Application of Particle Swarm Algorithm in Architectural Design Teaching System Under VR

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Abstract.
As a new technology, VR is changing people's study, life, work and entertainment, and has been widely used in various fields. Virtual reality, numerical control processing, artificial intelligence and other digital technologies are increasingly entering the architectural design classroom. Their changes to architectural teaching highlight the necessity of establishing a digital architectural design teaching system in architectural teaching. In order to solve the dilemma in this teaching practice, a very intuitive teaching method, computer simulation teaching method, is explored, and computer demonstration is used to cooperate with classroom teaching to give students a relatively acceptable teaching experience. The principle and workflow of particle swarm optimization algorithm are introduced. This paper will analyze the advantages of VR in the field of architectural design teaching in the information age, and discuss the application of VR in the field of architectural design teaching.

Keywords: *VR; Particle swarm optimization; Architectural Design Teaching*

1 INTRODUCTION

With the rapid development of computer technology, VR is becoming more and more perfect. In view of the current situation of engineering construction teaching in my country, the application of VR to teaching can well meet the requirements of contextualization and natural interaction in teaching [1]. VR is a computer simulation system that can create and experience a virtual world. Using a computer to generate a simulation environment is a multi-source information fusion and interactive system simulation of three-dimensional dynamic scenes and physical behaviors, which enables users to immerse themselves in this environment [2]. VR refers to the current popular VR technology. VR establishes a virtual environment through professional equipment and Internet means, and achieves multi-directional sensory touch of buildings through the virtual environment, so as to improve the intuitive experience of architectural design [3]. In this standard process of problem solving, analysis and modeling have high requirements on students' knowledge points and flexible application, while problem solving requires students to be proficient in applying professional tool software to achieve secondary programming, computational solving and parameter analysis. [4].

In architectural teaching, the courses related to digital architectural design have already become required courses for students majoring in architecture, and the teaching contents of the courses are constantly updated and changed [5]. At present, new digital technologies such as Building Information Model, Virtual Reality, and Digital Manufacturing have been introduced into architectural design classrooms, while information technologies such as big data and artificial intelligence are changing many traditional industries including the construction industry. Under this background, it is of practical significance to discuss the teaching of digital architectural design [6]. In this situation, first of all, we need a large number of architectural designers who are proficient in VR and can apply VR to the process of architectural design as a means and method of architectural design; Secondly, we require teachers to apply VR to teaching, well realize the requirements of situation creation and natural interaction in teaching, and fully reflect the advantages of VR in the field of Architectural Design Teaching [7].

2 VIRTUAL REALITY AND TEACHING APPLICATION

2.1 *The application of virtual reality in teaching*

The application of virtual reality in vocational education is mainly manifested experimental training teaching. Classroom teaching is the main way of teaching, and it is also the main battlefield where virtual reality is applied to teaching [8]. The main methods are as follows: ① use pictures to display through projectors. ② Physical display: it is a very practical method, but it has a serious disadvantage because each student is in different positions. Although the teacher takes the same physical object, the perspective is different in the eyes of students in different positions. ③ Through computer three-dimensional modeling and animation software, such as 3ds max, it is an ideal method to establish a model basically the same as the real object, and then display various perspectives through rotation, but it also has a serious deficiency [9]. Through virtual reality, we can construct a three-dimensional object that is the same as the real object, such as the structure in the design of high-rise buildings, which affects the overall shape [10].

Situational creation can make the teaching content of architectural design more vivid and real. Through VR, virtual, gorgeous and everyday buildings can be created, so that students can intuitively know the style of buildings. As an important form of intuitive teaching, VR can deepen students' cognitive sense in the process of architectural design in the field of architectural design teaching, highlight the teaching emphases and difficulties of architectural design, and visualize the abstract architectural design content. VR is an epoch-making technology. In 1993, American scientists burdea g. and Philippe coiffet proposed the 3I characteristics of virtual reality system in the book VR. Namely immersion, interaction and imagination. As shown in Fig. 1.
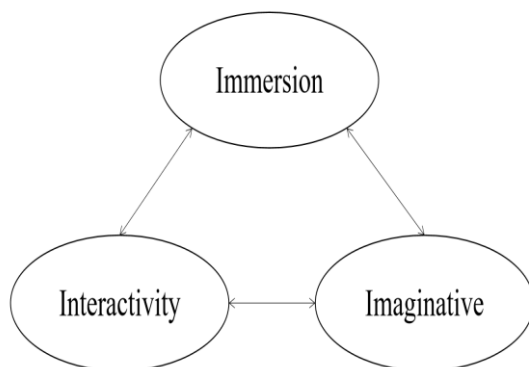

