A Visualisation Tool for Civil Engineering Using Virtual Reality

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SUMMARY

This paper describes some of the results achieved by the project entitled "Combined use of Virtual Scale Models and Space Geodesy", ongoing at the IESSG, University of Nottingham. The project aimed to investigate an innovative way to give engineers, and the community affected by Civil Engineering work, information that is often difficult to visualise via computer screens, 2D plans or scale models. One of the main differentiators of our project is the exploitation it makes of Collaborative Virtual Environments (CVE).

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1. INTRODUCTION

The description of Augmented Reality (AR) given by Azuma (1) – "AR allows the user to see the real world, with virtual objects superimposed upon or composite with the real world. It supplements reality, rather than completely replacing it" – can be completed if it is understood that the five human senses can be addressed, instead of only vision.

The project that is being developed at University of Nottingham has successfully explored the use of CVE (2, 3). The users have their perception of the surrounding environment augmented by vision, making them conscious of how much it will be modified by a proposed Civil Engineering work (4).

This paper gives an overview of the project, its current status and achieved goals.

2. OVERVIEW OF THE SYSTEM

Figure 1 gives a diagrammatic view of the idea behind the project. The users have been divided in two groups: field and office users. The field users are equipped with an integrated system, composed of a tilt sensor and an electronic compass to log the user's head movements. The user's location is given by a Real Time Kinematic Global Positioning System (RTK-GPS) receiver. Audio and video channels enable the field user to interact on a CVE with the office users. Finally a see-through Head Mounted Display (HMD) displays the augmented CVE produced by the Virtual Environment (VE) manager entitled MASSIVE-3 (2, 5, 6). The data produced by the positioning equipment is published and recovered on a data base by Equip, an in-house system developed at the Mixed Reality Laboratory (MRL) (7, 8). Audio and video are also transmitted through this system. The office users can explore and interact on the VE using their desktop computers. Both types of users are linked via a wave-Local Area Network connection (LAN) (4, 9)

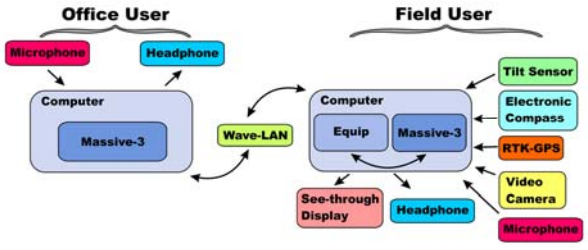

Figure 1: Diagram of the Present Work

3. IMPLEMENTATION

Even though the two platforms used on this study (MASSIVE-3 and Equip) were already fully developed, an important stage of this project was to understand in great detail how they work. The implementation of the link of the receiver and the sensors with the computer was achieved via JAVA classes. Each device runs autonomously, over a self-contained class. The advantage is related with the asynchronous method used to distribute the information over the data base managed by Equip. If one or more of the devices is suddenly disconnected, the whole system will not crash. Instead, the system will continue to operate with the available data and reconnect the device that failed when it returns back to normal functioning.

4. CVE

One of the main goals of our project relates to the implementation of the collaboration between the users of the system. The CVE is a digital "space" created over a net of computers where collaboration and interaction are the main concern between users. Each space has a connotation that will constitute a "place" where the users have the opportunity to understand the activities there performed. On this project, the activities on the CVE have straight relation with the activities performed on the physical environment. CVEs are fully described on (2, 3).

Field and office users are able to interact in three ways in this system: via embodiment movements, audio, and video. The users can see each other exploring the CVE through the embodiment. Both users can move to a common position with the intent, for example, of discussing if the configuration of a garden (on this context it could be imagine a virtual garden) is in agreement with what was solicited by the customer. At the same time they can talk via audio link to convey their ideas in real time. Finally, the video link transmits images from what the field user is seeing as a background placed on the CVE explored by the office user.

5. OBJECT BEHAVIOUR

Objects in the physical world may be associated to a particular behaviour. Such objects could be for instance a flag or a car.

In this project we have worked on a virtual tram station, where the CVE is constituted of lamp posts, shelters, bins, signs, etc. Although the scene was complete and in agreement with layouts provided by the designers, most users on the field trials stated that the environment seemed unrealistic without the presence of a tram. As a static tram stopped in front of the station would not have much visual appeal, a dynamic one was implemented. The result is an object (a virtual tram) inserted in the VE and repositioned in real time by the system. Figures 2 and 3 show a screen shot of the station with the tram.

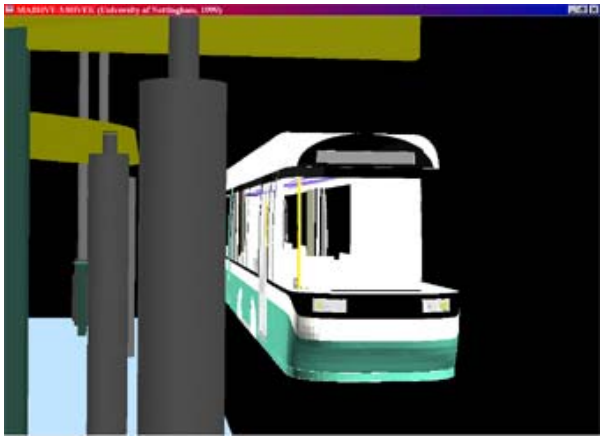

Figure 2: CVE – Tram Station and Tram

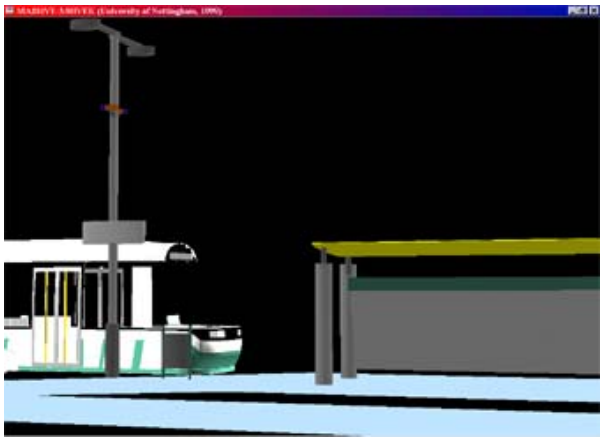

Figure 3: Objects that constitute the CVE

The model of the tram was originally created by Gilbert et al (10). It was modified for this project in order to reduce the quantity of details, in a way that it would make the CVE rendering run not too slowly in real time.

6. CONCLUSIONS

Collaborative digital environments are the next step for any type of system aiming for high productivity between the users. It is not an issue restricted to the area of Virtual Reality. The tool introduced with this project is just an example of what can be done nowadays and what the future may bring, with the availability of each time lighter and computationally faster hardware.

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