Application of Augmented Reality (AR) Technology in Low-Voltage Line Interruption Training and Power Grid Emergency Training

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Abstract. Augmented reality technology uses computer performance to create a virtual scene and accurately integrate the virtual scene with the real world, and finally uses a video projector to present the virtual and real scene to the user, thereby significantly improving the user's visual experience and Feeling knowledge. Therefore, augmented reality technology can be well applied to training companies. The use of virtual reality and augmented reality technology in the aerospace, construction and shipbuilding industries has achieved remarkable results, and the era of augmented reality applications in the power grid has also arrived. With the development of mobile terminals such as mobile phones, it has become an excellent platform for augmented reality applications. This article focuses on the application of augmented reality (AR) technology in low-voltage line interruption training and network emergency training. First, the basic technology of augmented reality (AR) and the application of augmented reality (AR) in power grid emergency training are introduced using bibliographic research methods. Then design a network emergency training system for low-voltage disconnection training, and finally test the algorithm used in this article. The detection result shows that the detection of feature points using AGAST takes less than 3ms, while the Shi-Tomasi operator is about 20ms. It can be seen that the use of AGAST operator to detect feature points has a great improvement in speed.

Key words: Augmented Reality, Power Grid Training, Low-Voltage Line, Line Interruption

1. Introductions
One of the main functions and applications of augmented reality (ar) technology in network application training is the training of operation and maintenance technical personnel [1-2]. At present, the main teaching modes adopted by some of the more advanced power grid training bases include theoretical education, masters with apprentices, direct hands-on operation of operation and maintenance facilities, and virtualized technical training combined with computers and virtual technologies [3-4]. Although it can meet the basic training requirements for operation and maintenance technicians, the training process...
is more cumbersome and complicated, which greatly reduces the learning enthusiasm of operation and maintenance technicians, and the training is limited [5-6]. Moreover, the use of virtual technology for professional training does not prompt the operation and maintenance personnel to directly recognize the operation and maintenance equipment. In actual operation, they are easy to encounter detailed operation and technical problems. The emergence of augmented reality technology has greatly improved the combination of virtual and real-time operation and maintenance scenarios in power training, and can enhance the experience and results of network training [7-8].

Research on the application of augmented reality (AR) technology in low-voltage power line emergency rescue interruption simulation grid high-voltage line emergency rescue training process. First of all, researchers have developed a set of simulation power grid system suitable for high-voltage power grid emergency rescue training. The simulation system mainly uses the combination of virtual reality and computer in AR technology to organically combine the hardware system and application software to create a virtual environment similar to the actual environment [9]. In actual use, it can also directly perform motion capture in the reference software, and realize the function of directly performing one-to-one simulation between the trainee's body movement and the virtual character, so that the trainee can experience the hardware more realistically. And the operation process of the system, thereby greatly improving the results of training [10]. According to the purpose of substation simulator training, some researchers have defined the overall goal of the substation simulation training system to achieve a complete physical process, flexible configuration, screen and site adaptability, and flexible configuration; conduct detailed analysis and training of business skills check the substation simulation training system must have, abnormal adjustments and failures, accident handling training operations, the creation and training of coaches and intern offices, and many other functions; the technical indicators of the training system recommended to be developed [11]. Some researchers have proposed that on the basis of virtual technology, more emphasis on the advanced nature of the algorithm, proposed a variety of scheduling algorithms such as model organization, level of detail, etc., which greatly improved the operating speed of the substation simulation training system [12].

This article focuses on the application of augmented reality (AR) technology in low-voltage line interruption training and power grid emergency training. First, the literature research method is used to introduce the key technologies of augmented reality (AR) and the application of augmented reality (AR) in power grid emergency training. Then the low-voltage line interruption training grid emergency training system is designed, and finally the algorithm used in this paper is tested experimentally.

