



The Design and Implementation of Interactive Online Training Teaching System in Digital Education Environment

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Abstract. With the digital transformation and upgrading of modern education, based on virtual reality, multimedia, visual interaction, network communication and other technologies, a virtual simulation interactive online training teaching system is constructed. Aiming at many problems existing in the current college training teaching process, comprehensive application solutions are put forward. This system will use 3ds Max, Unity3D and other key technical means to complete the design and development of virtual simulation training environment and training project based on the actual training teaching content, and complete the encapsulation and release of functional modules in ASP.NET development environment to form a standard Web application. By using multimedia resources, 3D digital models, virtual interaction and other ways to help students fully grasp the operation principle and workflow of the practical training project, and by consolidating and strengthening theoretical knowledge, it is not only beneficial to improve students' ability to integrate theory with practice, but also to enhance students' comprehensive ability and professional quality. It is also a useful attempt to realize the organic combination of modern education and practical training and promote the reform of digital teaching in colleges and universities.

Keywords: virtual reality · Simulation experiment · Interactive training · Digital education

1 Introduction

At present, high-quality development has become the core theme of China's social and economic development. Especially since the 19th National Congress of the Communist Party of China, strengthening the construction of "Digital China" has risen to the national strategic level. A series of high-tech information technologies, led by the Internet, big data and artificial intelligence, will go deep into various industries and fields to complete innovative integration, promote digital industrialization and digital industrial development, and make outstanding contributions to the construction of digital economy. With the publication of the "14th Five-Year Plan for Digital Economy Development", the proposal of "Deepening Wisdom Education" indicates that China's modern education has also entered a new era of digital transformation and intelligent upgrading.

The construction of new educational infrastructure, the establishment of demonstration areas for wisdom education and the comprehensive coverage of “Internet+ education” have become inevitable choices for China from a big educational country to a powerful educational country [1].

In the era of digital economy, the change of talent demand is intertwined with the demand of digital transformation and upgrading of higher education, which provides a historical opportunity for building a high-quality education system supported by digitalization, updating educational concepts and reforming educational models. For a long time, the talent training objectives of colleges and universities are mostly single output, with thousands of students, lacking of the times. The wide-caliber training mode compresses the personality development space of contemporary college students, and lacks independent and diverse learning environment, which makes it difficult for college students’ professional quality to keep up with the development of the times. On the other hand, in the process of education and teaching, the educational thought of “attaching importance to theory and neglecting practice” is often continued. The problems of outdated teaching form, single teaching content, insufficient interactivity and poor effectiveness are highlighted, and key features such as practicality and innovation are ignored, and the absence of collaborative subjects is serious. According to the survey data, in the current social recruitment process, 76.3% of college students are trapped in weak practical ability or lack of practical work experience, thus missing employment opportunities.

In view of this, this paper holds that colleges and universities should seize the key opportunity of the transformation and upgrading of higher education in the era of digital economy, aim at cultivating comprehensive professional application talents urgently needed by society, adhere to the core concept of “all-round education”, take practical teaching as the starting point, and build a virtual simulation interactive online training teaching system with the application advantages of virtual reality, multimedia, visual interaction, network communication and other technologies. The virtual simulation training and online teaching will be systematically and innovatively introduced into the practical teaching activities in colleges and universities, and the convenient and efficient Web application will be the main presentation form to create a new teaching mode with networking, digitalization, scene and experience. It is not only conducive to enhancing students’ practical ability, stimulating students’ learning autonomy and creativity, enhancing students’ in-depth understanding of theoretical knowledge, but also quickly narrowing the distance between college teaching and professional positions, alleviating employment pressure and achieving the purpose of improving the effectiveness of education and teaching. At the same time, the new teaching mode will further promote the improvement of high-quality education system, form a new mode and new ecology of modern education, and help the high-quality development of digital education in colleges and universities.

