

# Research on the design of intelligent virtual simulation experimental teaching platform based on augmented reality

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**Abstract:** This research developed a product virtual simulation system based on augmented reality technology. The special database of product components was established, and the augmented reality product database of rice cooker was constructed and modified by the user and the enterprise design and production database. The HoloLens head-mounted device and MR Hand-eye interaction technology were used to realize the real-time simulation of the running state of the product design, and the prototype system was assembled. The Unity3D engine adopts the target method based on special features for the 3D display of products, which is a display environment with high requirements for user experience. The experimental simulation platform system has the advantages of strong portability, strong expansibility, realistic rendering effect and high program execution efficiency, which provides a good 3D panoramic display experience and usability experience for students' experiments and enterprise users after future industrialization.

**Keywords:** Virtual Reality; Experiment teaching; Visual Design; Immersive experience

## 1. Introduction

To improve the practical ability of industrial design and electromechanical students' product development through the virtual simulation experiment of intelligent home appliance design with augmented reality. The use of augmented reality technology can solve the problems of excessive resource loss of hardware equipment in the design of traditional household appliances, and the difficulty of detailed observation and research in the experimental process<sup>[1]</sup>. In addition, the traditional product design and display mainly includes the physical display in the form of exhibition, store window, etc., and the multimedia display based on pictures and videos, which is limited by the site, capital, human and material resources, and inefficient. However, pictures, text, video and other multimedia display forms have a single interactive way, low user participation rate and poor experience<sup>[1]-[3]</sup>. The 3D virtual display based on augmented reality technology has the advantages of real-time, interaction and immersion. In the real environment and virtual digital product interaction to obtain a good, real user experience. Augmented reality teaching experiment is particularly important, and it is also an important content of students' education in the core curriculum of industrial design. It is necessary to improve the students' comprehensive design and innovation ability, and to improve the teachers' teaching ability, expand the field of practice, and enrich the teaching content. To promote the combination of teaching, scientific research and technical personnel, which is conducive to the cultivation of students and teachers, and to promote the formation of experimental teaching teams with advanced educational concepts, high academic level, rich practical experience and strong innovation as soon as possible<sup>[4]-[6]</sup>. It is helpful to establish the teaching effect assessment, evaluation and feedback mechanism to stimulate students' learning and improve students' innovation ability.

## 2. Augmented occurrence theory

When the camera of the augmented reality device recognizes the preset object, the 3D product model automatically appears, and the 3D product model is attached to the surface of the preset object, which can well present the experience of the integration of the product and the real scene. Figure 1 shows the route of augmented reality technology based on special features. The interactive interface allows students to zoom and rotate the content using gestures used in product simulation experiments<sup>[7]</sup>. The experimental simulation platform system has strong portability and expansibility, realistic rendering effect, and high

program execution efficiency, which provides a good 3D panoramic display experience and usability experience for students' experiments and enterprise users after industrialization in the future.

The user psychology analysis, product function module redesign and simplified design research analysis of the current mainstream rice cooker products in the market. Finally, the core identification features of rice cooker products were extracted, and the interactive platform system was designed for the virtual simulation system of rice cooker products across time and space by augmented reality technology. The exclusive database of the components of the rice cooker product was established, and the augmented reality product database of the rice cooker was constructed and modified by the user and the enterprise design and production database<sup>[8]</sup>. HoloLens head display and MR Hand-eye interaction technology are used to realize the real-time simulation of the running state of the product design, and the prototype system is co-assembled. The Unity3D 3D engine is used to use the target method based on special features for the 3D display of products, which is a display environment with high user experience requirements.

### 3. Teaching experiment platform software and hardware

Helmet and large-screen VR blackboard interactive teaching interactive operation, multi-person collaborative operation by operating the left and right handles, can interact with the system. unity3d (version 5.6) is used seamlessly, and supports 3ds Max, Pro/e, UG, SolidWorks and other models after conversion to import, visual design and production. 3D Studio Max, ZBrushSketchUp, Animate CC, Blender software and related materials. The development of intelligent virtual simulation experiment teaching platform is shown in Figure 1.

On the premise of ensuring the quality of the 3D model of a single scene, a finer model was constructed for rendering, and the overall guarantee was within 500 000 faces. The map is strictly controlled by the project personnel according to the primary and secondary relationship of the scene, and the maximum resolution of the main components of the main products is 2048X2048. Minor scene minor parts under the premise of quality assurance, minimum 56X56 resolution map; The rendering times of each frame will be affected by the scene effect. Under the premise of ensuring the overall quality, the optimization is not less than 30FPS, the action feedback time is not higher than 20ms, the display refresh rate is not lower than 30S, the resolution is adopted by default ultra-clear 1920X1080 size, and the resolution can be backward compatible with other resolutions.

