

Research on the Construction of Virtual Simulation Training System for Intelligent Manufacturing Based on Outcomes-Based Education Concept

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Abstract—Outcomes-Based Education (OBE) is the core concept of professional accreditation in engineering education, and is a teaching and learning approach that determines teaching strategies based on learning outcomes. In the context of new engineering, it is important to actively cultivate high quality composite new engineering talents with international competitiveness that are compatible with the emerging industries, and improving their teaching effect is important to accomplish the training objectives and graduation requirements. This paper analyzes the necessity of using virtual reality technology in the teaching system, explains the application and development of OBE concept and virtual simulation technology in the teaching system, and finally proposes specific objectives, ideas and methods for the construction of virtual simulation training teaching system for intelligent manufacturing.

1. INTRODUCTION

The concept of outcome-based education (OBE) is a new teaching and learning philosophy that centers on the design, implementation, and evaluation of teaching and learning activities around student learning outcomes. With the reform of teaching and learning in China, the OBE teaching concept has been gradually launched in higher education institutions. In recent years, the application of virtual reality technology in teaching experiments has injected new vitality and vigor into the current multimedia teaching mode. However, there is a lack of systematic research on the construction of virtual imitation training platform for intelligent manufacturing based on the construction of new engineering disciplines, which makes universities lack systematic guidance in building virtual imitation training teaching platform. In order to effectively meet the demand of local economy, new science and technology and industry enterprises for high quality composite talents, higher education institutions must establish virtual imitation training teaching system which is compatible with the background of new engineering.

2. THE NEED TO USE VIRTUAL REALITY TECHNOLOGY IN THE TEACHING SYSTEM

The use of virtual reality technology in education teaching is the demonstration and embodiment of the high-tech level of education and one of the symbols of modernization and informatization of education. The

application of virtual reality technology in education makes teaching courses vivid and interesting, reduces the difficulty of teaching, and increases the opportunities for interaction between teachers and students. It can not only reduce the cost and danger of teaching, but also has a strong flexibility to customize different teaching systems according to different majors and update the content of the virtual teaching system when the course content changes, without the need to purchase new instruments. In such an experimental system, users can interact with the human-machine in real time and watch the experimental process repeatedly, which allows students to thoroughly understand each step of the experimental process and thus achieve knowledge mastery. There is also a question and answer module in the lab system to help students solve the difficulties encountered in learning, which is of great practical significance to help students pre-study before class and review after class.

Therefore, the virtual imitation real training teaching system developed based on the intelligent manufacturing practical production demonstration line is conducive to stimulating users' learning interest and improving the learning efficiency in the teaching process of intelligent manufacturing production line, thus solving some drawbacks existing in the teaching process of intelligent manufacturing production line, which has important theoretical significance and application value.

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3. APPLICATION AND DEVELOPMENT OF OBE CONCEPT AND VIRTUAL SIMULATION TECHNOLOGY IN THE TEACHING SYSTEM

The OBE concept has received widespread attention in teaching in domestic universities[1,2].The OBE concept is a new teaching and learning philosophy that focuses on designing, implementing and evaluating teaching and learning activities around student learning outcomes[3,4].The OBE teaching concept originated in the United States, and OBE certification standards have been proposed in Japan, Canada, Australia and other countries.With the teaching reform in China, a new evaluation method with three-level accreditation as the evaluation system of undergraduate teaching level has been gradually launched in higher education institutions.Anhui University of Engineering introduces OBE teaching concept into the applied undergraduate training program for textile majors[5].Beibu Gulf University Adopts OBE Concept to Improve Curriculum Modularity in Computer Science[6].Guizhou University of Engineering Science Integrates the OBE Concept into the Teaching of Comprehensive Practical Training Courses for Mechanical Engineering Majors[7].However, no one has yet organically integrated the virtual reality technology based on OBE concept with the experimental teaching of smart manufacturing production demonstration line.

