Research on Civil Aircraft Customer Service Application Based on Augmented Reality Technology

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Abstract: Civil aircraft customer service mainly includes technical publication support, Aircraft Operations Support, and Aircraft Customer Training. Using Augmented Reality technology to carry out customer service work can effectively improve work efficiency, reduce customer use costs, and shorten aircraft maintenance cycles. This paper makes a preliminary exploration of the application of Augmented Reality technology in civil aircraft customer service work, and gives the application framework of the Augmented Reality civil aircraft customer service system to provide help for the future upgrade of civil aircraft customer service technology.

1. Introduction
Augmented Reality (Augmented Reality, AR for short) is a technology that superimpose virtual information in the real environment with the help of photoelectric display, human-computer interaction, visualization and other technologies to achieve enhanced effects on the real environment[1]. In the field of mechanical manufacturing and maintenance with high complexity, AR is usually used as a navigation system to assist in assembly or repair. For example, Klinker and others have developed the AR system STARS for nuclear power plant maintenance. The operator can complete the maintenance process according to the guidance of the display[2]. In 2016, the Boeing Technology Department used Google Glass to guide employees in the assembly of aircraft wiring harnesses. After using Google Glass, the average dress time of employees was reduced by 25%, and the amount of errors was reduced by half[3]. Generally, Augmented Reality development requires the use of a Software Development Kit (SDK). Vuforia is a commonly used SDK in the field of Augmented Reality. It is launched by PTC and is mainly aimed at the development of Augmented Reality applications for mobile devices. This article uses the Vuforia SDK to explore the Technical Publication Support Services, Aircraft Operations Support, Aircraft Customer Training, etc. of Augmented Reality technology in civil aircraft customer service work, to assist the crew to carry out their work, prevent human errors, improve technical support capabilities, and enhance Aircraft Customer Training effect.

2. Application of Augmented Reality in Technical Publication Support Services
Civil aircraft Technical Publication Support Services include the publication, distribution, and full-life services of publications such as Aircraft Maintenance Manual (AMM), Fault Isolation Manual (FIM), and Aircraft Illustrated Part Catalog (AIPC). Interactive Electronic Technical Publication (IETP) is a technical publication that is stored in digital form, expressed in various forms such as text, models, video, audio, charts, and has human-computer interaction functions[4]. IETP based on Augmented...
Reality technology has high application value in the work of aircraft route inspection. When the AR technology is applied to the general visual inspection work in the aircraft maintenance manual, the necessary three-dimensional models such as parts and tools to be inspected should be stored in the model database, and then according to the work order, the traditional paper manual will be transmitted to the aircraft machinist in the form of video and text. In the course inspection application, the system obtains the inspection scene through the terminal camera, automatically recognizes the parts to be inspected and displays them with a three-dimensional model, and prompts the content to be worked through text and voice, and the operator carries out inspection work based on the information. The process of supporting services for aircraft technical publications using Augmented Reality technology is as shown in Table 1.

Table 1 Augmented Reality work process

| Step | Description |
|------|-------------|
| 1    | Call library: Unity Engine, Vuforia; |
| 2    | Call the module “Camera” to intercept each frame picture; |
| 3    | Call the module “Image Converter” to convert “Camera” images to OpenGL ES rendering images; |
| 4    | Call the module “Tracker” to achieve target object feature tracking; |
| 5    | Call Vuforia Web Services API to upload to CloudDatabases; |
| 6    | Feedback metadata; |
| 7    | If the “recognition is successful” Generate “Trackable Result” object; |
| 8    | Call the “get Pose ()” function to obtain the external parameter matrix; |
| 9    | Retrieve the corresponding AR resources; |
| 10   | Unity Renderer converts resources into game bodies; |
| 11   | Access “Application Code” rendering resources and display. |
| 12   | Otherwise, “the identification is failed” |
| 13   | Update “Tracker”; |

When using the system, first of all, we need to click the identification button on the smart terminal. After the recognition is successful, the system automatically loads the corresponding three-dimensional model information to indicate the position of the engine blade to be inspected, and the effect is shown in Fig.1. Inspectors carry out visual inspection according to the prompts, and can continue to the next inspection after completing the previous inspection. During the test, the aircraft components were identified smoothly, and the stability of the light conversion and small-angle viewing angle changes was maintained. The recognition speed was fast, and the model was loaded smoothly, and the accuracy was high. The operator can adjust the size of the model by adjusting the distance. This function has played an effective role in guiding the route inspection, preventing the occurrence of human errors such as missed inspections and misdetections, and reduced the inconvenience caused by paper technical publications to the maintenance of the route.

