

# Weapon Equipment Auxiliary Maintenance Platform based on Augmented Reality Technology

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**Abstract.** With the development of science and technology and the progress of society, many large-scale equipment with extremely complex structure and high technology density is gradually equipped with our army, and such equipment has very high requirements for the technical level of personnel in the maintenance process. At present, the traditional maintenance technology has the problems of poor security and low efficiency, and augmented reality technology, combined with computer vision, machine learning and other fields of knowledge, has become the mainstream method in auxiliary maintenance, which plays an important role in improving accuracy. In this paper, Augmented Reality System to Assistance Maintenance Platform (ARSAMP) is established. Firstly, the advantages and functions of augmented reality are analyzed. Secondly, it gives the development situation of foreign countries. Then the advantages and disadvantages of traditional maintenance and ARSAMP are compared and the advantages and disadvantages of the current maintenance platform are pointed out. Finally, the effective solution to improve the maintenance effect is put forward and the future development direction of the platform is prospected.

**Keywords:** Augmented reality; Computer vision; Machine learning; Auxiliary maintenance.

## 1. Introduction

Augmented Reality [1] (referred to as AR) as a new type of artificial intelligence technology, the use of additional information generated by computers to the user to see the real world scene to enhance the technology, additional and real two kinds of information complement each other, It increases the amount of information and understanding of the real scene of human perception. In view of its intuitive and transparent way of interaction and potential huge development space, augmented reality technology is being paid more and more attention by scholars all over the world, and its application areas are gradually spread throughout the entertainment, medical, business, teaching, military, engineering and other aspects of all sides.

At home, due to the late start of research on augmented reality technology, few people are currently involved in the field of augmented reality. The existing maintenance and assembly are by looking through the paper text block or check the electronic manual, so that the operator side to look at the side repair, resulting in inefficiency, easy to be affected by the environment, the emergence of maintenance and assembly errors. And rely entirely on the maintenance skills and experience of maintenance personnel, maintenance and assembly quality controllability is poor. Therefore, it is of great theoretical value and practical significance to carry out the research of maintenance technology and method with the goal of improving the maintenance level of weapon equipment and reducing the difficulty of maintenance.

This paper introduces the research progress of AR Technology, analyzes the feasibility of AR technology in auxiliary maintenance, studies the key technology, develops a kind of auxiliary maintenance platform ARSAMP based on augmented reality, reduces the difficulty of maintenance work, reduces the operation error, and the following figure shows the work flow:

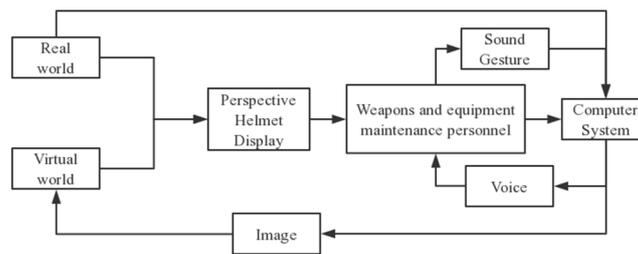


Fig. 1. ARSAMP flowchart

## 2. Basic Theory

### 2.1 Augmented Reality Concepts

Augmented reality is an important branch of the development of virtual reality [2] Technology (VR), AR Technology focuses more on real-time method research, virtual information as an auxiliary means to add virtual objects to the real world. The relationship proposed by Milgram [3-5] is shown in Figure 2 below:



Fig. 2. Real-Virtual environment

Augmented reality technology is the use of computer graphics technology and visualization technology to produce virtual objects that do not exist in the real environment, and through the sensing technology to accurately "place" virtual objects in the real environment, with the help of display equipment to integrate virtual objects with the real environment, presented to the user with a real sensory effect of the new environment, the effect of the following:



Fig. 3. Augmented Reality application effects

Figure 3 The arm for the real environment, the watch for virtual information, augmented reality technology will be the virtual information watch accurately "placed" on the real environment arm, to achieve a virtual combination.

### 2.2 Augmented Reality Features

Augmented reality systems feature Display technology [6], Human-Computer Interaction [7], Three-dimensional Registration [8].

#### 2.2.1 Display Technology

The problem solved by display technology is how to make it easy for users to perceive the intuitive fusion between real-world scenes and virtual objects through their eyes. At present, perspective helmet display [9-10] is often used in augmented reality applications to achieve this function. The Perspective helmet display is divided into two types, Optical See-Through and Video See-Through displays, as shown in Figure 4.