Virtual reality technology is a kind of computer graphics technology, interactive sensing technology and three-dimensional display technology, etc., to simulate the real production life environment[8].Virtual simulation teaching is the use of virtual reality technology to develop a virtual teaching platform, according to the teaching theory and teaching content needs set to add teaching system content, users can wear a helmet and handle or operate the mouse and keyboard to call the system content, become a member of the virtual scene, in the virtual scene to move, design, watch and other interactive operations.In recent years, driven by the rapid development of virtual reality technology, many research scholars at home and abroad have devoted themselves to the research of virtual reality in the field of education, especially the application of virtual reality technology in teaching experiments, which has injected new vitality and vigor into the current multimedia teaching mode.Irina analyzed the impact of virtual reality technology in engineering education on the quality of education.Analyze the impact of virtual reality on business, students, and education systems through its use in the automotive industry[9].Dilogo and others have implemented VR in interactive teaching, which uses the Web to create a teacher interface that allows students to borrow Google cartons to explore the world[10].Despite the late start of research on VR technology in China, the research on VR technology in education has not been taken lightly.Shandong University of Construction and Jinan Kemin Digital Co., Ltd. have developed a reinforced concrete experimental teaching platform, and Huazhong University of Science and Technology has researched and developed a hydraulic circuit performance and hydraulic component assembly and disassembly

teaching system based on the syllabus of hydraulic and pneumatic transmission, with the help of which users can carry out the cognition of hydraulic components and master the assembly relationship between hydraulic components.Virtual digital workshop is a subset of the digital factory concept, which is the result of deep integration of virtual manufacturing content and real manufacturing process applications[11].The digital factory is the basis for the construction of strategies such as "Industry 4.0" in Germany, "Advanced Manufacturing" in the United States, and "Made in China 2025".Since the early 1990s until now, the concept of Digitalized Factories has been gradually developed.The digital factory is an important element of Industry 4.0 applications. The digital factory is generally defined as an integrated network of digital tools, models and related methods, including virtual simulation and 3D visualization, as well as continuous data management and analysis[12].There is already a wealth of discussion and research on digital factory concepts and application scenarios.Huilong Zeng argued that the construction of digital workshop needs to be guided with the actual practice, and discussed the construction ideas, construction scope and model of digital workshop[13].Dashun Zhang researched a three-dimensional reconfigurable digital workshop based on the Internet of Things, and built a digital workshop from the perspective of workshop interconnection through the intrinsic logic of data collection, processing and control.However, there is a lack of systematic research on the construction of virtual simulation training platform for intelligent manufacturing based on the construction of new engineering disciplines, which makes universities lack systematic guidance when building virtual simulation training teaching platform.

4. OBJECTIVES, IDEAS AND METHODS FOR THE CONSTRUCTION OF VIRTUAL SIMULATION TRAINING SYSTEM OF INTELLIGENT MANUFACTURING BASED ON OBE CONCEPT

Under the guidance of the education concept of result derivation, with the teaching goal of cultivating students' innovative design ability and comprehensive design ability, closely combined with the construction of Shandong University's new engineering and intelligent manufacturing production line practice platform, the application of virtualization technology solves the problems of large-scale and high consumption of experimental devices, reduces the maintenance cost of equipment, makes the controlled objects easy to transform, facilitates the expansion and redevelopment of experimental teaching links, breaks through the limitation of the number of people carried in the practical training classroom, and expands the beneficiary area.The use of virtual simulation technology to share the platform to the Internet has further broken through site restrictions and expanded the scope of sharing.The construction of this intelligent manufacturing virtual simulation training teaching system is also conducive to enriching the practical teaching content of undergraduate students,

enriching the means of engineering education cultivation, and meeting the innovative practice needs of multi-disciplinary and multi-level students. This project adopts literature method, experimental method and comprehensive comparison method, etc. to carry out research on the construction of virtual imitation real training teaching system of intelligent manufacturing, teaching mode and innovation of teaching evaluation method, etc., according to the idea of Figure 1.