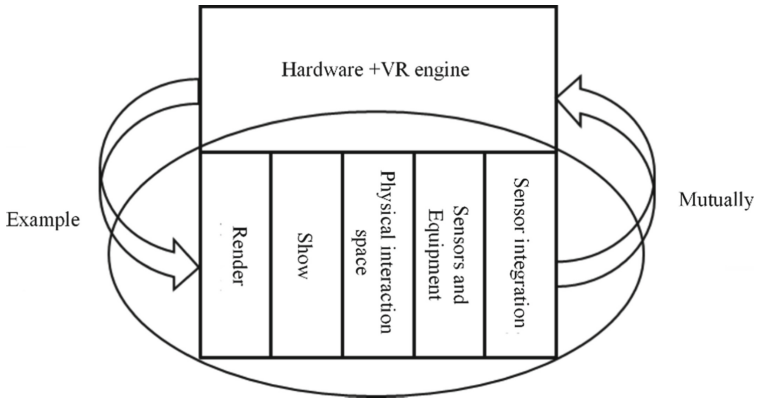


Fig. 1. Schematic diagram of virtual reality technology

2 Overview of Key Technologies

2.1 Virtual Reality Technology

The Virtual Reality technology (VR technology for short) was officially released in 1989 by Jaron Lanier, founder of VPL Research, and was approved for use. Based on computer science and technology, virtual reality technology comprehensively uses computer 3D graphics technology, simulation technology, sensor technology, man-machine data interface technology, display technology and other means to generate a virtual scene, so that users can interact with the models in the virtual scene naturally from visual, tactile, auditory and other angles with the help of special input or output devices, in order to get the same feeling as the real world [3]. The essence of virtual reality lies in the simulation and simulation of the real world. Its technical principle is shown in Fig. 1, that is, through the comprehensive application of information technology, it can achieve the virtual construction and high-reduction reproduction of all kinds of objective things in the real world, and it also includes the design and construction of many detailed functions and characteristic parameters. It also supports users to use different sensors or devices in the physical interaction space, with the support of computer hardware and VR engine, and actively choose different interaction ways to feel different scene feedback, so that they can get the best experience.

2.2 Visual Interactive Technology

The visualization technology refers to the way of accessing information or interacting with information under the theory of human-computer interaction. With the appearance of visual interaction technology, the mode and form of interaction have changed, which is different from the traditional code input and programming execution. More computer graphics are used as the standard method, and the user's operation is converted into instructions that can be understood by the computer, which greatly improves the convenience of the user's operation and enables the man-machine interaction to be completed more naturally and efficiently. And the virtual reality is a brand-new way for people to

visualize and interact with complex data through computers. Compared with the traditional man-machine interface and the popular window operation, virtual reality has made a qualitative leap in technical thought [5].

In the virtual reality system, users can operate the physical models or objects in the virtual scene or environment by means of a large number of input and output devices, so as to complete the data information exchange with the computer system. The virtual reality technology can unify people's consciousness and actions with the computer's data operation and processing ability in a virtual and natural way, and realize the simulated and three-dimensional real-time interaction between man and machine. On the other hand, the emergence of Web3D technology provides a brand-new and lightweight solution for visual interaction of virtual reality system, and it is the latest technology to realize virtual reality in web pages. With the help of Web3D rendering engine technology, users can complete the application and display of virtual reality system in the client browsers of various terminal devices, and can realize a variety of human-computer interaction operations. For example, the rotation, movement and splitting of images in the page can be realized by clicking the mouse or sliding the touch screen, so as to enhance the richness of interaction between users and virtual scenes.

2.3 Unity 3D

Unity 3D is a development tool for creating games and three-dimensional interactive content released by Unity Technologies in June, 2005. It is a professional game engine compatible with 2D/3D development. Compared with other software platforms, Unity 3D has a relatively complete operating system, forming a standard development ecology. The Unity 3D can receive the import of 3D model resources in various formats, and use its own rendering engine, physical engine, collision detection system, sound engine, script engine, animation system, artificial intelligence, network engine, scene management and many other functional modules to complete the development of visual interaction. Finally, it relies on interactive programming script interface to complete the output and release of design content [6].