Fig. 1. Virtual reality system architecture

Interactivity refers to the feature that VR system is different from traditional 3D animation. Instead of passively accepting information given by computer or bystanders, users can use interactive devices to manipulate virtual objects to change the virtual world. Conceptuality means that users can get perceptual and rational understanding from the environment of qualitative and quantitative integration by using VR system, so as to deepen the concept and germinate new ideas, and let users experience the advantages of virtual reality system.

2.2 *Construction of virtual scene*

Virtual scenes refer to some scenes that may or have appeared in real life, represented by virtual reality at different times or places. Most of the students can only accept it passively. For some situations, the teacher's description may be far from what the students understand. If virtual reality is used, let the students enter the virtual Yuanmingyuan, let the students do it by themselves, and visit the halls, pavilions, platforms, buildings, pavilions, pavilions, garden corridors, Xuan, Zhai, rooms, boats, and pavilions in this magnificent garden. A total of twelve architectural forms, and then in comparison with the textbook, the teaching effect will be very good. The application of VR in architectural design enables designers to roam and interact in buildings immersively, and fully feel the actual space ratio of future buildings, so as to continuously scrutinize, compare, weigh and make design details. Optimum design choice. Designers are immersed in the architecture of the future, and their design thinking is no longer interrupted by the mutual transformation of "two-dimensional" and "three-dimensional" in their heads, thus greatly inspiring the creativity and design inspiration of designers. As an architectural design tool, VR also has positive significance in architectural planning.

The emergence of VR provides architectural designers with a new and high-level architectural design means. Through the drawing of CAD plan and elevation, 3D modeling and image modeling technology of environmental photos, post-processing of rendering model and architectural animation design, users can experience a new design concept, and modern architectural design needs to meet the needs of future social development. If the VR of real three-dimensional graphics is used to design buildings, the ideas of designers can be presented through a variety of senses, so that users or other personnel can be immersive, and can provide sufficient opinions and suggestions to designers to achieve the best design. When designing buildings, designers can use the interactive system in VR to design, give full play to the software advantages of computers, and combine social conditions, natural conditions and even social background on the basis of architectural design, through effective comparative analysis And after referring to the customer's design requirements from multiple parties, the relevant data can be adjusted in a timely and effective manner, and specific parts are systematically modified, and the revised scheme is

compared with the previous scheme through VR, so as to further meet the objective needs of customers. Therefore, in the process of building design, it is necessary to effectively analyze the feasibility of building construction, and through the application of VR, the problems encountered in the process of building construction can be effectively solved by using the dynamic simulation effect, thus ensuring the reasonable implementation of building construction. On the basis of

students' knowledge and technical reserves, how can we guide students to realize virtual architectural design? From the teaching method, this paper chooses the task-driven teaching method, which includes the process of "setting questions (task display)-analyzing questions (task analysis)-solving questions (problem solving)-questioning (effect evaluation and feedback)". As shown in Fig. 2.
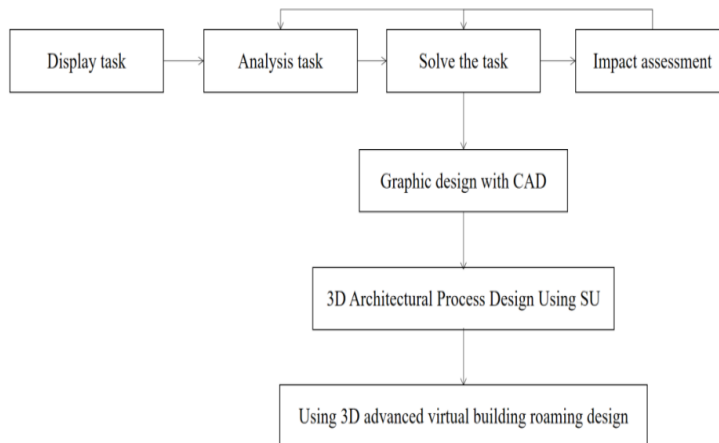

Fig. 2. Teaching Steps

3 APPLICATION OF PARTICLE SWARM OPTIMIZATION IN COLLABORATIVE BUILDING DESIGN

3.1 *Particle swarm optimization*

This speed is dynamically adjusted according to its own flight experience and those of its companions.

