Application of Augmented Reality Technology in Workshop Production Management

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Abstract. Mobile terminal-based augmented reality is one of the hot spots in the field of mobile applications and human-computer interaction. This paper introduces how to use Unity and Vuforia SDK to develop mobile terminal augmented reality applications, in view of the problem that most of the traditional workshop production management can not easily access the relevant equipment and production information anytime and anywhere, we can apply the augmented reality technology to the workshop production management. Finally, taking i5OS production unit of Tongji University as an example to introduce how augmented reality used in workshop production management.

1. Introduction
With the expansion of the scale of equipment and workshops in industrial workshops, as well as the digitization and informatization of manufacturing industry, the amount of production information is becoming more and more huge. How to use those information more conveniently in workshop management is one of the keys to improve the operation efficiency of the workshop. Those years, people began to focus on the application of augmented reality technology in workshop production management.

Due to the continuous development of the manufacturing industry, the management level of the production workshop is far behind the production pace. How to obtain all kinds of information in the workshop anytime and anywhere becomes more and more important for the real time optimization and management of the workshop. Augmented Reality can be found to be a very friendly technique for interacting with reality. Workshop contains a wide range of equipment information and a lot of production information. Nowadays, most manufacturing enterprises cannot obtain the workshop operation information anytime and everywhere in the workshop, such as the basic information and processing information of a specific equipment. Using augmented reality technology can easily obtain the corresponding specific information anytime, anywhere in the workshop.

2. Augmented Reality Technology and Development Methods

2.1. Augmented Reality
Augmented reality means to take digital information such as audio, video, touch or haptic sensations and to overlay them over in a real-time environment [1]. Most commonly, the signal of a digital camera is used, allowing the user to see the real world equipped with virtual objects[2]. To develop augmented reality applications, a variety of software development toolkits are available, such as ARToolKit and Vuforia SDK.
2.2. Development Method of Augmented Reality Application based on Unity and Vuforia SDK

2.2.1. Unity and Vuforia SDK overview

Unity is a multi-platform, integrated development engine developed by Unity Technologies that enables developers to easily create interactive content such as 3D interactive screens, architectural visualizations, real-time 3D animations, and interactive 2D content. Developers can publish developed projects to multiple platforms without cumbersome secondary porting[3]. Unity is a powerful integrated game engine and editor that allows developers to quickly and efficiently create objects, import external resources, and connect them together using scripting code[4]. The Unity editor is visual and built around this principle where developers can do their job using a simple drag-and-drop action or even connect scripts and write their own scripts to do specific things.

The Vuforia SDK is Qualcomm's software development kit for mobile augmented reality applications. It uses computer vision technology to recognize and capture images or simple 3D objects (such as boxes), it allows developers to place virtual objects through the camera viewfinder and adjust the position of the object[5]. The application based on Vuforia SDK uses the mobile device's display as a hub to connect the augmented reality world. The application renders the real webcam preview image onto the display device as a real image[6]. Virtual 3D objects are superimposed on the real image, giving users a sense of immersion.

2.2.2. Develop application of augmented reality with Unity and Vuforia SDK

Unity is the mainstream of game engine which has good support for 3D animation. And the Vuforia SDK is one of the most popular augmented reality development kit in the world[7]. What’s more, Vuforia SDK has a specific version for unity, so it can work well with Unity.

It’s extremely easy to develop your own augmented reality application with Unity and Vuforia SDK, it can be broken down into the following steps:

1) Create your Unity project.
2) Download Vuforia SDK and load into Unity project.
3) Apply your License for Augmented Reality Applications in Vuforia and add them to the corresponding settings in Unity
4) Create a database of identification image, which is created for creating identification marks for the actual objects you are tracking. We use the identification image in the database to identify the actual objects in the real world and overlay the virtual model we want.
5) Download database and load into Unity.
6) Develop your application of augmented reality accord to your own requirements.
7) Publish as Android or iOS application.

2.2.3 Advantage of Unity and Vuforia SDK

For using Augmented Reality in workshop, we’d better find an easy way to develop our application because we may change our requirement frequently and need to develop application in short time. Unity is a powerful integrated game engine and editor that allows developers to quickly and efficiently create objects, users can get perfect user experience during using Unity. Compare to other SDK of Augmented Reality, Vuforia SDK can work well with Unity and it’s very easy for a common user to develop good application in short time.

3. Application of Augmented Reality in Workshop Production Management

3.1. Application Occasions of Augmented Reality Technology in Workshop

Application occasions of augmented reality technology in the workshop production manage- men can mainly consider from the following perspective:

1) Equipment management and maintenance: each equipment can be bound with a unique QR code, and the augmented reality application can recognize the corresponding equipment by QR code,
then information of equipment will display on the specific position, for example, we can see basic information of equipment in different position according to the information belonging to which part of the equipment. Through this way, workers can clearly know what the information stands for and find corresponding problems of the equipment timely, then works can do some preventive maintenance and real-time monitor.