As a powerful 3D model, Unity3D has obvious advantages in 3D model visualization, 3D animation creation, custom external extension, platform design and development, etc. It can play a huge role in virtual reality, virtual simulation and other fields. As shown in Fig. 2, the demand solution of Unity3D in the virtual reality system, in which the physical engine can realize the display, movement and interactive operation in the virtual scene, is the key to the overall system development; The UGUI interface is responsible for controlling the development process of the whole interface and the final display effect; The multi-platform packaging is related to the scalable development of the system and the subsequent cross-platform application [7]. And C# script can support users to realize different personalized functions through code input.

2.4 Development Process

According to the application requirements of the above related application technologies, the configuration and deployment of the virtual simulation interactive online training teaching system development environment are completed. The development content of

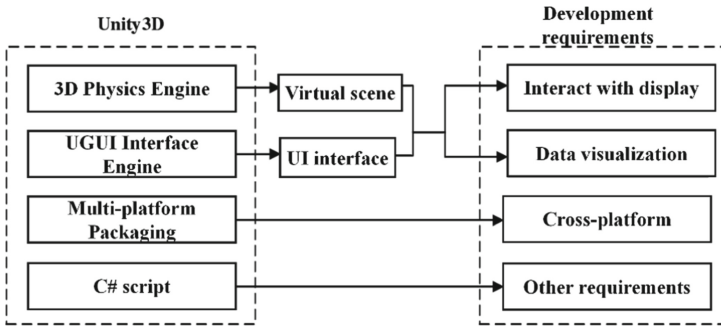


Fig. 2. Requirements solution based on Unity3D

the system is divided into two parts. One is the design and implementation of the virtual simulation training function module. Secondly, under the development environment of ASP.NET, the virtual simulation training function module is integrated and packaged with other function modules to form a networked online training teaching system based on Web application.

The design of virtual simulation training function module needs to go through many steps, such as content analysis of training project, original material collection, 3D digital modeling, virtual scene construction, model scene combination processing, interactive design and overall export. Among them, the content analysis of the training project will be completely deconstructed and classified according to all kinds of training scenes, training equipment, training process and training results contained in the actual training project content. For example, the training scene can be a school laboratory or a real factory or operation room; The training equipment includes all kinds of electronic instruments, tools, raw materials and other auxiliary tables, chairs and countertops. The original material collection will involve various physical attributes such as shape, size, color, texture, etc., which will provide the necessary data foundation for the subsequent 3D digital modeling and virtual scene construction. The 3D modeling will be done by 3ds Max software, and the basic model will be baked after it is finished, which makes the model more realistic and vivid. The production of texture materials needs to be done by Photoshop software. As shown in Fig. 3, the effect comparison between the basic model of training equipment and the baked texture is shown.

Upon the completion of all kinds of model design and construction, 3ds Max software exports all 3D models as FBX files, and introduces such files into Unity 3D. The virtual scene needs to be built first under Unity 3D. Taking the laboratory as an example, the materials of the floor, walls and ceiling of the laboratory will be set, and tiles with different textures will be selected to achieve the decorative effect. When the basic scene is built, the model scenes will be combined, mainly including the placement of various models according to the requirements of the training project, the setting and deployment of indoor light sources, the addition of model special effects, and the setting of cameras at various angles. Then, users are required to complete the interactive design according to the training process and training results, even if the model in the virtual scene can complete the simulation operation of the actual project and get the corresponding training

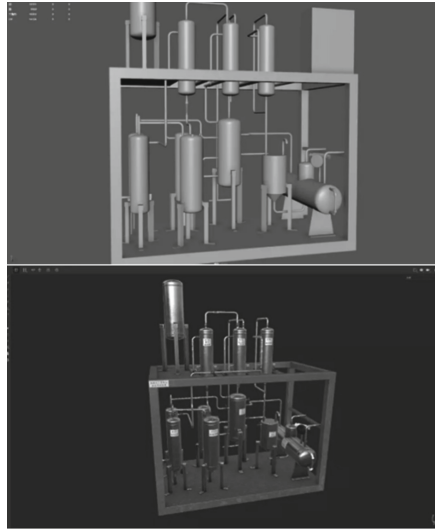


Fig. 3. Comparison of baking effect between basic model and map.

```

public float speed;
void FixedUpdate()
{
    float moveHorizontal = Input.GetAxis("Horizontal");
    float moveVertical = Input.GetAxis("Vertical");
    Vector3 movement = new Vector3(moveHorizontal, 0.0f, moveVertical);
    GetComponent<Rigidbody>().AddForce(movement * speed * Time.deltaTime);
}

