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Design and Implementation of Auxiliary Application of Middle School Geography Textbook Based on Augmented Reality Technology

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***Abstract*—In order to overcome the problems of the poor three-dimensional display effect and weak interaction of traditional middle school geography textbook, an auxiliary application for middle school geography textbooks based on augmented reality technology (AR) was designed. Application according to the teaching content in the middle school geography textbook, based on augmented reality technology, the Unity3D game engine and 3D modeling software are used to combine 3D models, animations and videos with the pictures and text in the geography textbook to achieve the integration of virtual and reality. After downloading the application through mobile devices, students scan the illustrations in the textbooks, watch the displayed 3D models and animations, and interact with the displayed UI interfaces and models, so as to intuitively understand geographic knowledge, improve learning efficiency, and cultivate learning interest. The AR geography textbook auxiliary application also adds AR virtual button interaction and 360 ° panoramic interaction in the interactive design, which enriches the interactive functions of the AR geography textbook auxiliary application. Through investigation and research, the application of geography teaching in middle school is helpful to improve students' learning enthusiasm. However, there are still problems with higher application design and development requirements and greater difficulty in teaching management, and further exploration and research are needed.**

Keywords-Wisdom Education; Teaching Auxiliary Application;Augmented Reality Technology;

INTRODUCTION

With the continuous development of information technology, a variety of high and new technologies have gradually been applied to modern education that is networked, visualized, and three-dimensional [1]. Among them, augmented reality technology (AR) is a technology that superimposes virtual content or digital model content into real scenes through computer image recognition technology to achieve effective integration of virtual scenes and real scenes. With its good interactivity and intuitiveness, It is widely used in the field of education and teaching [2].

As an important carrier of education and teaching, textbooks have gradually realized the in-depth integration of information technology and paper textbooks with the rapid development of technologies such as the Internet, augmented reality, and artificial intelligence. This kind of auxiliary application of teaching materials based on augmented reality technology is mostly based on the mobile terminal display to realize the superposition of virtual information and teaching materials. By recognizing the pictures in the teaching materials, real-time viewing of the virtual scenes presented allows students to perceive the fun of interactive learning. The multi-dimensional display of complex problems and the principles of knowledge points further strengthens students' understanding of knowledge [3,4,5].

This paper designs an auxiliary application based on augmented reality technology for middle school geography textbook, combining three-dimensional models, animations, and videos with the content of middle school geography textbooks. After students download the corresponding application through their mobile phones, they can scan the illustrations in the paper textbooks to realize virtual interactive operations, which are visualized and intuitive. This application expands the functions of paper textbooks, gives full play to the advantages of modern technology, and provides a new way for students to learn independently and improve classroom efficiency.

I. APPLICATION DESIGN

A. Application flow design

The use process of the auxiliary application of AR geography textbook: Open the application on the mobile terminal and enter the first interface of the application. There are three buttons: start, quit and instructions for use. Click start to enter AR teaching. According to the prompts, use the mobile camera to scan the relevant pictures on the textbook. After the correct scan, virtual resources such as 3D models, animations, and videos will appear on the display screen. Students can interact with the UI interface or interact with Model interaction, intuitive understanding of the knowledge in the textbook. After the camera leaves the picture, the virtual resource disappears. The applied system flow chart is shown in Figure 1.

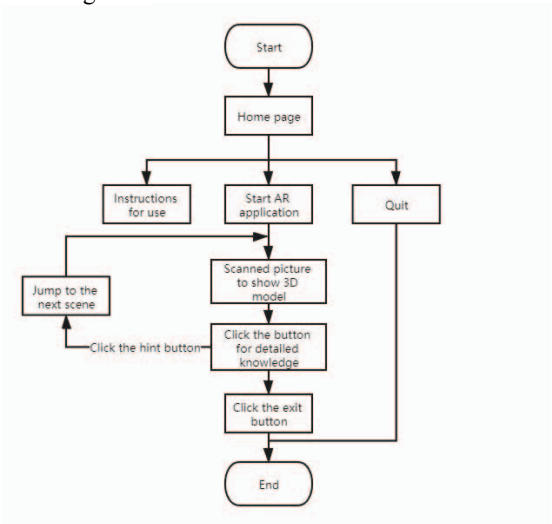

Figure 1. Application flow design

B. Application function module design

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Application function modules are mainly divided into interactive function modules, model animation function modules, panoramic roaming function modules, voice explanation function modules and video playback function modules, as shown in Figure 2.