![Fig.1 Contrast before and after application of Augmented Reality](a) Without AR technology (b) After using AR technology

3. Application of Augmented Reality in Aircraft Operations Support

Augmented Reality technology is mainly used in aircraft daily maintenance work in Aircraft Operations Support. When maintenance personnel encounter thorny problems, they can perform
remote video connection via the Internet and perform maintenance operations with the help of remote experts. Remote experts can also communicate information to maintenance personnel through voice, text, pictures, etc.

During use of the system, the AR display can read the technical manual data from the central server, and can transmit the real-time pictures (virtual scenes and real scenes) in the AR glasses to the central server. The central server can transmit the real-time pictures in the AR glasses. It is transmitted to the expert auxiliary terminal, and the expert auxiliary terminal transmits the auxiliary result data (3D annotation, voice, etc.) to the server, and displays it in real time through the AR display terminal to assist the operator in operations or maintenance. The Expert System interface is shown in Fig.2.

Aircraft Operations Support is the core element of the civil aircraft customer service system. Combining Augmented Reality technology, the development of AR-assisted operation intelligent maintenance systems for aircraft can improve customer service capabilities, which in turn is conducive to promoting business growth.

4. Application of Augmented Reality in Aircraft Customer Training
Aircraft Customer Training is also an important part of civil aircraft customer service. Aircraft Customer Training mainly includes training for civil aircraft pilot, aircraft machinist, dispatcher, and cabin crew attendant. Augmented Reality technology is of great help in aircraft machinist training and teaching. By making a maintenance teaching example set and showing it to the trained aircraft machinist, the trained aircraft machinist can see the disassembly and assembly process of aircraft parts through the smart terminal.

In development, first collect the target part picture set, and recognize the picture through Vuforia SDK. Vuforia SDK records image features through corner recognition. Corners usually include sharp points and contour intersections of the image. In the cloud database after the corner recognition of the target object is completed, Vuforia will rank according to the number and distribution of the recognized corners. When rating, the image is divided into five levels, high-level images are easier to recognize. As shown in Fig.3.
After processing with Vuforia's own feature recognition and description algorithm, “.dat” and “.xml” files will be generated on the Vuforia web page. Then download these files and the Vuforia SDK and import them into the development platform Unity3D to create a scene information library. On this basis, developers develop functions such as interface effects and virtual buttons. After the development is completed, the data and code files included in Unity are packaged into .APK files and installed on the phone.

When the operator recognizes the training parts through the smart terminal, the maintenance steps of the parts will be loaded into the smart terminal through the three-dimensional model and text. Trainees can understand the structure of the components and precautions for disassembly based on the display of the smart terminal, and participate in the virtual disassembly and repair process of the components according to the prompts. This method does not require real equipment and venues, while greatly improving the customer’s immersion. It reduces the cost problem of actually disassembling aircraft parts, and at the same time, it also effectively improves the training quality. The effect is shown in Fig.4.

![Fig.4 Teaching effect of disassembling a 3D printed part](image)

### 5. Summary

Based on the civil aircraft customer service work, this paper proposes a civil aircraft customer service technical solution based on Augmented Reality technology. Experiments prove that Augmented Reality technology maintains good robustness to camera angle of view changes, ambient lighting, and object occlusion, and it has feasibility in guiding route inspection, remote operation support, maintenance training and teaching. In the future, we can continue to enrich application system functions and realize the integration of aircraft public source databases and other resources, so that the system can be smoothly applied in civil aircraft customer service work.

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