The application of human-computer interaction technology in the teaching reform of mechanical drawing

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ABSTRACT. *To establish the mechanical drawing teaching system based on human-computer interaction technology, using unity5.5 software and AutoCAD 2 d images into 3-d shape, and through the leap motion sensors to realize human-machine interaction, through gestures or the mouse to control the rotation of the three dimensional figure, scaling and cutting, make obscure difficult mechanical drawing lessons lively and interesting, which widens the stereoscopic thinking of students, inspired their interest in learning.*

KEYWORDS: *Human-computer Interaction, Augmented Reality (AR), Mechanical Drawing*

1.Introduction:

Mechanical drawing is required a professional basic course for engineering speciality, as fledglings students first come into contact with one of the professional course, its importance is obvious [1] and the majority of engineering drawing course in colleges and universities in our country, still adhering to the "delivery - accept type" of the old teaching mode, namely the system theory knowledge training basic drawing skills as the goal, the memory and reasoning ability of students is more focused on mining[2], with the rise of artificial intelligence and information technology highly developed this kind of teaching mode has far couldn't keep up with times demand[3], based on the technology of mechanical drawing teaching reform is imminent Technology of human-computer interaction as the current research hotspots, won wide attention all over the world, the augmented reality (AR) and leap motion controller is developed based on virtual reality technology. AR technology incorporates the scenario of computer generated to the real world, expansion and complement rather than replace the real world to the real world, thereby strengthening the user to the real sensory and cognitive[4], leap motion controller can be connected to the computer, the design gesture control computer, realize the human-computer interaction literature [6] has accepted AR technology in human-computer interaction system in detail. Literature[7] uses AR technology to

scan and position human brain, making contributions to medical science. This paper introduces human-computer interaction technology into the teaching of mechanical drawing, and controls the demonstration of CAD model through gestures designed by leap motion controller.

2. The Theoretical Basis

2.1 Augmented Reality Technology

AR (Augmented Reality) is a technology developed based on VR(Virtual Reality). AR is a technology, a real-time calculation of camera image position and angle and corresponding image technology. Through the computer to virtual objects, pictures, video, sound and real situation, you can feel more three-dimensional virtual objects in the real environment. AR's virtual information complements the real world, and it can present a new real environment to the user's sensory effect, making the virtual object a part of the surrounding environment from the senses. AR enables the enhancement of the real environment, enhances the user's perception of the real world and the ability to interact with the real world. AR can be used to make models of learning needs in simulation teaching, which is beneficial to abstract content teaching and stimulate learners' learning pleasure. AR is actually a bridge between the virtual environment and the real world.

The key part of implementing AR in unity 5.5 is the combination of virtual and real. The basic process of the image recognition type augmented reality program is to capture the scene in the real world through the camera, input the computer in the form of digital information, and obtain the tracking information through the image analysis method, thereby presenting in the corresponding position of the preset space coordinates 3D solid model. For image processing, a two-dimensional zero-mean discrete Gaussian function is often used as a smoothing filter. Set the image $f(x, y)$ from h to h (in pixels) and width w, $(0 \leqslant x \leqslant w, 0 \leqslant y \leqslant h)$, $f(x, y)$ is the pixel value of a point, and the pixel value of the point is replaced by the weighted average of the neighborhood of the pixel. The Gaussian filter width is determined by the parameter σ , function expression is:

$$G(x, y) = \frac{1}{2\pi\sigma^2} \exp\left(-\frac{x^2+y^2}{2\sigma^2}\right) \tag{1}$$

This is a circular symmetric function, convolution of this function and function $f(x, y)$ to obtain a smooth image $f_x(x, y)$:

$$f_x(x, y) = f(x, y) * G(x, y) \tag{2}$$

Smooth image $f_x(x, y)$, $f(x, y)$ is the pixel value of a point, $G(x, y)$ is a circular symmetric function.

2.2 Leap motion controller

The coordinate system of Leap motion is the Cartesian coordinate system we are familiar with. The data obtained by Leap motion is in millimeters. The coordinate origin of the Cartesian coordinate system is at the center of the Leap motion sensor itself, and the Y axis is perpendicular to the plane formed by the X axis and the Z axis. The farther from the top of the Leap motion sensor, the larger the Y value, the farther away from the computer screen, the Z The larger the value, the farther away from the right side of the computer screen, the larger the X value.