2. Augmented Reality (AR) Technology and Power Grid Emergency Training Research

2.1. Key Technologies of Augmented Reality (AR)

Display output technology. In most cases, the most direct and effective way for people to obtain information about the external environment is through visual perception. The most basic problem to be realized by the augmented reality system is to complete the fusion of reality and reality to enhance people's visual experience. Therefore, as the output terminal of the augmented reality system, display technology is one of the most basic technologies in augmented reality. In most cases, the corresponding display technology can be divided into helmet mode and non-helmet mode according to different modes of fusing virtual and reality. First, the helmet is used to observe the environment, which is mainly composed of virtual scene display channels, real scene display channels and image fusion display channels. Combining the difference in the format of the real scene, the screen placed on the head can be divided into two perspective screens: video and optical. For a projector without a helmet, it mainly includes standard portable screen technology and projection technology. In a specific application, it is necessary to select the corresponding projector and display technology in combination with the actual application environment and related tasks.

Tracking registration technology. Use index-based video detection method to place, and then obtain the corresponding conversion table by calculating the conversion rate between coordinate systems, and finally superimpose the virtual object on the real scene. This process is called record tracking, and this
technology is also the key to AR. The monitoring of recording technology is the core of the development of AR technology, and it will determine the development prospects of the entire AR technology. From the current point of view, relevant researchers and institutions attach great importance to the study of record tracking technology. The main task of this technology is to accurately place virtual objects in real scenes, and then realize the realization of virtual objects and real scenes. The process of obtaining the position of the virtual object in the real scene is called the 3D recording process. Since the user is dynamic in the real environment, the system first receives real-time environment information, analyzes the user's location, state and movement, and then modifies the position of the virtual object. The screen ratio and angle direction are based on the user's information. This process is called monitoring.

Interactive technology. Interaction technology is a technology used for human-computer interaction. It can identify the user's function, and then make corresponding annotations to interact with the user. Through this technology, users can control the system according to their own needs, which can greatly improve the flexibility of the system. For a complete AR system, human-computer interaction is obviously an essential part. To realize these interactive technologies, the system must enter relevant commands in advance. If the user activates these commands, the system will give corresponding feedback behavior.

2.2. Application of Augmented Reality (AR) in Power Grid Emergency Training
Training implementation plan. In the training process, AR technology can be applied to on-site training, such as operation training, patrol training and test training. According to training requirements, it is divided into three modes: guidance, training and evaluation.

Description: The operation steps are described in detail through 3D models and videos. Training: In addition to explaining the operation steps, it also provides functions such as environment simulation, real-time user training guidance and recording user functions. Evaluation: No explanation is provided, only functions such as environment simulation and user function recording are provided. The monitoring controller can provide teachers' evaluation results based on on-site operation records and videos, and provide suggestions for improving functions combined with videos.

Operational training application. The training system function combined with enhanced technology includes functions such as operation preparation, order training, execution operation training, practical operation guidance, remote guidance and so on. Using AR technology, operation and maintenance personnel can accurately understand operation specifications by pushing operation videos and 3D operation videos, and train operators to complete operation tasks according to standard requirements.

2.3. Augmented Reality (AR) Tracking Target Algorithm
Assuming that I and J are adjacent frames in the image sequence, first construct an image pyramid for I and J. u is the set of feature points in the tracking target in image I, and the point set v corresponding to u in image J needs to be solved, which is initialized to u.

\[ u = v \]  \hspace{1cm} (1)

Assuming that the pyramid has a total of L levels, \( L = 0, \ldots, L_m \). \( u^l = [u_x^l, u_y^l] \) is the coordinate of point u corresponding to l in the Lth layer of the pyramid. The calculation formula of \( u^l \) is as follows:

\[ u^l = \frac{u^{l+1}}{2} \]  \hspace{1cm} (2)

Optical flow field \( v^k = [v_x^k, v_y^k] \), initialized to \([0,0]\), where k is the number of iterations in each layer, and Newton’s steepest descent method is used in the algorithm. If the initial value is equal to the true value is not much different, so generally up to 5 iterations can converge to an accurate value. But if the initial value differs greatly from the true value, the result of the iteration is divergent. v Superimpose according to formula (3):

\[ v^k = v^{k-1} + \eta \]  \hspace{1cm} (3)
3. Design and Experiment of Power Grid Emergency Training System for Low-Voltage Line Interruption Training