2) Production optimization management: The augmented reality application can be combined with the Internet of Things (IoT). The production system collects data from sensors and cameras on the equipment and uploads the data to the cloud. After integrating and analyzing big data, the augmented reality display device show result in augmented reality way, it provides support for production and maintenance personnel to optimize workshop management.

3) Material Management: In an extensive product warehouse, augmented reality can show the information of each product to the warehouse manager in a strong visibility way which can make material management easily.

3.2. Design of Augmented Reality Application in Production Management

In view of above situation in workshop, we can develop an augmented reality application for information visualization anytime and anywhere in workshop to improve the efficiency of workshop production management.

In traditional workshop nowadays, there is no timely way to get different kinds of real-time information of a production line or equipment anytime and anywhere, such as equipment information and manufacturing information. If we want to get some real-time information, we may need to find a computer and search the information which uploads by the equipment. It's very inconvenient if we need to search information in computer every time we want to get some information in large workshop.

In large-scale production management, we can use augmented reality technology and network technology to solve the above problems.

As mentioned earlier, it’s easy to use Unity and Vuforia SDK to develop mobile augmented reality applications, and developers can easily develop different augmented reality applications according to the specific needs of the different workshop.

The workshop augmented reality system mainly needs to do the work in three aspects: list the information needs, publish the information service, develop the augmented reality system.

1) List Information Needs: The workshop production management is mainly aimed at the production operation phase and the maintenance phase. According to the characteristics of workshop production management, information needs mainly includes the equipment monitoring information, production information, material information, employee information, and Workshop key performance indicators (KPI).

   a) Equipment monitoring information: contains basic equipment parameters and real-time equipment health indicators. Such as the installation method, the weight of the equipment, etc. But also some dynamic information, such as real-time temperature, working hours and so on.

   b) Production information: Contains the information of all orders (finished and unfinished), real-time tracking information of product quality, the information of Processing product.

   c) Material information: mainly includes information of material area and finished product area.

   d) Personnel Information: Mainly contains information of all personnel and on-duty personnel. Such as name, age, job number, proficiency, level and other information.

   e) Workshop Key Performance Indicators (KPI): Mainly based on the relevant information collected above.

   The above information can be mainly divided into static and dynamic information, static information is stored in the production database, and dynamic information is some real-time collected data and real-time analysis data.

2) Information Service Release: Publish the above processed information as Web Service interfaces according to different requirements, those interfaces will be called in augmented reality application.
3) Develop Augmented Reality Application: use Unity and Vuforia SDK to develop augmented reality applications according to the specific needs of workshop production management.

![Development flow chart of AR application.](image)

As shown in Figure 1 is the basic development flow chart for developing an augmented reality application in workshop production management, developers can according to the flow chart and their own needs to develop customized augmented reality application.

**Figure 1.** Development flow chart of AR application.

3.3. Application Case
This part takes i5OS production unit of Tongji University as an example to introduce how augmented reality used in workshop production management.

3.3.1. i5OS production unit overview
i5OS production unit mainly includes two i5 industrial robots, automatic material warehouse, two stereoscopic warehouse, a laser engraving machine and a information acquisition device named IBox. The main work of this production unit is Laser engraving for rings.

About the running mechanism of the unit , first, we can Order in WeChat by ourselves , then through MES system for the unit , we can give work order to i5OS production unit through internet . After receiving the order given by MES system , the unit can work fully automatic.

All the dynamic information during work time can received by the IBox, such as angle information of robots, signal information of laser engraving machine and so on.
3.3.2. Development of augmented reality application based on i5OS system
Finally, the paper takes the above i5OS system as a workshop production management case, and on this basis, develops an augmented reality application.

There are two type information, static and dynamic information in i5OS production unit. The key technique is how to get the dynamic information. In this System, the import real-time information such as signal information of robots and laser engraving machine is sent to the IBox. We can get the dynamic real-time information from IBox by our own specific protocol. Then publish as webservice interfaces to be used by AR System. Also, we can get real-time detail information of work order from MES system by webservice.

As show in figure3, we bind a QR code to the production unit, our augmented reality application can recognize the unit by the specific QR code, we can get different real-time information through choosing different button on the application UI. If we are in a real huge workshop, how convenient it is if we can get real-time information anytime and anywhere just with a mobile camera.

Application developed above is a basic augmented reality system. With Unity, we can easily add the information we want to get, and we can overlay the information in any place we want with good visualization. One of the benefits of augmented reality application is that it takes only one mobile phone camera to achieve our goals. This is a very portable and convenient way in a complex, practical workshop.

4. Conclusion
This paper briefly introduces the augmented reality technology, the development methods of augmented reality application and what can augmented reality technology do in workshop. When we in a large factory workshop, how convenient it is if we can get real-time information anytime and
anywhere just with a mobile camera. The information application based on augmented reality introduced in this paper can be easily applied to the workshop production management. As long as the QR code of the corresponding system or equipment is scanned, the information we want can be conveniently obtained in a good visualization way, which can greatly improve the work efficiency of technicians.

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