The basic principle of Leap motion is to measure the round-trip time of the light to determine the distance, that is by modulating the light pulse during scanning and continuously transmitting and capturing the depth of the entire scene. Leap motion consists mainly of three infrared LEDs and two cameras hidden under black glass. Motion tracking of opponents and fingers can be achieved when the hand is moving over the sensor.

3. Design and Implementation of Human-computer Interaction Technology

3.1 Model Establishment and Drawing of Drawings

In order to realize the three-dimensional teaching system of AR-based CAD, the basic hardware required is a computer, a camera, a Leap motion sensor and a CAD 2D part drawing required for the demonstration. The implementation process of mechanical drawing human-computer interaction technology based on AR and leap motion is shown in Figure 1. The 2D part drawing is picked up by the camera and input into the computer, and the image recognition and feature extraction is realized by the Image tracker module in the language unit 5.5. The 3D registration is realized by the easyAR module in unity 5.5, and the extracted features to the 3D model in the system library and realizes the fusion of the virtual and the real. Finally realizes the interactive control of the image through the leap motion design gesture or directly controls the rotation and cutting of the 3D image through the software.

The Leap motion sensor can be connected to the computer's USB interface through a data cable. At this time, the Leap motion sensor will establish a three-dimensional space with its center as the origin. The human hand movement can be captured within this range to control the model and perform a model demonstration. The camera is connected to the USB port of the computer through the data cable, and the processed drawing is placed in front of the camera. The camera will recognize the drawing graphic, and the model will appear above the drawing.
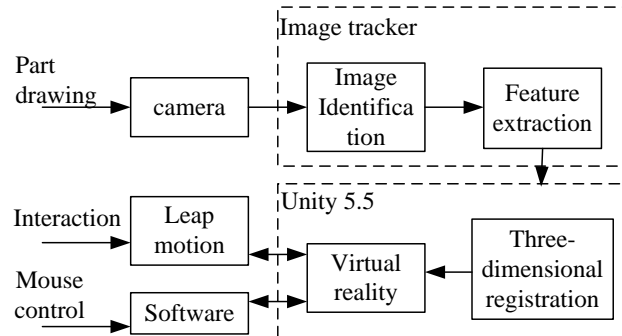
Fig. 1 implementation process of interaction technology

First of all, we must implant a large number of three-dimensional graphics consistent with CAD 2D parts drawings in the development system. We take the bearing lower case as an example and use CAD software to create a 3D solid model as shown in Figure 2:

Create a model according to the requirements, click Layout 1 to create 4 viewports, and set the main view, left view, top view, and the last viewport can be left unset. Then select the active object of the main view and generate the outline by using the SOLPROF commands, the remaining two views perform the same operation to extract the outline. Then copy and paste the outline of the main view to layout 2 and the remaining two views do the same. Note that each view outline is copied to layout 2, which form a complete graphic entity, and the decomposition command (EXPLODE) is used to decompose them into several basic graphic entities, and then edit and modify according to the drawing. After checking, the 3D solid model and its three views are exported. Then the output drawing is further processed by Photoshop, and finally converted into JPEG mode, as shown in Figure 4.
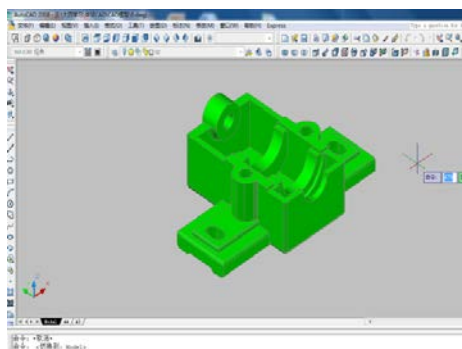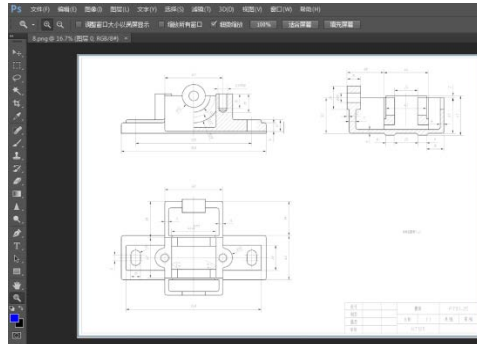

Fig. 2 3D modeling

Fig.3 Generate 2D part drawing

3.2 Implementation of software operation functions

Register and log in to the AR website, in order to initialize the Easy AR SDK, you need to generate a Key on the original web page. On the AR website, download the Easy AR SDK and the Easy AR SDK Unity Sample installation package.

