複合現実感技術による監視カメラ視野の可視化

ダオ ゴック タン　北原 格　亀田 能成　大田 友一

筑波大学大学院システム情報研究科知能機能システム専攻

Abstract

屋外複合現実型情報提示分野の研究の一つとして、本研究では監視カメラの視野をモバイルデバイスの画面中に可視化するシステムを提案する。可視化のためには、屋外でモバイルデバイスを用いて複合現実空間を観察している利用者に、監視カメラの視野を理解しやすい形態でリアルタイムに表示することが必要である。本稿ではそのために考案した5種類の可視化形態について提案し、合わせて本可視化実現のためのシステム構築法について述べる。

1 Introduction

Surveillance cameras are widely used for monitoring in our society, but people do not have tools to know the monitoring areas via the cameras. In this research, we propose a new visualization method by which people can easily understand the location of the cameras and their monitoring areas. Since people should see and understand the monitoring areas on site, we exploit Mixed Reality technology for the visualization.

We use an ultra-small PC equipped with builtin camera, Global Positioning System (GPS), and gyrocompass. On visualization of the monitoring areas of surveillance cameras, we expect the followings:

- The user can look around and move the camera arbitrary on site by holding the PC. He/she can see the video taken by the camera on the PC display on line.
- Location and orientation of the surveillance cameras in the scene are fixed and the data is given to the system in advance (Fig.1).
- GPS and gyrocompass give the system the position and orientation of the camera.
- The video is processed to integrate the viewing field of surveillance cameras. The user can watch the integrated video on the mobile device screen [1, 2].

Our goal is to find the best method to visualize the viewing fields of surveillance cameras on the mobile PC display.

Visualization of Viewing Fields of Surveillance Cameras using Mixed Reality
Ngoc Dao Thanh, Itaru Kitahara, Yoshinari Kameda, Yuichi Ohta
Department of Intelligent Interaction Technologies, Tsukuba University

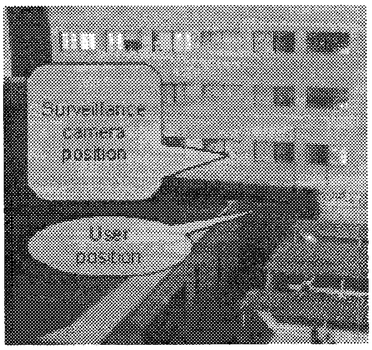

Figure 1: Positions of a user in a scene and a surveillance camera

2 Visualization methods

The visualization method should be able to express a 3D sub-space, which corresponds to the space where a surveillance camera can shoot. It is also preferred to have the property that can tell viewers the location of the surveillance camera. We have studied the five visualization methods to fulfill these requirements.

2.1 Volume visualization method

A natural method to visualize the viewing field is simply visualizing the volume (Fig.2 left). However, the volume may occupy most of the scene viewed from the mobile camera especially when the user is inside the viewing volume of the surveillance camera. The visualization produced by this method is not good for such situation.

2.2 Shadow visualization method

This method visualizes the virtual shadow created by the light positioned at the eye-point of the camera and the near plane of the camera frustum (Fig.2 right). This method gives more understandable visualization especially when there are objects in the viewing field. There are various ways to render the shadow, the two popular are shadow mapping [3] and volume shadow [4].

2.3 Contour visualization method

An alternative method is to only visualize the contour of the viewing field on surfaces in the scene (Fig.3 left). Rendering only the contour is much

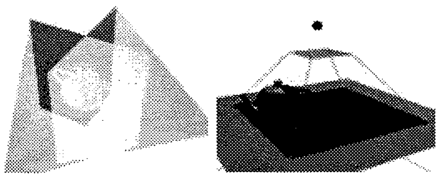

Figure 2: Left: the tea pot is being observed by two cameras, one on the left and one at the bottom. The teapot is in the intersection of two view volumes. Right: view field visualized by shadow. The black dot indicates the location of the camera.

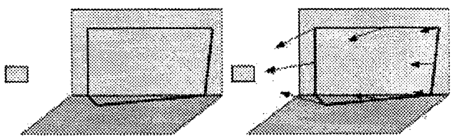

Figure 3: Left: contour of the viewing field. Right: vectors.

lighter in computation than rendering the whole shadow.

2.4 Vector visualization method

Users may want to know not only the viewing field but also the position and distance to the surveillance camera. To visualize these properties, we add vectors to the contour of the viewing fields (Fig.3 right). In the figure, all the vectors are pointing the camera, and the length of the vectors is reverse proportional to the distance from the root of the vectors to the camera.

2.5 Animation method

In this method, animated objects coming from the surveillance cameras are used to visualize the viewing fields. Compared to other methods, users may easily know the camera positions even when the camera on PC is fixed at a certain position and orientation. The CG objects rendered on line do not block the scene. The disadvantage is its high rendering cost.

3 Experiment setup

The experiments aim to verify and evaluate the understandability of the visualization methods and any combinations of them shown in section 2. Thus, trial and error methodology needs to be applied. To shorten the trial and error cycles, a development environment which enables fast protyping should be introduced.

The mobile device used is a SONY VAIO VGNUX90PS (150.2mm x 95mm x 32.2mm, 520g, Core Solo U1400 1.20 GHz, 512MB DDR2). Though

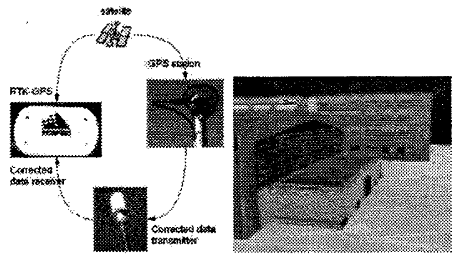

Figure 4: Left: RTK-GPS system. Right: 3D model

it has two built-in cameras, we use the camera at the back as 15fps@320x240. The gyrocompass is an InterSense InertiaCube3 (26.2mm x 39.2mm x 14.8mm, 180Hz). The gyrocompass and the RTK-GPS device are connected to the mobile device by RS232-USB adapter. The system does not use a server or real surveillance cameras. A 3D model of the place where the experiments are conducted, together with hard-coded geometry information about the virtual surveillance cameras are installed on the system in advance (Fig.4).

4 Conclusion

In this research, we have proposed an outdoor MR system which enables a user to use his mobile device to easily understand the viewing fields of surveillance cameras surrounding him/herself in real-time.

Up to this moment, not all the experiments have not been conducted yet. However, it is expected that the visualization method using animation would give the most understandability.

References

[1] Yoshinari Kameda, Taisuke Takemasa, and Yuichi Ohta. Outdoor see-through vision utilizing surveillance cameras. *IEEE and ACM International Symposium on Mixed and Augmented Reality (ISMAR04)*, pages 151–160, 2004.

[2] Takahiro Tsuda, Itaru Kitahara, Yoshinari Kameda, and Yuichi Ohta. Smooth video hopping for surveillance cameras. *The 33rd International Conference on Computer Graphics and Interactive Techniques (SIGGRAPH2006)*, 2006.

[3] L. Williams. Casting curved shadows on curved surfaces. *SIGGRAPH*, pages 270–274, 1978.

[4] Frank Crow. Shadow algorithms for computer graphics. *SIGGRAPH*, pages 242–248, 1977.