The velocity of particle $i(i = 1,2,\cdots,N)$ is represented by $V_i = (v_{i1}, v_{i2}, \cdots, v_{iD})$ motion. (1)

For each generation, the d-th dimension (1≤d≤D) changes according to the following formula.

$$V_{id} = wv_{id} + c_1 rnd()(p_{id} - x_{id}) + c_2 rnd()(P_{ga} - x_{id}) \tag{2}$$

The d-dimensional position information of the particles is adjusted by the following formula.

$$x_{gd} = x_{gd} + v_{id} \tag{3}$$

The first part of formula (1) is the previous speed of particles, the second part is the cognitive part, and the third part is the social part, which indicates the information sharing and cooperation among particles. So that each individual can remember his own beliefs and consider the beliefs of other individuals in the process of seeking consensus cognition among cooperative groups. When it perceives that other individuals' beliefs are better, it will adjust its own behavior adaptively.

Information set information: information (Ω P) contains Determine the objective optimization function aim of the problem to be solved: construct or transform the corresponding objective optimization function according to the characteristics of the actual application problem. Determining characteristic parameters: characteristic parameters mainly refer to some main parameters in the algorithm, such as acceleration constants C1 and C2. Generally, these parameter values should be determined by experiment. The premise of applying particle swarm optimization algorithm to architectural design is that architectural designers have produced various architectural design component libraries in the form of manual or computer generation. For example, the building component library is a collection composed of a large number of building components with various styles or characteristics. The roof component library is a collection composed of roof components. The work to be done is to use the particle swarm optimization algorithm to dynamically find the optimal building components from the component library, form the overall optimal component combination, and assemble the ideal building body. Since the assembly of building components is constrained by the partial order relationship, it is agreed to first select the building body, then get the bottom of the building, and then assemble the roof. When using the particle swarm algorithm for component selection, a combination of global search and local search is used, and parallel random search is performed from multiple initial points. There is no requirement for derivation of the objective function and

transfer function during the search, and the amount of calculation is small and convergence. high speed.

3.2   *Ways of Teaching Evaluation*

To evaluate a student's academic performance, we must first collect information for evaluation in some way. As far as evaluation methods are concerned, this study adopts a combination of pre-teaching evaluation, summative evaluation and diagnostic evaluation. In the course study of freshmen, Auto CAD has been systematically studied, and 80% of the students said that they can basically use Auto CAD to divide the architectural plane functions. Students have studied

3DMAX systematically in their sophomore year, and about 70% of them can use 3DMAX for architectural design. The content of the test is to enable students to complete the same design task. When the design task is completed, we grade the students' design works, record the students' achievements, and finally return to class for comparison and test the learning effect. The purpose of issuing the questionnaire is to test the students' response to the application of VR in architectural design teaching, the prospect of the application of VR in architectural design teaching, and the effect of task driven teaching mode in architectural design teaching. As shown in Table 1.

Table 1. Comparison of results between two classes

Class	Student ID	Score	Class	Student ID	Score
(1) Class	1	88	(2) Class	1	84
(1) Class	2	85	(2) Class	2	65
(1) Class	3	79	(2) Class	3	75
(1) Class	4	91	(2) Class	4	79
(1) Class	5	85	(2) Class	5	84
(1) Class	...	75	(2) Class	...	76
(1) Class	38	83	(2) Class	38	80
Average		83.7			77.5