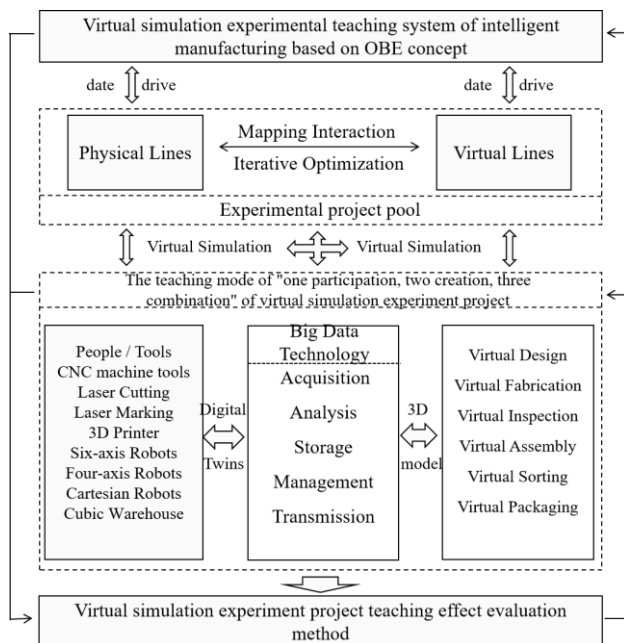


Figure 1. The design idea of virtual simulation training system of intelligent manufacturing based on OBE concept

4.1 Development of virtual simulation experimental teaching system of intelligent manufacturing based on OBE concept

System UI design and model construction: With the help of Solid Works and 3Ds Max, 3D models of actual hardware equipment such as CNC machine tools, laser cutting machines, laser marking machines, 3D printers, six-axis industrial robots, four-axis industrial robots, Cartesian coordinate manipulators, and three-dimensional warehouses are established according to the layout, structure and size of the actual intelligent manufacturing production line. The key parts of each CNC machine tool (such as: drive axis, feed mechanism, manipulation mechanism, etc.) need to be established separately to facilitate the addition of key frame animation to the model through the animation curve in 3Ds Max; according to the layout of the real teaching site, the scene model is established for users to operate and interact with.

Model optimization and 3D animation production: use 3Ds Max modeling software to optimize the imported model, add material mapping to the model, in order to simulate the real scene, the production and addition of mapping is particularly critical, you can use UVW mapping to add material to the complex shape of the model; in addition, use the 3Ds Max software 3D animation production function to produce processing, assembly, testing and other operations animation. Set up

the key frame of the animation, plan the animation curve, and render the animation output after completion. Function development of intelligent manufacturing virtual simulation experimental teaching system: add various module functions in Unity3D, such as: innovative design, intelligent identification, CNC machining, robot application, intelligent inspection, intelligent assembly, etc.; also explore the key technologies involved in the development process, including machining technology, tool combination clamping technology, visual identification and inspection technology, as well as UI and script optimization technology.

4.2 Establish the teaching mode of virtual simulation experiment "one participation, two creation, three combination"

"One participant": that is, teachers, students and school enterprises participate in practical teaching work together.

"Second innovation": innovation and entrepreneurship education. We develop virtual simulation experimental projects and carry out "application-oriented" education around entrepreneurship concept training, innovation skill enhancement, innovation project optimization and innovation project implementation, forming an education development model led and supported by virtual reality technology and experimental modules.

"Three Combinations": It refers to the composite new engineering talent cultivation practice teaching system with cross-penetration between majors, i.e. "Major 1" + "Major 2" + "Intelligent manufacturing specialty". It realizes the professional training goal of industry chain adding up, supply chain connecting and value chain multiplying.

4.3 The evaluation method of virtual simulation experiment project by combining "virtual and real" evaluation mechanism

Based on the OBE teaching concept model, students' experimental performance is composed of two parts: pre-study (assessment "virtual"), on-site lecture (assessment "virtual, real"), and practical training (assessment "virtual, real"). Through the training of this experimental project, students will combine the theoretical knowledge and experimental skills and integrate them, and combine the school experiments with the school-enterprise production and education projects and the "double creation" competition projects, so that students can meet the requirements of capacity training.