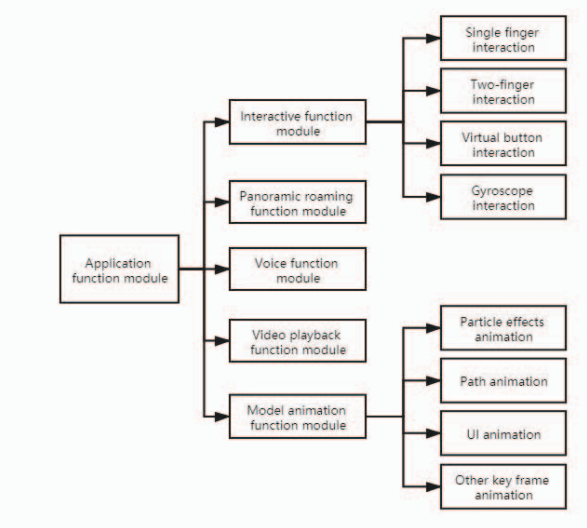

Figure 2. Application function module

a. Interactive function module

The main interactive functions of the application are: single-finger touch interaction, mainly including the click of the UI interface, the movement and rotation of the model. Multi-finger touch interaction mainly includes controlling the zoom of the model. Mobile device gyroscope interaction, using mobile phone gyroscope to achieve panoramic viewing of virtual scenes. AR virtual button interaction can realize the function of touching the virtual button to display text or play video. Students touching different models with one finger on the mobile phone screen will also bring different interaction effects. Students can interact with models, watch instructional videos and animations, listen to voice introductions, complete virtual experiments, etc., thereby assisting the learning of geographic knowledge [6,7,8].

b.Model animation function module

The model animation function is mainly to add animation effects to the 3D model, add different animation effects according to different knowledge, and express the knowledge that is difficult to express clearly in text and pictures through animation, so that students can more easily understand, deepen the impression, and increase the interest.The animation function modules mainly include: particle special effects animation such as simulating rain and snow weather animation, path animation such as Magellan fleet circumnavigation route animation, UI animation such as latitude and longitude coordinate positioning animation, and other key frame animation [9,10].

c.Panoramic roaming function module

Using three-dimensional modeling or panoramic images to build a three-dimensional panoramic space, students can use mobile devices to view virtual scenes in 360 ° , such as the "space" scene in the geography textbook. This function realizes the VR roaming effect, and students can use this function to experience immersive geographical scenes that cannot be reached due to physical limitations.

d.Voice explanation function module

Each case in the textbook has a corresponding voice explanation function, and students can choose to turn it on or off. The voice explanation function can better help students understand what they have learned and AR application operations.

e.Video playback function module

After recognizing pictures, the application can not only display 3D models and animations, but also play videos related to knowledge points. The user can control the playback and pause of the video through the buttons in the interface.

II. APPLICATION DEVELOPMENT PROCESS

This article takes the content of the first chapter of middle school geography textbook as an example to introduce the development process of the auxiliary application of AR geography textbook. The overall process can be divided into three stages: the analysis of the teaching material content, the production of models and animations, and the realization of AR interactive functions.

A. Analysis of the content of the textbook

The application in this article is based on traditional middle school geography textbooks. First, we need to analyze and plan which parts need to be integrated with augmented reality technology based on the content of the textbook and technical feasibility, and finally compile a plan. For example, an augmented reality technology case is added to the cover part of a geography textbook. When students scan the cover picture with an AR application, a 3D globe model with animation will pop up on the screen, and there will be voice explanations of the main content of the textbook and teaching goals.

