

THE VIRTUAL-AUGMENTED-REALITY ENVIRONMENT FOR BUILDING COMMISSION: CASE STUDY

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ABSTRACT

This paper presents a Virtual-Augmented-Reality Environment (VARE) which is an augmented-reality (AR) system integrated with a virtual-reality environment. The system has been developed to support the building commissioning (BC) process. The CAVE, a projection-based virtual reality system, is used as an immersive interactive environment in which the building being commissioned is modeled and displayed in accordance with the user's input. The AR system is a computer vision-based visualization system specially designed for displaying BC data. We also investigated RFID (Radio Frequency Identification Device) technology as an alternative object tracking approach. A series of case studies were conducted to verify the performance of the proposed system with various kinds of information commonly being generated during the BC process. VARE would be well suited to a training program for prospective operators. The system is cost-effective and provides the user with compatibility with other software packages that support the Industry Foundation Classes (IFC).

INTRODUCTION

Building commissioning (BC) includes a series of testing the operation of equipment, building systems, and their sub-systems to ensure that they operate as designed and can satisfy the needs of the building throughout the entire range of operating conditions [1].

During BC, a large quantity of information is created and types of the information are also diverse. The most common types include drawings, inspection documents, specifications of equipment, manuals, and sensor data. Therefore, there has been a need for intuitive systems that manage and display information effectively.

Based on that need, one of the primary objectives of this research was to develop a visualization system that provides easy display of information and support especially for field inspection. Since proper training program for prospective operators is one of the functions needed during BC, development of a cost-

effective training program was also a research goal.

RELATED WORK

Ehret et al [2] presented a visualization system that scales information to meet the characteristic of output devices such as a PDA, a tablet PC, and a desktop PC. The system determines how to display information according to the type of the output device that the user needs. If the user uses a PDA without 3D hardware, the system creates an image of the queried information. The image is then used as an interaction medium between the user and the system. On the other hand, if the user uses a laptop or a desktop PC that provides sufficient computing power for 3D visualization, the system creates a VRML input file with the required information. In this approach, the user needs either a simple image viewer or a regular HTML browser with a VRML plug-in. A merit of this system is that it supports various kinds of information appropriate for field inspection by changing the format of the output medium.

Goose et al [3] introduced a PDA-based AR system integrated with a speech recognition technology, called PARIS (PDA-based Augmented Reality Integrating Speech). The system consists of several sub-systems: an AR-based manager to locate the user and to coordinate other sub-systems, a VoiceXML module to interact with the user, a VRML engine to visualize geometries, and a plant automation software package that manages raw sensor data. PARIS successfully demonstrated that contemporary PDAs have enough computing power to visualize 3D objects and manage multi-modal interactions between users and the system. However, it is still a critical problem to manage the size of VRML files with limited capacity of PDA memory space.

The visualization systems introduced above were developed to mainly support operation and maintenance of building systems. The data exchange issue among sub-systems in different domains does not appear to be a priority. However, compatibility of data among sub-systems is critical for intra-system to communication for the BC domain.