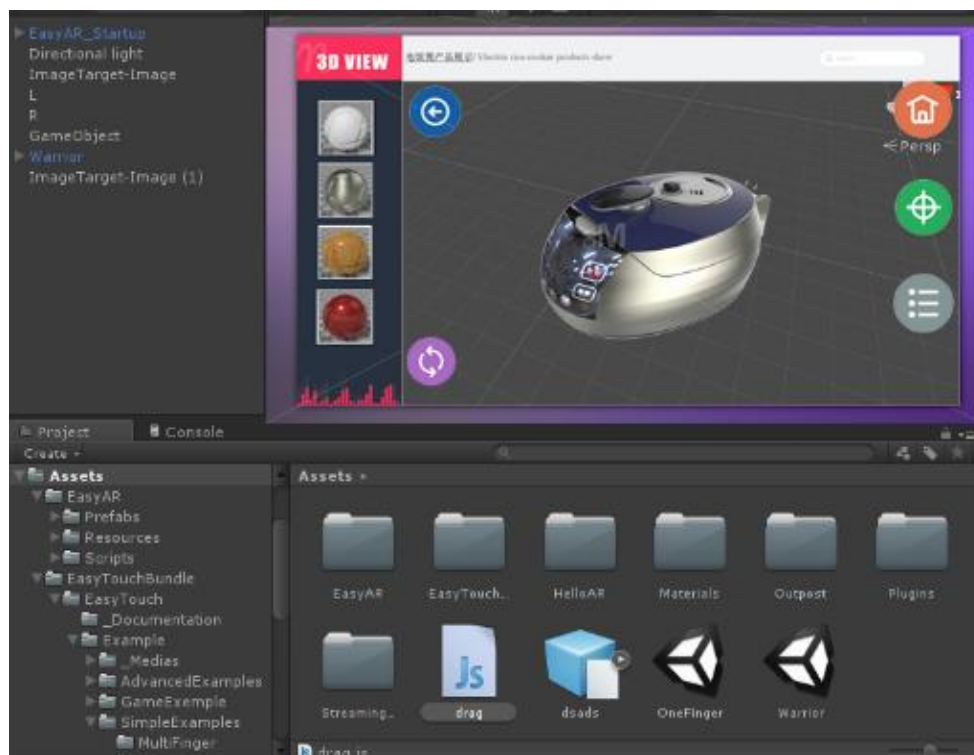


Figure1: Intelligent virtual simulation experiment teaching platform development diagram

## **4. Experimental teaching method**

### **4.1. Purpose**

In the experimental teaching of the course, product model making and virtual review of design projects are involved. The augmented reality virtual simulation experiment is more intuitive than the traditional three-dimensional software to perceive the design effect, thus greatly improving the accuracy of the experimental process. The multi-person collaborative design system based on augmented reality technology supports remote interaction, combines students' curriculum design, graduation design, extracurricular experimental skills projects and discipline competitions, and other extracurricular practice links, encourages students to actively learn the corresponding design learning tasks, and realizes the teaching content of virtual simulation experiment teaching and research of intelligent appliance design based on augmented reality.

Based on the user model and enterprise requirements, the mixed reality display functions mainly include: the display of a series of rice cookers, the demonstration of components, the demonstration of rice cookers with different materials, and the presentation of product parameters. The system can display enterprise products in real time and obtain user experience perception feedback. Through virtual product presentation, the number of its display is not limited; Through the network channel, its region is not limited, which meets the needs of serialization design of enterprises, and also meets the experience needs of users for newly listed or unlisted concept products.

### **4.2. Teaching experiment method and procedure**

Experimental design: In terms of experimental content, the innovative experimental project mainly adopts the actual cases of enterprises, the cases of teachers' projects and the subject matter of discipline competitions as experimental content. These cases provide the actual user needs, the subject matter is true and appropriate, and can be used in practice to increase the enthusiasm of students to participate. In the virtual simulation experiment platform, we can combine the physical experiment, integrate the case, try it in advance, and supplement and improve it. Students in the selection of materials, structure design, virtual simulation experiment platform realistic finished product effect provides a good reference for the design.