Open Unity5.5 and import Easy AR from the Easy AR SDK Unity Sample into Assert. Find Easy AR objects and type 'Key' in the inspector. If the key is illegal, the screen may be blank. Enter key as shown in figure 4-a, and then you can use Unity normally. How to configure the Easy AR SDK: First find the Easy AR.unitypackage in the downloaded Easy AR archive, open it and import it into the unity, as shown in Figure 4-b. In order for the Easy AR to work properly, Easy AR prefab or other prefabs needs to be added to the scene. Drag the Easy AR prefab to the scene, as shown in Figure 4-c.
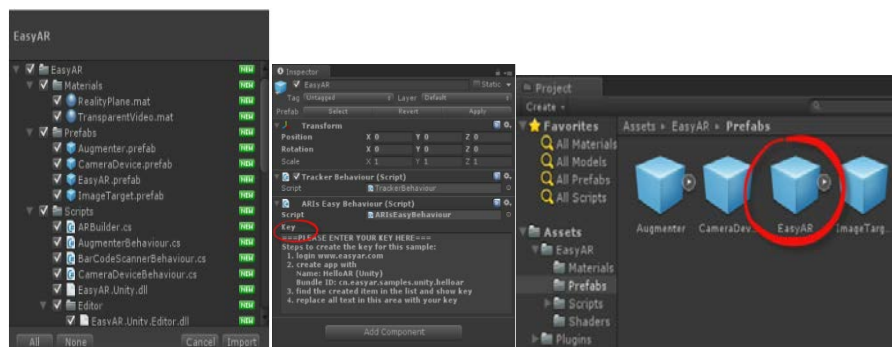
A key page   B plug-in   C Adding process of easy AR
Fig.4 Interface of Unity

Import the pre-processed CAD 3D solid model and model view into Unity. Drag the existing idback of the system to the Direction-light and change the name to image Target-Jsonfile-idback(1). Then copy several copies and rename, drag the solid model to the stage, adjust the 3D entity and identify the position of the image. The idback is replaced by the inverted JPG1-8. The target image is placed under the camera, and the camera automatically scans the image. On the output device, a three-dimensional model is generated over the three-view drawing，as shown in Figure 5. Log in to the Leap motion website, register and download Leap motion-Core Assert 4.15, Leap motion-HandsModule-2.1.0.unitypackage, Tnteraction Engine-0.3.0.unitypackage, Attachments-1.0.4.unitypackage, extract the installation package and import unity5. 5. Use a data cable to connect the Leap motion sensor to the computer's USB port. The leap motion establishes a connection with the computer. Leap motion captures the human gesture and presents it on the computer screen. The printed drawing is placed in front of the camera and the corresponding three-dimensional model on the computer monitor plane. The Leap motion sensor is connected and the three-dimensional solid model can be enlarged, reduced and rotated by gestures. You can be displayed to the students according to the actual needs of the teaching, as shown in Figure 6.
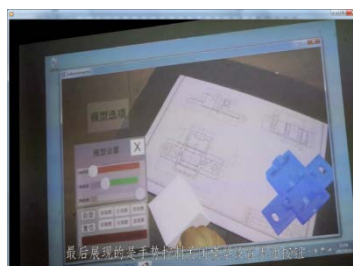

Fig. 5 Model generation diagram

Fig. 6 Gesture Control and Display

4. Brief summary

Mechanical drawing based on the technology of interactive teaching method compared with the traditional teaching method, interactive technology provides students with a more realistic virtual learning environment, the three dimensional model generated directly on three view drawing drawings, students will be more easily linked to three view drawing and the entity model of the object, is helpful to improve the students' space imagination Use gestures to control model of teaching is much easier to mobilize students' learning enthusiasm and initiative, to help students to break through the teaching emphasis and difficulties, achieve efficient classroom mode and inspire students' innovative thinking, so will be introduced to the interactive technology to the teaching of mechanical drawing, to drawing class teaching provides a new and more effective means of teaching demonstration.

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