```

Fig. 4. Key codes for controlling ball movement by keyboard

effect. This process depends on the writing of script code. After the model is given the rigid body attribute and the physical engine, the script is hung on the corresponding model, so that it can receive the instruction from the user and complete the corresponding interaction. For example, the user can call the `FixedUpdate()` function to control the motion of the ball model, and the key code is shown in Fig. 4.

The whole design is finished, and the whole content is exported by Unity3D. Select WebGL export when exporting. When the project is exported, all content-specific files containing WebGL are generated.

For the overall development of the system in ASP.NET environment, Windows 10.0-64 bit system is selected as the operating system, C# is selected as the development language, and Visual Studio 2019 is selected as the integrated development tool. The Web server is Windows IIS 10.0, and the database is SQL Server 2019. Under Visual Studio 2019, the interactive operation between Unity3D programs and elements in web pages is realized by selecting `SendMessage()` and `Application.ExternalCall()`, and the real-time data transmission is realized by the interaction between functions inside Unity and methods on web pages. [8] Through the introduction of the above key technical

theories, the overall environment of system development, the running process of related software and tools are determined, and the technical feasibility of the whole project of virtual simulation interactive online training teaching system is also defined.

3 Needs Analysis

3.1 Functional Requirements

The virtual interactive online training teaching system will focus on the practical teaching direction, innovatively complete the organic integration of virtual simulation training and online teaching, and build a brand-new teaching mode, in view of the difficulties faced by talents training in colleges and universities in the era of digital economy, combined with the actual needs of the renewal of educational ideas and the reform of educational models in colleges and universities, with the help of the application advantages of new information technologies such as virtual reality, multimedia, visual interaction and network communication. The construction of the system is not only conducive to the further improvement of the high-quality education system, but also meets the requirements of the current transformation and upgrading of digital education.

The system will support students and teachers in different roles to obtain unique account information through registration, and cooperate with passwords to complete the login and use of the system. According to the actual functional requirements of students and teachers, the system will set two subsystems: students and teachers. At the student end, users have the right to use multiple functions such as home page, training teaching, project simulation training, assessment and evaluation. While teachers' designs tend to organize, supervise and control the training courses, and the main functional modules include the publishing of training projects, uploading of teaching resources and viewing of evaluation results.

3.2 Overall Design

The virtual interactive online training teaching system will be guided by the idea of Web application development, based on B/S architecture and designed according to MVC design pattern. The overall system framework is divided into three parts: integration layer, logic layer and application layer, as shown in Fig. 5. In which, the application layer is mainly responsible for obtaining user interactive operation instructions and displaying related data results; The logic layer relies on the Unity engine and .NET Framework to complete the internal logic control of each functional module of the system, and transmits all kinds of data generated in the interactive process to the integration layer and the application layer respectively; As the foundation of the system, the integration layer will use the Web API data interface to complete the data information transmission with the logic layer, and provide necessary data support for the display layer and the interaction layer [9].

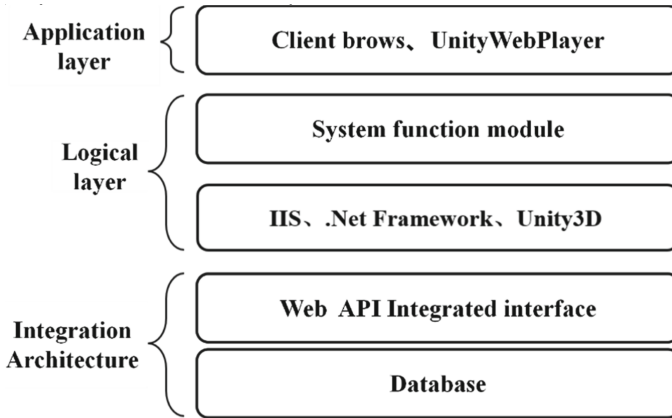


Fig. 5. Structure diagram of system framework

4 Detailed Function Realization

4.1 Students End

When the student user logs in to the system using the account number and password normally, the system will automatically jump to the homepage interface. In this interface, students can browse the practical training courses comprehensively, including all teaching plans, teaching objectives and assessment requirements. Before the start of the practical training course, students can plan the course as a whole and work out their own learning plans, so as to stimulate students' learning autonomy.