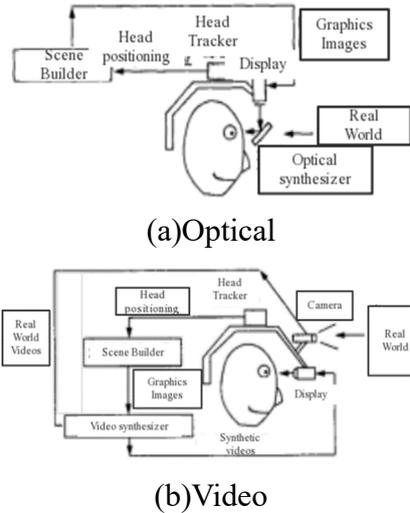


Fig. 4. Perspective Helmet Display

**2.2.2 Human-Computer Interaction**

Human-Computer Interaction (HCI) refers to the process of exchanging information between people and computers in a certain way, in order to complete the task between the person and the computer. In this process, people crave the most natural way to interact, so that users can "touch" to virtual objects, can pick up and drop at will, and even feel the hard and soft weight of virtual objects and so on. In general, the traditional ways of interacting are keyboards, mice, touch devices, Mike, and so on, and in recent years there have been some more natural ways of interacting based on speech, touch, eye movement, gestures, and body sensations, as shown in Figure 5.



Fig. 5. Human-Computer Interaction

The interaction mode of literature [11-17] needs to set the corresponding action of each instruction in advance, and operate against the prior knowledge in the process of system recognition.

**2.2.3 Three-dimensional Registration**

Three-dimensional registration refers to the technology and equipment used to correctly present virtual information in a specific location in a real scene, the effect of which is shown in the following figure:



Fig. 6. Three-dimensional Registration effect

To achieve these effects, it is necessary to clarify the exact posture that a virtual object will present into a real-world scenario [18], as well as the observer's real-time perspective. Its commonly used methods can be divided into the following three types:

(a) sensor-based registration technology

The registration technology based on sensor [19] is mainly realized by hardware sensor, this method is lighter, the technology algorithm is simple, the acquisition speed is fast, but the equipment is expensive, and it is easy to be affected by the external environment.

(b) registration technology based on vision

The research of registration technology based on computer vision [20] is currently in the dominant position in AR field. It is through the image processing of one or more video images, obtains the tracking information, determines the position and direction of the camera fixed in the user's head in the real environment. This type of technology is low cost, easy to develop and robust. In the implementation mode, the tracking registration method based on computer vision can be divided into methods based on artificial markers and methods based on natural features. The former generally places objects containing specific artificial markers in real-place scenes, as shown in Figure 7, which obtains posture by extracting feature points from images.



Fig. 7. Artificial markers

(c) hybrid registration technology

The hybrid registration technology [21] refers to the above-mentioned registration technology based on visual and sensor-based coexistence.

### 2.3 Auxiliary Maintenance Concepts

Bernd[22] defines ancillary maintenance as an auxiliary maintenance and training tool for complex equipment. Augmented reality Auxiliary Maintenance system is a guidance and training system for large and complex equipment maintenance, which is composed of augmented reality, man-machine natural interaction, virtual prototype and interactive electronic manual.

Maintenance personnel through natural interaction means to perceive the surrounding scene and maintenance object state changes, the use of augmented reality three-dimensional registration display and tracking positioning technology will be required digital maintenance guidance information in accordance with the natural interaction instructions (line of sight and voice, etc.) seamless real-time display to the optical perspective helmet, thus liberating the hands of the operators, Focus on maintenance work, improve operational efficiency and reduce maintenance errors, as shown in Figure 8:



Fig. 8. Vehicle assisted Maintenance system

### 3. Research Status of Auxiliary Maintenance Platform Abroad

With the increasing complexity of modern combat environment and weapons and equipment, the maintenance and maintenance of military equipment is becoming more and more demanding for maintenance personnel. The Augmented reality maintenance technology developed abroad on the basis of augmented reality is also gradually developing and perfecting.