B. Model and animation production

Use 3DMax, C4D, Maya and other three-dimensional modeling software to complete the production of models and animations. For example, the production of world ocean current models and animations. Use the C4D pen tool to make the arc of the ocean current to ensure that the location and length of the ocean current are consistent with the map. Add a scanning tool to combine the drawn ocean current arc with the cuboid model in the pen tool to form a three-dimensional ocean current arc. Then add a conical arrow according to the flow direction of the ocean current on the ocean current distribution map, and make a path animation for the arrow so that the arrow can move according to the direction of the ocean current. Finally, the warm current is given a red material and the cold current is given a green material to distinguish the warm current and cold current, and add ocean current text descriptions to the model，as shown in Figure 3.

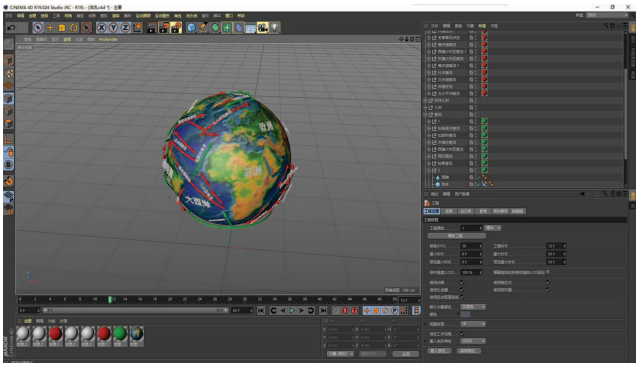

Figure 3. 3D model production

C. Realization of AR Interactive Function

The Unity game engine is used for the production of augmented reality applications. First, the model and animation are imported into Unity, and the vuforia plug-in is used to realize the picture recognition and the display and hiding of the 3D model. For example, the camera recognizes Magellan's route illustrations, and displays a three-dimensional globe and route animation on the phone screen,as shown in Figure 4.

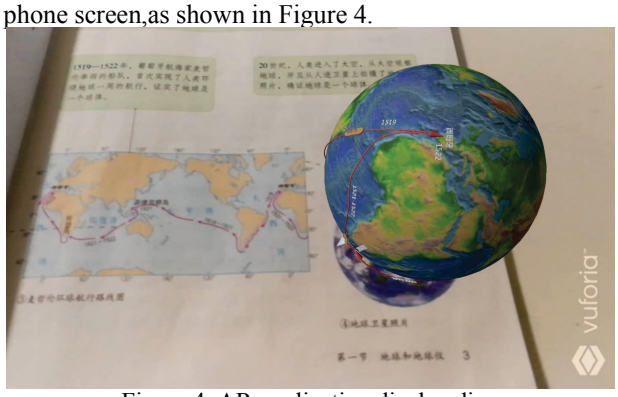

Figure 4. AR application display diagram

a.UI interaction

Use UGUI in Unity, add Button to canvas and bind onclick event to realize functions such as clicking UI interface button, jumping to scene, displaying instructions for use, or exiting the application. Scan the cover of the textbook, four chapter buttons appear, and the earth model on the left. The four buttons are: Chapter One "Earth and Map", Chapter Two "Land and Ocean", Chapter Three "Weather and Climate", Chapter Four "Inhabitants and Settlements". Click the button to realize the display and hide of the model, play introduction voice and other functions,as shown in Figure 5.

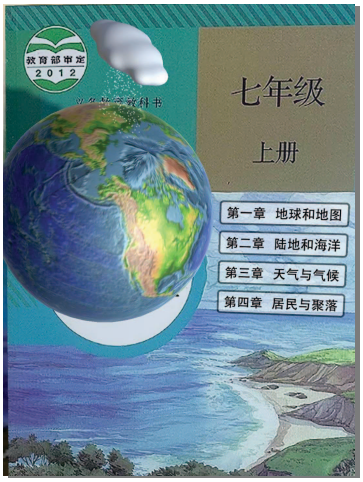

Figure 5. Interactive effect of textbook cover

b.Finger touch interaction

There are two ways to interact with finger touch. One is to use Input.GetTouch() to obtain the number, position, and displacement information of the finger touching the screen, and realize the function of rotating, dragging, and zooming in the model through C# programming. . The other is to bind the Collider component to the model, and use the OnMouseDown() method to realize the collision detection function between the finger and the model.

c.Virtual button interaction

Use the Vuforia plug-in to create a virtual button on the recognized picture. When the camera recognizes the picture, the corresponding virtual button will appear. Use your hand to touch the virtual button placed in the picture to trigger the corresponding event. As shown in the figure, when you touch the contour illustration with your hand, a three-dimensional model of the mountain with contour lines corresponding to the illustration will pop up,as shown in Figure 6.