The teaching experiment content supported by augmented reality technology allows students to participate in the research and development process of enterprise product design, modification and production. The establishment of product virtual simulation system based on augmented reality technology, using HoloLens head display and MR Hand-eye interaction technology, can realize real-time simulation of product design running state, collaborative assembly prototype system, for school students, to improve students' practical product design ability, get rid of the shackle of traditional knowledge, It has positive significance to connect with the actual requirements of enterprises.

Innovation of teaching methods: The augmented reality virtual simulation product design teaching experiment platform establishes the exclusive database of product components, and the mixed reality product database of rice cooker and enterprise design and production database are constructed and modified by users. With the help of augmented reality technology, students can participate in the whole research and development process of enterprise product design, modification and production in the classroom, realizing the modularization of product design and greatly simulating the real product development process; Interactive mixed reality space display design to provide high imitation and efficient product review simulation; The platform adopts the product mixed reality simulation technology of open source augmented reality 3D engine with high program execution efficiency to design the interactive platform system, which can provide users with good 3D panoramic experience and usability experience.

Innovation of evaluation system: In order to encourage students to participate in research experiment, the evaluation of research experiment course should be different from the ordinary achievement assessment method. No matter what kind of achievement evaluation method is adopted, the key is to implement the process evaluation. Because the research experiment pays attention to the process, the evaluation should run through the whole experimental process, so the assessment should be implemented in every step of the experiment, from the design, modification and completion of the entity model, it should be investigated whether the students are serious about designing, analyzing and solving problems, and whether they are integrated with innovative design concepts<sup>[9]</sup>. In addition, in order to improve the

enthusiasm of students to participate, the results submitted after the completion of the experiment can be three-dimensional models, solid models, or winning materials to participate in the competition.

The extension and expansion of traditional teaching: The experimental training plan and experimental manual were digitized to provide students with text, image, animation, audio, video and other content. The interactive interface allows students to zoom, rotate, and so on the content using simple gestures. Compared with the traditional experimental teaching, the training method based on augmented reality technology becomes interactive, breaks through the location limitation, and realizes remote simulation<sup>[10]</sup>. In order to improve students' learning ability, skills and quality, but also to ensure the personal safety of students during the training, the system interaction flow is shown in Figure 2.

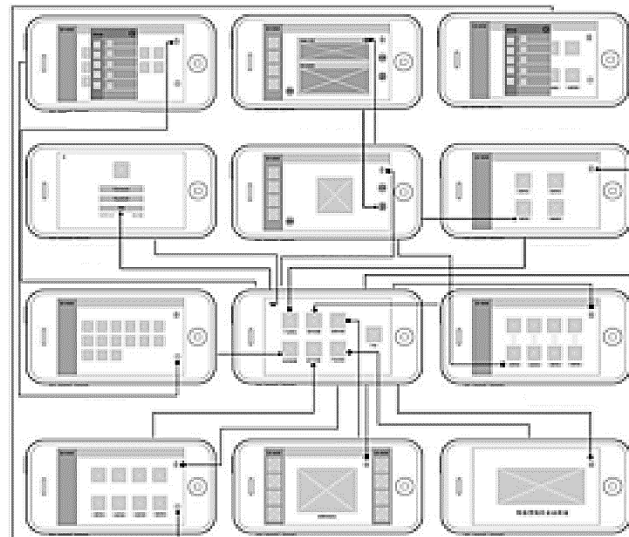


Figure 2: System interaction flow diagram

#### 4.3. Project continuous construction and service plan

The construction of virtual simulation experiment of augmented reality smart home appliance design can better carry out innovation and innovation education. In the implementation of innovative experimental projects, independent, cooperative and inquiry-based learning are advocated. Students can choose the design scheme independently, and teachers can assist students to provide design help. The completed design works can participate in discipline competitions and production applications. This kind of research-based learning method not only increases students' interest and initiative to explore, but also improves students' innovation ability. With the support of the virtual simulation experiment teaching platform for the design of intelligent appliances in augmented reality, design students' participation in various competitions such as industrial design competition and Innovation and entrepreneurship competition can promote the continuous improvement of students' innovation ability.

The virtual simulation experiment platform of augmented reality intelligent home appliance design mainly focuses on cultivating methods and skills, improving artistic expression, innovation ability, and improving comprehensive literacy. To change the current theory of education in the "emphasis on knowledge, less ability; Emphasis on theory, light on practice; Emphasis on memory, light on innovation", the lack of innovation in personnel training, and the problem of personnel training in colleges and universities is not in line with the task. The augmented reality entity experiment strengthens the practical ability, uses the virtual simulation experiment platform to perfect, combines virtual with reality, gives full play to the role of each experimental equipment, increases the experimental projects that can be implemented, enriches the content, greatly enhances the enthusiasm of students to participate in the experiment, and also provides favorable conditions for innovative design.

