Research on The Application of AR Technology Based on Unity3D in Education

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Abstract. Augmented Reality (AR) has developed rapidly in recent years and is widely used in education teaching due to its strong sense of immersion and interaction. In this context, this paper analyzes the key technologies of AR and designs a complete display system of human body tissues and structures with interactive functions based on Unity3D and Vuforia. Finally, this system is packaged into an android app. The running results show that the app has a strong sense of immersion and interaction, and it also has strong expansibility so that we can change the human structure model into any other models.

1. Introduction

AR technology is an extension of Virtual Reality (VR) technology, which allows users to see the virtual generated model objects in the background of the real environment. It has been applied to military, medical, education, entertainment and other aspects. This interaction technology is based on the real world and is enhanced by virtual data which provides people a better way to display the learning content, and also builds a space for learners to explore independently with a more appropriate way. AR technology is very instructive for the presentation of abstract content. Because of its characteristics, AR technology has great potential and opportunity for development in education field. The characteristics of AR technical simulation and interaction can display the abstract and obscure knowledge in a more vivid, intuitive and comprehensive way, and can enhance students' sense of immersion.

The mobile AR system can strengthen the ubiquitous cooperative and scene learning with the help of virtual objects in the real environment. Everything in real life can become a prop for AR learning, achieving convenience, interactivity, situation, connectivity and personalization.

With the coming of the shallow reading age, more and more learners become less dependent on books and more inclined to the shallow reading of electronics. AR technology can take content out of the screen and books with more entertainment and interactivity. AR digital publishing will become an explosive opportunity for the culture education industry.

2. Development tools introduction

2.1 Unity3D introduction

Unity3D is a game engine and is developed by Danish company Unity. It is a multi-platform game development tool, a fully integrated professional game engine, and can provide such functions as rendering engine, physical engine, script engine, lighting mapping and scene management[1]. Unity3D
is mainly used to create games and interactive 3D and 2D experiences such as training simulation, medical and structural visualization. A complete Unity3D program is composed of several scenes, each of which contains many models (GameObject) and their behavior which is controlled by scripts (including JavaScript, C#, etc.). What we see in the scene are presented and controlled by camera.

2.2 Vuforia SDK introduction
Vuforia is a Qualcomm's software development kit for mobile AR applications, and it is an AR SDK for developers[2]. It uses computer vision technology to identify and capture flat images or simple three-dimensional objects in real time, and allows developers to place virtual objects through camera viewfinders and adjust the position of objects in the physical background in front of the lens.

3. Research on key technologies
In the whole process, AR technology realizes the perfect combination of things in the virtual world and the real environment around it and the real-time synchronization between the virtual world and the real world. The basic process of augmented reality based on Unity3D is:

1. Obtain the image of the camera;
2. Marker identification;
3. Position and direction detection of Marker Marker;
4. Superposition the virtual scene with the real scene.

3.1 Image acquisition
The Vuforia platform provides both local identification and cloud identification. The local recognition method is adopted here. This method first processes the identification image, then matches the local data, and finally returns the matching result.

The ARCamera object of the Vuforia SDK gets the Image and converts the Image captured by the camera from the OpenGL ES rendering format of the camera to the tracking format required by subsequent Image detection and matching and tracking module through Image Converter [3].

The Trackable base class is used to identify objects in the real world that the Vuforia SDK can capture in three dimensions. This class defines the basic properties of the target, such as name, type, ID, and user-defined data.

3.2 Image matching
Marker is a kind of 2D matrix code, which is usually used in image recognition technology, and image symbol recognition is carried out by a special template matching algorithm.

Firstly, the system saves the information of the Marker image and calculates the position of the virtual object in the camera according to the information. Then the processor uses the image recognition technology to identify the Market image in the current image, and finally matches the virtual object with the real scene.

3.3 Virtual reality superposition
After Marker identification and 3D calibration, we get enough information to set the location of the virtual model, and then we need to combine the real world and the virtual model to present to the user[4]. The process of virtual and real combination involves three aspects: 3D registration, object posture and light stripe.

3D registration is the registration of virtual graphics in real scene by tracking camera attitude in real time. The pose information of virtual object is completed in the phase of "feature matching" of virtual object model by comparing the similarity of real object image features and virtual model features[5]. As the surrounding environment and lighting conditions are changing, virtual objects can automatically collect texture information from the images of real objects can enhance the immersion sense of the real environment and truly realize the seamless combination of virtual and real objects.
4. Overall structure and function realization of the system

This system consists of three parts: interaction module, UI module and sound module. The system framework is shown in Figure 1.