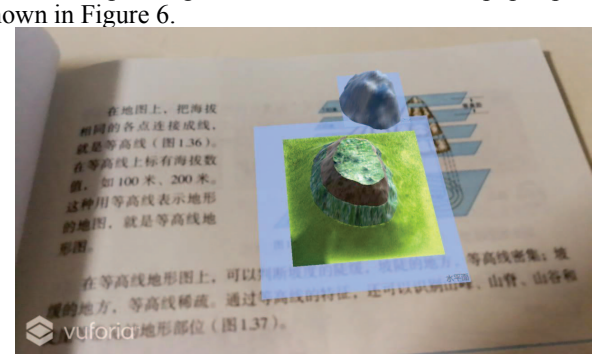

Figure 6. Virtual button interaction effect

d.Panoramic interaction

The main function of panoramic interaction is to rotate the mobile phone. The camera in the scene can also be rotated to achieve the effect of viewing the entire scene in 360 ° , allowing users to experience the wonder of the universe. For example, simulating the universe scene in the heliocentric theory in the textbook. First realize the space sky box in Unity, create a Material material in Assets, then change its Shader to Skybox/6 Sided form, and then add six starry sky pictures to form a sky box of

the universe starry sky. Select the Lighting Settings option of Rendering in the Window of the Unity 3D taskbar, and add the starry sky box to the Skybox Material to change the sky box of the scene. Then add a code to call the phone's gyroscope to the camera to get the effect of the Unity 3D scene camera following the phone's free rotation,as shown in Figure 7.

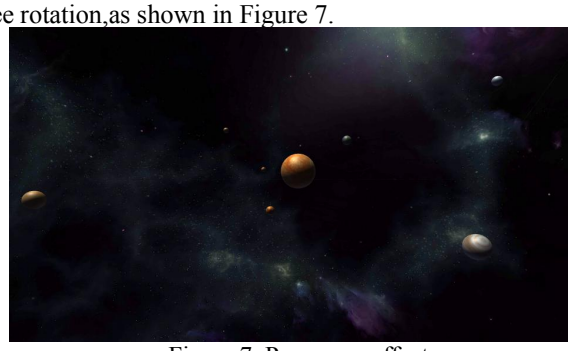

Figure 7. Panorama effect

III. PROBLEMS WITH THE APPLICATION

A.High application design and development requirements

The development of auxiliary applications for middle school geography teaching materials based on augmented reality technology involves not only three-dimensional modeling and animation production in the field of digital art, but also application development in the field of computers and software, as well as part of the content of middle school geography teaching. This puts forward higher requirements for the design and development of applications. Without a comprehensive interdisciplinary team, it is difficult to complete the production of the project.

B.Teaching management is more difficult

At present, the secondary application of geography textbooks based on augmented reality technology must use high-performance mobile terminals. However, mobile smart terminals specially used in the school environment have not been used in middle school education, and students ' own mobile smart devices are difficult to control in teaching.

IV. CONCLUSION

Textbooks are the carrier of knowledge. Under the background of wisdom education, realizing the informatization and three-dimensionalization of traditional textbook is an inevitable trend in the development of textbooks. The auxiliary application of augmented reality technology in middle school geography textbooks will enhance the interactivity of the textbooks, realize a super-sensory experience, change learning from passive to active, enhance students' interest in learning, and improve learning efficiency. The combination of virtual and real using augmented reality technology refers to simulating geographic experiments, which also saves teaching costs. Of course, the application of augmented reality technology in textbook still has technical limitations, which requires continuous exploration and research.

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