Strengthen the cooperation and sharing with internal and external schools, universities, research institutes and development enterprises in system research and development and software production. We will deepen school-enterprise cooperation. Based on the construction of virtual simulation experiment teaching resources, expand the depth and breadth of cooperation with local home appliance enterprises in Zhanjiang, such as Hongzhi Electric cooperative enterprises<sup>[11]</sup>. It includes the co-construction of

virtual simulation experiment of intelligent household appliance design with augmented reality, the co-construction of virtual simulation experiment courses and textbooks of intelligent household appliance design with augmented reality for three-dimensional detection of geological resources, and the improvement of the co-construction, co-management and shared experimental resource construction and sharing mechanism with cooperative enterprises. To establish the incentive mechanism of "mutual benefit" in school-enterprise cooperation, and promote the sustainable development of school-enterprise cooperation. The operation effect of the intelligent virtual simulation experiment teaching platform is shown in Figure 3.



Figure3: The operation effect of the intelligent virtual simulation experiment teaching platform

## 5. Conclusions

At present, the construction of the virtual simulation comprehensive research platform has not broken through the bottleneck of design professional scientific research "not deep, not broad, not fine", which is not conducive to teachers' virtual realization of real scientific research through the digital platform. There are still some problems, such as students' interest in learning is not lasting, practical training becomes coping style, simulation training operation is simplified, practical training results are idealized, examination and evaluation are not objective and can not reflect the true level of students.

1. Strengthen the discipline advantages of design and gradually form the characteristics of scientific research

Virtual reality technology is used to create a multimedia experimental platform that integrates professional course experimental practice, teaching research, teaching resources, scientific research, and international design competition. Developing towards the direction of "fine + intelligence + heritage", the design quality is more refined, people-oriented and more intelligent. Following the development of the design industry, it constantly strengthens its advantages as a research discipline, and forms an integrated platform for design research driven by design models.

2. Build a sharing platform for design-related majors and form a cluster of advantageous majors

The existing specialties and disciplines should be developed into professional clusters, and professional advantages and resources should be integrated according to the focus of design model development of each specialty. The implementation of the specific path of the college's scientific research and development thinking will promote the reform of talent training mode and curriculum system of various majors through wisdom guidance, lead the college's professional reform, and improve the quality

of talent training.

Real-time visualization interactive module: in the laboratory, the hardware environment of simulation experience is built through the large screen projection display technology. The virtual simulation technology and real scene video technology are dominant, and the application scene is directly moved into the classroom, such as the indoor space scene in the interior design, so that students can get immersive experience. In this way, students can truly perceive the direct differences between different design scales. In the virtual space, they can perceive the size, virtual reality and atmosphere of different Spaces through the differentiated experience of five senses, and conduct human-computer interaction with the scene through the interactive system to improve the visual teaching experiment research. Multi-party cooperation module: universities should carry out interactive and connected virtual simulation experiments. In the actual construction process, universities need to carry out the top-level design of virtual simulation experiments, school-enterprise joint construction of experimental platforms, and enterprises to provide mature virtual simulation software platform construction technology and practical experience.

### 3. Shared teaching team building

The goal of the construction of the shared teaching team is to build a teaching team with professional ability, market awareness and industrial vision. The construction idea is to build the teaching team of basic platform courses, the collaborative teaching team of professional courses, and the school-enterprise collaborative team of practical courses. Among them, the teaching team of basic courses is a unified platform teachers, the teaching team of professional courses includes corresponding professional teachers (the main speaker) and related professional teachers, and the teaching team of practical courses introduces enterprise teachers to teach together. The construction measures include: first, breaking the division of disciplines and majors, establishing the teaching team of basic platform courses of disciplines and majors; Secondly, clarify the relationship between the upstream and downstream of the industrial chain and the relationship between the post group and the post, find the support or cohesion relationship between the corresponding professional courses, and reasonably allocate the main teacher and assistant teacher; Third, strengthen the cooperation between schools and enterprises, colleges and universities introduce enterprise teachers or send young teachers to enterprises for training, so that schools and enterprises can share resources and complement each other's advantages in teaching.

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