Jayaram has developed an augmented reality assembly design environment system that provides a fully immersive virtual environment to help designers take into account the process of assembly and disassembly of parts from the early stages of design, and to assist in the analysis of product design; D ' Fusion[23], which is used for maintenance and maintenance, is an augmented reality solution developed by Total Immersion, which is based on PC platform, fast operation, strong compatibility, support HD image input and output, manipulators can use D ' Fusion to process information in real time; The Starmate project helps users achieve assembly and maintenance procedures; To use portable electronic devices worn on the wrist to query the information of the next operation related to the training of users, to guide users to complete the relevant procedures through video and language prompts; The Arvika project is mainly aimed at the assembly and maintenance of aircraft cars, assembly workers can call virtual cues through the voice, easy to follow the prompts of each step, complete the high-density wiring work; Zhu[24] aiming at the problem of poor correlation between AR auxiliary maintenance system and maintenance environment in the traditional sense, a programmable environment perception augmented reality system is developed, which combines the content of virtual maintenance information with the professional level of the operator and the maintenance state in the actual scene. Allow the operator to modify the maintenance content according to the actual maintenance scene, in order to further improve the maintenance efficiency of the purpose; Benbelkacem[25], Aiming at the problem of pump maintenance in photovoltaic solar energy system in remote area, a photovoltaic pump maintenance system based on augmented reality technology was developed. United States Army Equipment Maintenance Induction System; Siemens ' Cylicon system for industrial pipeline maintenance.

### 4. Comparison of Traditional Maintenance and Repair Platforms

Traditional maintenance to the paper maintenance manual as the carrier, maintenance personnel more with experience to operate, in the maintenance process exposed the main problems are as follows:

- (1) Paper maintenance materials are difficult to distribute, difficult to use and preserve;
- (2) Maintenance personnel training costs a lot of repetitive labor and funds, lengthening the work cycle of maintenance personnel;
- (3) The carrying and use of paper maintenance materials is inconvenient and will encounter great difficulties in the process of preparation, transportation, use and maintenance.

Especially when used, it is difficult to quickly and accurately find the required technical information in a large number of paper materials, thus affecting the efficiency of use.

- (4) Relying on the maintenance skills and experience of maintenance personnel, the quality controllability of maintenance and assembly is poor. Difficulty in updating paper materials.

Based on the augmented reality of the auxiliary maintenance platform ARSAMP, compared with the traditional maintenance has the following advantages:

- (1) Technical information using database management, large information capacity, can cover all kinds of training content, and information can be used and updated multiple times;
- (2) strong interaction ability, can achieve convenient and efficient information search and acquisition;
- (3) can be integrated with the expert system to improve the intelligent maintenance;
- (4) Small size, light weight, easy to carry;
- (5) can be set for different users of the corresponding maintenance library, itself independent of complex equipment, with a separate construction, update, delivery process.

## 5. Problems of Arsamp of Current Auxiliary Maintenance Platform

The above analysis shows a variety of advantages of auxiliary maintenance platform, but because of its theoretical analysis, optimization design, experimental research and other key content of the research is not mature enough, there are still the following shortcomings:

- (1) ARSAMP needs a large-scale database, if the database is not comprehensive enough, the corresponding maintenance problems can not be resolved;
- (2) Large-scale database in the use of maintenance detection speed is slow, long time;
- (3) ARSAMP Three-dimensional registration technology is not mature enough, virtual enhancement information can not be completely accurate "placed" in the real environment;
- (4) The augmented reality technology mostly adopts the deep learning model, the model often has the redundancy situation, carries on the large amount of unnecessary calculation, wastes the maintenance time and the resources, reduces the maintenance speed;

## 6. Summary

The application of augmented reality technology in weapon equipment maintenance operation can effectively reduce the generation of misoperation in maintenance operation, improve the quality and efficiency of maintenance operation, and can effectively reduce the cost in maintenance operation. With the increasingly changeable operation of modern information and the increasing complexity of weapons and equipment, augmented reality maintenance will occupy an important position in the modern military field.

However, the auxiliary maintenance platform based on deep learning still lacks intuitive meaning and clear theoretical guidance, such as the establishment of database is not comprehensive enough, the database is huge, the platform computation is large, and the precise "placement" of virtual information in three-dimensional registration is not fully theoretical guidance. Therefore, the future direction of development is mainly two aspects: on the one hand, how to build a comprehensive maintenance database, while reducing the operation time of the platform, on the other hand, how to improve the accuracy of three-dimensional registration, develop a more accurate combination of virtual reality effect, and further improve accuracy.

Although there are still shortcomings in ARSAMP, an auxiliary maintenance platform based on augmented reality, ARSAMP shows many advantages in line with the development of the times through comparison with traditional maintenance. With the enhancement of reality, the enrichment and development of computer vision theory and the renewal of computing platform, the auxiliary maintenance platform based on augmented reality has great development potential in the future, and the application in the field of military maintenance will become an inevitable trend, which can significantly improve the maintenance efficiency in the maintenance and maintenance of equipment. It is of great significance to improve the level of military informationization and combat capability.

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