In the practical teaching module, the system will provide a large number of theoretical knowledge of practical training, including the introduction of practical training projects, practical training objectives, implementation plans, key tips and so on. In addition, the system will also provide training teaching videos and interactive online training teaching system operation videos for students to watch and learn independently, which can not only help students to strengthen their understanding and mastery of the content of training programs, but also facilitate students to learn repeatedly and strengthen the actual operation process.

In the project simulation training module, the system supports two types of training, namely cognitive training and comprehensive training. Among them, cognitive training is mainly aimed at a single link in the project, and all kinds of equipment models involved in this link are comprehensively understood and observed from multiple angles. Students can split and assemble the equipment model through the control of mouse and keyboard, and switch between the first person and the third person perspective through the buttons of the interface. This function depends on the interactive design in Unity3D. By defining the Button ViewChangeBtn event, users can switch between the two perspectives through the buttons in the scene [10]. The key code is shown in Fig. 6.

For comprehensive training, users will simulate each link in turn according to the implementation plan of the training project. In the process, some multimedia guidance contents such as text, pictures and videos will pop up in the system interface according to


```
using System;
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.UI;
public class ViewCtrl : MonoBehaviour
{
    public Button ViewChangeBtn;
    private bool firstViewState=true;
    public Transform FirstCamera;
    public Transform ThirdCamera;
    public Transform Offset;
    private void Start()
    {
        ViewChangeBtn.onClick.AddListener(ChangeView);
        FirstCamera.gameObject.SetActive(firstViewState);
        ThirdCamera.gameObject.SetActive(!firstViewState);
    }
    private void ChangeView()
    {
        firstViewState = !firstViewState;
        FirstCamera.gameObject.SetActive(firstViewState);
        if(!firstViewState)
        {
            ThirdCamera.position = Offset.position;
        }
        ThirdCamera.gameObject.SetActive(!firstViewState);
    }
}
```

Fig. 6. Key code for switching the third-person perspective from the first-person perspective

some nodes in different links, so as to assist students and users to complete the operation. And then strengthen students' understanding and cognition of practical training projects from a macro perspective, and improve students' professional quality.

The system can support the online training project assessment under the assessment module, that is, the system automatically evaluates the students' practical operation process. At the same time, it can also join the students' network mutual evaluation, which can not only complete the evaluation of students' training quality with comprehensive and scientific data information, but also reduce the influence of teachers' human factors and improve the fairness of the evaluation results.

4.2 Teacher's Side

After the teacher logs in to the system, the main functions include: the release of the course information of the practical training project, the production and uploading of all kinds of materials under the practical training teaching module, and the statistics and viewing of the students' evaluation results. The application advantage of the system

greatly reduces the workload of teachers, helps teachers to complete the teaching tasks of experimental courses with high quality and high efficiency, and effectively achieves the purpose of assisting teaching.

5 Conclusions

With the aim of cultivating applied talents of comprehensive majors in colleges and universities, based on the construction of high-quality education system, seizing the important opportunity of digital transformation and upgrading of modern education, taking practical teaching as the starting point, and with the application advantages of virtual reality, multimedia, visual interaction, network communication and other technologies, this paper constructs a virtual simulation interactive online training teaching system. This system realizes the organic combination of virtual simulation training and online teaching, which not only improves students' professional knowledge level and strengthens their professional ability, but also provides necessary technical conditions for the new mode of modern education and the new ecological reform, and promotes the development of digital education in colleges and universities. In the follow-up research, we will continue to expand the application scope of virtual reality technology, realize the application of more interactive technologies and improve the adaptability of the system.

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