I compiled a questionnaire survey after the application of VR in architectural design teaching, and distributed it to the students in the experimental class. This time, 36 questionnaires were issued, 36 were returned, and 36 valid test papers were obtained. The questionnaire data analysis is shown in Fig. 3.
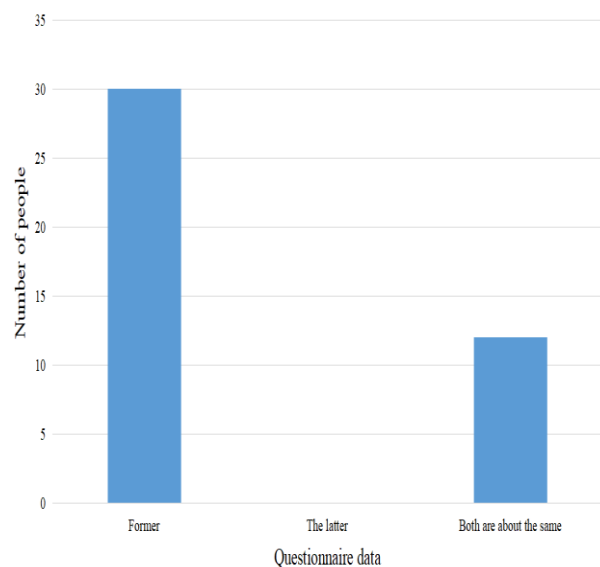

Fig. 3. Data Analysis of the Questionnaire

It is worth mentioning that the eighth question of the questionnaire survey, students' investigation of teaching mode, found that the vast majority of students think that it is better to learn architectural design teaching by task-driven method. When answering why, 12 students filled it out: it can stimulate students' interest in learning; Eight students filled it out: it can improve students' awareness of active participation; Four students filled it out: to make it easier for students positive attitude towards learning virtual architectural design with task-driven teaching mode. As shown in Fig. 4.
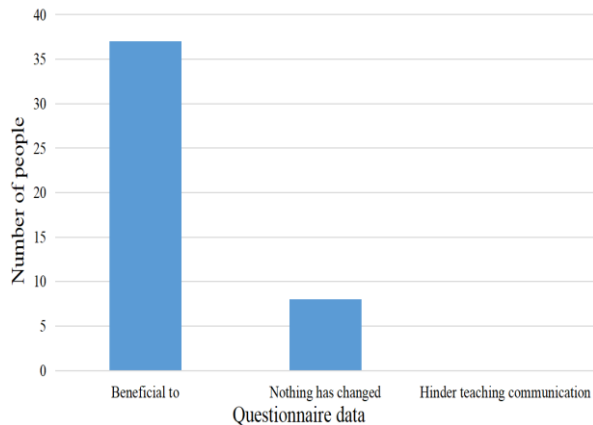
Fig. 4. Using virtual reality to learn architectural design data analysis

From the above survey data, we can see that the vast majority of students hold a positive attitude towards the role and effect of the application of VR in architectural design teaching. It plays a positive role in improving the teaching effect, communication between teachers and students, and improving students' enthusiasm and initiative. Finally, the author conducted an interview with a small number of students who have a relatively indifferent attitude towards the application of VR in architectural design teaching. According to the interview, these students have weak information technology foundation and poor mastery of software knowledge of advance courses such as Auto CAD, 3dmax or sketch up, so it is difficult to keep up with the learning progress. In a word, the virtual architectural design course is a highly flexible subject. During the implementation of task teaching, teachers must not simply and rigidly teach students to make a few cases, but should constantly guide students to draw inferences from one case and learn and apply them in real life., focus on cultivating students' creative thinking ability, so that students learn to discover problems, analyze problems and solve problems independently. Only in this way can the advantages of VR in the field of architectural design be reflected, the expected teaching effect can be achieved, and excellent architectural design talents can be cultivated.

4 CONCLUSION

To sum up, VR is one of the popular technologies at present. Applying VR in architectural design can not only change the defects existing in traditional architectural design, but also help designers improve the overall design efficiency, and at the same time promote the communication between designers and users, so as to help designers improve their architectural design scheme and make the design more in line with users' needs. The superiority of swarm intelligence in the existing application fields has attracted the attention of researchers in related fields. Although the research on swarm intelligence is still preliminary, it can be seen that this research has great development potential, and it has a very attractive research prospect both in the theoretical basis of swarm intelligence and in the expansion of its application fields. VR gives students more intuitive and vivid space scenes with the characteristics of diversity, three-dimensional and intelligence, which will greatly improve students' interest and learning effect in architectural design, and cultivate more and better architectural design talents.

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