3.1. System Hardware
The hardware architecture of the ar-based low-voltage line simulation and maintenance training system mainly includes infrastructure n low-voltage line interruption devices, n ar helmets, training management servers and wireless routers within the training range, ar helmets are the most basic of ar's technology facility. Use microsoft hololens and can directly use 2d stereo vision unit to realize coordinate recognition in space, target facility recognition, tracking and recording, and integrate a virtual environment into a real environment. Through simple gesture recognition and voice recognition technology to recognize the user's gestures and voice commands to the operation and maintenance technicians, a good human-computer interaction ar learning environment for users is formed, which realizes the learning and technology of the operation and maintenance technicians in the system, practice and complete the evaluation interaction. The training management server can monitor and record the training and evaluation of each ar helmet system through the wireless communication between the wireless router and each ar helmet system.

3.2. Software Structure
The low-voltage maintenance and maintenance system simulation and training management software system based on ar technology (see Figure 1), which uses c / s functions, display, space layout and space recognition. These include theoretical knowledge training, theoretical knowledge evaluation, virtualized operation training, virtualized operation evaluation and feedback on training for students. The server management and training system is controlled by the person in charge.

![Training management server](image)

**Figure 1.** Training management software system

3.3. Calibration Algorithm Based on Improved LK Optical Flow Method
In this section, the SIFT algorithm and the improved optical flow method LK will be used to apply the calibration unit to the AR system. The algorithm flow of the calibration module is: first train the target, locate the attribute points and create the descriptor. Then use SIFT to allocate and detect objects in the video sequence. After locating the target, the enhanced LK visual flow method will be used to track the target. Before using the enhanced LK optical flow method for monitoring, the grayscale image can be normalized to reduce the impact of brightness changes. After the image is standardized, the ROI area can be adjusted in the image, and only the ROI area can be monitored, which can increase the monitoring speed.

3.4. Algorithm Experiment of Power Grid Emergency Training System
Based on the design of the power grid emergency training system for low-voltage line interruption training, it can be seen that the target recognition of the AR helmet client is the most critical step. Based on this, the target tracking algorithm of the system is tested.

4. Analysis of Experimental Results

Experimental Design. In this paper, the statistical feature point detection time is based on 100 feature points as the unit of statistics. The experimental results are shown in Table 1:

**Table 1. Feature point detection schedule**

| Feature points | Improved LK optical flow method | Traditional LK optical flow method |
|----------------|---------------------------------|-----------------------------------|
| 1              | 0.2                             | 26.7                              |
| 100            | 1.2                             | 25.6                              |
| 200            | 2.1                             | 22.3                              |
| 300            | 2.6                             | 21.8                              |
| 400            | 2.7                             | 21.1                              |
| 500            | 3.1                             | 21.2                              |
| 600            | 3.2                             | 21.3                              |

![Figure 2. Feature point detection](image)

As can be seen from Figure 2, the orange solid line is the time of the Shi-Tomasi operator, and the blue solid line is the time of the AGAST operator. It can be seen that using AGAST to detect feature points takes less than 3ms, while Shi-Tomasi operator is about 20ms. It can be seen that the use of AGAST operator to detect feature points has a great improvement in speed.

5. Conclusions

The continuous improvement of ar technology makes it more possible to apply them to Internet training. At this stage, the traditional means of training network physical facilities will not only bring us a waste of manpower and time, but also lead to the rapid update of network facilities, increase a lot of financial costs, and consume a lot of manpower and time. The extensive application of augmented virtual reality technology in power grid training not only reduces the waste of manpower and resources caused by traditional training methods, but also effectively provides an application scenario for power grid technology training workers, so that students can more Intuitively perceive and understand the true
operating status of the equipment, and improve the effect of low-voltage line fault repair and maintenance training.

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