4.4 Program design and working methods

The development of virtual simulation teaching system for intelligent manufacturing based on OBE concept is carried out to restore the objective teaching scenario and teaching process, so that users can experience an immersive learning style and achieve the teaching purpose. It is different from other teaching products in that it enables a scenario-based teaching model.

Based on the system design idea, in order to meet the system requirements, the development technology route of the system is first designed as shown in Figure 2. Firstly, we designed the system interface in Photoshop, taking into account various factors such as visual perception and simulation effect, firstly, we determined the base color of the design and designed the UI images of the system interface, selection buttons and module background respectively. According to the actual drawing size, Solid Works is used to establish the common equipment of intelligent manufacturing production line: CNC machine tools, laser cutting machines, laser marking machines, 3D printers, six-axis industrial robots, four-axis industrial robots, Cartesian coordinate manipulators, three-dimensional warehouses, etc. The key parts of the equipment: base parts, guide parts, positioning parts, fasteners, compression parts, support parts and general parts, etc. At the same time, the models of intelligent manufacturing module, intelligent inspection module, intelligent assembly module, intelligent sorting module and intelligent packaging module are established for teaching scenarios. Import the created model into 3DsMax for optimization and add material mapping. By adding materials to each part model, adding lighting and other rendering means to simulate the restoration of the real teaching scene, so that users produce a sense of immersion. In Unity3D development engine for scene construction, by writing the code of the mount program to achieve the system model call display, module scene conversion, model animation playback and other functions. Finally, we set the release parameters, select the platform and version type to be released, and finish the system release.

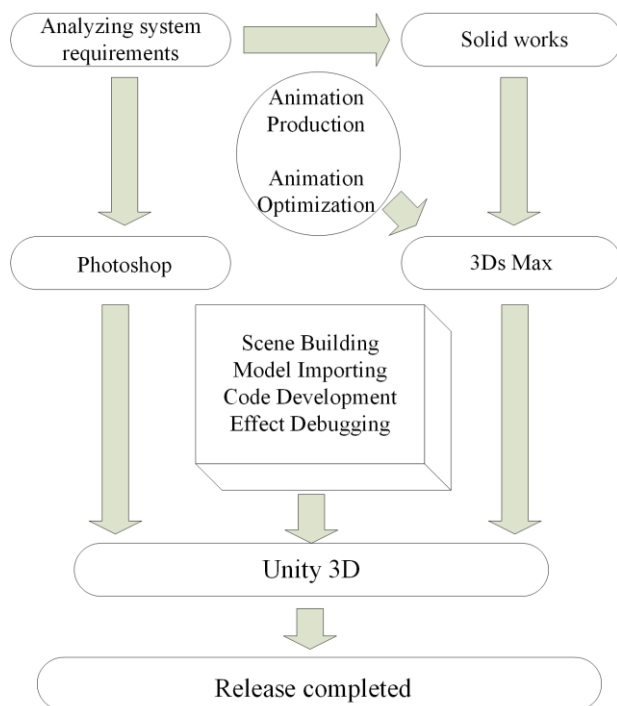


Figure 2. Design of virtual simulation experiment system

5. CONCLUSION

Virtual simulation technology is used to develop virtual teaching platform and add teaching system contents according to the teaching theory and teaching content requirements, so that students can acquire engineering knowledge as well as research, design, development, communication, cooperation, management and other comprehensive quality capabilities in the process of course experiment, course design, practical training and graduation design, and cultivate students with a perfect knowledge system and professional skills. Through the quantification of the learning process, students combine the theoretical knowledge and experimental skills with the real and virtual, and combine the school experiments with the school-enterprise industry-education projects and "double creation" competition projects to meet the requirements of capacity training. Ultimately, the student is no longer an ordinary student in the traditional education model, but a successful learner based on the concept of outcome output.

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