The interaction module is mainly responsible for the interaction between the user and the model; the UI module is responsible for displaying the text introduction of various tissues and organs of the human body; the sound module is responsible for the sound reminder of the touch and the text reading.

4.1 Interaction module

This development mainly runs on the mobile side, so it is necessary to recognize the touch gesture and add a trigger event. The flow of touch interaction is shown in Figure 2.
Gesture recognition is divided into three parts:

(1) Single finger click

Single-finger click is primarily used to trigger buttons. There are two types of buttons, namely "Text prompt" button, "Reset" button and "Take apart". "Text prompt" button is mainly used to display the detailed description of each body structure. When users click the corresponding button, the corresponding text introduction will pop up; "Reset" button is used to restore the initial state of the model and "Take apart" button is used to disassemble the mannequin.

(2) Single finger moving

Single-finger moving has two functions, rotating models and dragging models. In order to avoid conflict between the two methods, the project will use the method of ray detection to determine whether to rotate or drag. A ray is an infinitely long line that is emitted from a point in one direction in a three-dimensional world[6]. In this example, the ray is emitted from the camera to the touch point. The code example is as follows.

```csharp
Ray ray = Camera.main.ScreenPointToRay(Input.GetTouch(0).position);
private RaycastHit hit;

On the trajectory of the ray, once collided with models which are attached with collider component, a bool value will be returned, and the RaycastHit class is used to store the collision information generated after the ray is emitted.

If the ray hits the object, the progress will perform "Drag" operation, otherwise perform "Rotate" operation. In addition, in order to more intuitively display whether the model is touched, the system will play the enlarged model animation when finger is long pressed or dragged.

(3) Two-finger moving
Two-finger moving is mainly used to adjust the size of the model. The specific algorithm is to judge the enlargement and reduction commands by calculating the positive and negative of the distance difference between the old and new touch points. And the scope of zooming in and out is specified. The specific implementation code is as follows:

```csharp
float oldDistance = Vector2.Distance(oldTouch1.position, oldTouch2.position);
float newDistance = Vector2.Distance(newTouch1.position, newTouch2.position);
float offset = newDistance - oldDistance;
float scaleFactor = offset / 500f;
Vector3 scale = new Vector3(localScale.x + scaleFactor, localScale.y + scaleFactor, localScale.z + scaleFactor);
```

4.2 UI module
The UI part mainly plays a role of the display. The UI system of this example is divided into two parts: "button" and "prompt message". The button part is used to trigger a click event, for example, when the user clicks the "Reset" button, the model "Reset" method is triggered; when the user clicks the "Take apart" button, the mannequin will be take apart. The prompt information interface is triggered when the circular button corresponding to the organ was clicked. The prompt information part is mainly used to display the text introduction of the human body structure to users more stereoscopically and intuitively, and add UI special effects in the prompt interface to enhance the interactive sense.

4.3 Audio module
The audio part is mainly used to prompt users to click on the behavior and read the text. When the user clicks on the circular button corresponding to the organ, the mobile phone will read the text in the UI while triggering the prompt information interface, which not only enhances users experience but also allows users to practice oral skills.

Sound is mainly triggered by the "Audio Source" component. First, the component is obtained in the script. When the button is triggered, the "Enable" property is set to True, and the sound can be played. Clicking the button again can stop playing sounds. The code example is as follows:

```csharp
public AudioSource audio;

public void OnClickPlaySound()
{
    if (audio.enabled == false) { audio.enabled = true; } else { audio.enabled = false; }
}
```

5. Conclusion
AR technology combines the virtual world with the real world, providing a richer presentation mode for education and enhancing the interaction and participation of learning. It makes knowledge and information more accessible and attractive for learners, and is becoming a new hot spot for education application of information technology. The final display effect is shown in figure 3.
Following the pace of technological development, this study proposed multi-interactive and cross-platform Vuforia+Unity3D AR technology scheme based on mobile terminal, and developed AR application of "human tissue structure demonstration". Through testing, the accuracy rate of the recognition image of the application reached more than 98%. In terms of content, this application also has good expansibility. By replacing content, we could quickly transform various demonstration and teaching works. Therefore, the Vuforia+Unity3D augmented reality technology scheme is very suitable for education field and has extensive application value.

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