IPT & EGVE Workshop (2005)
R. Blach, E. Kjems (Editors)

Applications of Augmented Reality for Maintenance Training

Dongdong Weng, Yongtian Wang and Yue Liu
School of Information Science and Technology
Beijing Institute of Technology, Beijing, 100081, P.R. China

Abstract
An Augmented Reality system that is designed for maintenance training is introduced. The proposed system adopts a projector to display the augmented video of the components to be repaired. With the augmented video, students can observe not only the real video of the components to be repaired, but also the additional information about the components such as contour, name and inner structure of the key parts etc. In order to accurately track the spatial relationship between the camera and the repaired components, several markers (small infrared LED) are attached with the components to be repaired, which ensure the dependability of the proposed system.

Categories and Subject Descriptors (according to ACM CCS): I.4.9 [IMAGE PROCESSING AND COMPUTER VISION]: Applications

1. Introduction

Augmented reality is a branch of virtual reality, which provides a powerful interface to enhance the user's understanding of the scene to be augmented. With an augmented reality system, a user can observe a composite view that consists of the images of real scene and the information generated by the computer.

An augmented reality maintenance training system has been developed, in which two cameras are used to obtain the image of the actual components in real-time and the teacher can handle the camera with his hand. One camera is used to capture the real image of the scene and the other camera with an infrared filter is used to capture the infrared image of the scene. The images captured with the two cameras are handled by the computer to generate an augmented video, then a projector shows the augmented video to the students. With the augmented video, students can watch not only the real video of the components, but also the additional information such as the contour, name and inner structure of the key components, etc.

2. System overview

The proposed augmented reality system adopts a projector and vision-based tracking device to present additional information of the components under repair to the students. Figure 1 shows the framework of the proposed system. A number of infrared markers are fixed on the surface of the components and the markers adopted are infrared LEDs with relatively large emitting angles. When the system is in operation, the teacher takes a hand-held device and uses the cameras to shoot the components to be repaired. The hand-held device is composed of two cameras and the spatial relationship between the cameras is fixed. One of the two cameras (camera 1) captures the scene and the other camera (camera 2) captures infrared image of the scene via an infrared filter. After capturing the images with the two cameras and transferring them to the computer, the computer first extracts the markers from the infrared image and those detected points are used to compute the rotation and translation of the components relative to the camera 1, with which the computer can add virtual object and additional information to the image of the real scene. Finally the augmented video is sent to the projector and projected on the screen.

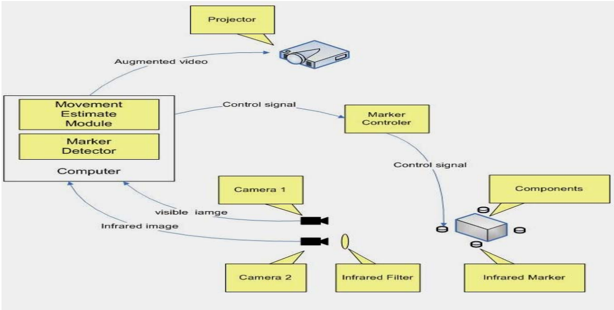

Figure 1: *Framework of the proposed system*

3. Estimation of rotation and translation

In the proposed system, the infrared images are used to perform vision-based registration. The infrared image is captured via an infrared filter which can get rid of most of visual information, which means only light emitted form the infrared markers which can pass the band-pass filter can be found in the captured image. For each tracked infrared image, the computer first detects the 2D feature points, which is realized by the Harries point detector and clustering analyzer. The tracked 2D feature points are the projection of the real 3D markers in the captured scene. In the subsequent frames, those tracked 2D feature points are used to compute the rotation and translation between the component and the cameras.

In order to track and compute the relative rotation and translation between the cameras and the components, the correspondence between the marker points and their projection in the infrared image are required. Since the markers to be used are the infrared LED, the correspondence between the detected 2D projections and their original 3D positions can be built directly and a marker controller is used to build the correspondence. When a new unknown projective point is detected by the computer, a signal will be sent to the marker controller, then the controller will make each marker wink orderly; at the same time notify the computer the sequence of the marker winking now. The winking of marker can also be detected by the computer, with which the system can finally identify the new 2D feature points and build the correspondences between the point and its 3D marker. Finally the corresponding points can be gained and a KLT feature tracking algebra is used to track the 2D feature points.

4. Conclusions and future work

A prototype augmented reality application system for maintenance teaching is presented, which uses a projector to show the augmented video for the component to be repaired, Fig.2 shows the application scenario of the proposed system.

Figure 2: *Application scenario of system*

Acknowledgements

This project is supported by the National Basic Research Program of China (National 973 Project, Grant No.2002CB312104).

References

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