interactive laboratory knowledge base, customize laboratory on-site machine teaching assistants and remote teaching. Through mining, management and analysis of laboratory education big data, we build an intelligent guidance system for student ability cultivation and a comprehensive ability digital portrait system, and provide personalized and accurate solutions for student ability cultivation and assessment.

At present, the construction of smart laboratories is still in its infancy, and there is still a long process of future development, and many problems will inevitably emerge to be solved. The construction of the smart laboratory should be based on the overall development of the school, and all parties should cooperate and carry out in an orderly manner. Through the construction of smart laboratories, the informatization level and management level of colleges and universities will be greatly improved, and it will play a major role in building the core competitiveness of the university and enhancing the leading and exemplary role of society.

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