Environmental Media:
Linking Virtual Environments to the Physical World

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Abstract

The goal of this project is to explore potential applications of location-based information services over wireless networks. Initial efforts have been focused on the design and prototyping of an "environmental media" system for linking virtual environments to the physical world through integration of capabilities and technology components from the fields of virtual reality, mixed reality, mobile multimedia, and wearable computing. In effect, the user is able to browse a spatially correspondent digital information database about a specific location as it changes over time, or can access interpretive annotations posted by domain experts.

Keywords: Augmented Reality, Mixed Reality, Mobile Multimedia, Wearable Computing, Context visualization, Environmental Media, Location-based Services.

1 Introduction

In the past decade, the development of Virtual Environment technologies has provided a unique capability to completely immerse a user in computer-generated worlds for a wide variety of application domains. But in general, the user's senses are isolated from their physical surroundings and focused completely on the computer-based simulations. More recently with the improvement of see-through display technology, Augmented Reality technology has been developed that provides a capability to overlay digital information onto a user's immediate surroundings - although applications have mostly been confined to interior settings as a result of restrictions on data transmission, tracking, and image registration capabilities. Currently, with the addition of high-bandwidth wireless network and high-resolution tracking technologies, a Wearable Environmental Media platform (WEM) is under development to display a wide range of location-specific and context-sensitive information to a mobile user in an exterior environment.

2 Overview and Objectives

The goal of this research is to design and prototype a wearable system that will allow a mobile user to access digital information in the form of virtual media objects, virtual environments, and real-time data visualizations that are linked to specific locations. The primary objectives in development of this environmental media system are:

- To assist, enhance, and amplify a user's interactions with the physical world though use of environmental media.
- To develop innovative interface techniques and authoring tools for the development, display, and access of location-linked virtual environments.
- To implement a robust and flexible wireless communications infrastructure for transmission of multimedia data about a specific location to a mobile user.
- To explore the concept of "context visualization" and to develop design guidelines on how to make explicit, and display for a mobile user, the layers of information and digital data that are attached to objects, people, places, as well as information about the relationships between them.

A long-term goal is to evaluate the unique advantages and opportunities that Wearable Environmental Media can provide as a learning technology in such applications areas as virtual fieldtrips, ecological literacy, environmental perception, and context visualization.

3 System Development

The primary emphasis of this project is on the development of methods for organization and presentation of site-specific information to both remote and on-site users, and on development of user-interface configurations and software "authoring" tools for linking information to specific locations. As a test bed to evaluate these concepts and configurations, an initial technology platform has been developed that consists of a very lightweight stereoscopic camera and display system with wireless audio/video transmission that is mounted on a remote users head and body. Additional

subsystems are added for: presenting audio information; tracking the user's location and head orientation; controlling a virtual 3d cursor; accessing and caching data about the environment (both archived and local sensor data); and configuring or generating data to be displayed.

4 Implementation Scenarios

As a test site for this research, a 10 square meter area has been prepared in a outdoor location of the Keio SFC campus close to the primary research laboratory facilities where the system can be field-tested and evaluated under moderately controlled conditions. Existing imagery and data about the test site such as satellite imagery, aerial photographs, IR imagery, topographic maps, and personal photographs is being collected in order to compile a comprehensive, site-specific database of information. This site will also be documented with audiovisual media on a regular schedule and from a grid of specific viewpoints in order to record and archive changes in the site over time, and a variety of real time sensors will be installed to measure a range of basic environmental factors such as air-quality, pressure, moisture, air and soil temperature, rainfall, wind activity, fluctuation of light/dark, electromagnetic radiation, etc.

With the information collected from these sensors and from the ongoing audio-visual documentation, the dynamic multi-media database about the local test site is made available in real-time to the user of the Wearable Environmental Media system. By tracking location and attention of the user as they move through the actual site, a wide variety of information virtually encoded in the site can be displayed in various formats. In effect, the user is able to browse a spatially correspondent digital information database about the site as it changes over time, or can access interpretive annotations posted by domain experts. Alternatively, the real-time video stream of the site as a user walks around can be transmitted to a remote location where observers can also experience the digitally augmented location or even request the on-site user to move to a different area.

5 Applications

The Wearable Environmental Media system has been developed for use in a variety of application scenarios. The first demonstration of the system focuses on an educational application called the "Virtual Field Guide" with which the user can access photographic and computer-generated information about plant and insect forms that are specific to the test site as well as video clips about history of the site. While traversing the site with the WEM system, the user can see many 3d icons superimposed onto the location that indicate where information has been embedded. To select the icon, the user aligns a virtual 3d cursor over it with the hand-held 3d input device. Upon selection, an image based, 3d computer generated menu shows additional information that can be chosen. For example, one icon embedded in a tree contains information about a kind of insect that typically lives there such as a 3d CG model, a diagram of it's life cycle, a video clip of egg laying, an audio clip of it's sound, etc. Other icons in the site point to similar information about other insects or plant forms. In future versions, a user will also be able to investigate changes in vegetation though different seasons by comparing the actual view with previously captured images from the same viewpoint, or view real time visualizations of environmental variables from sensors on the site.

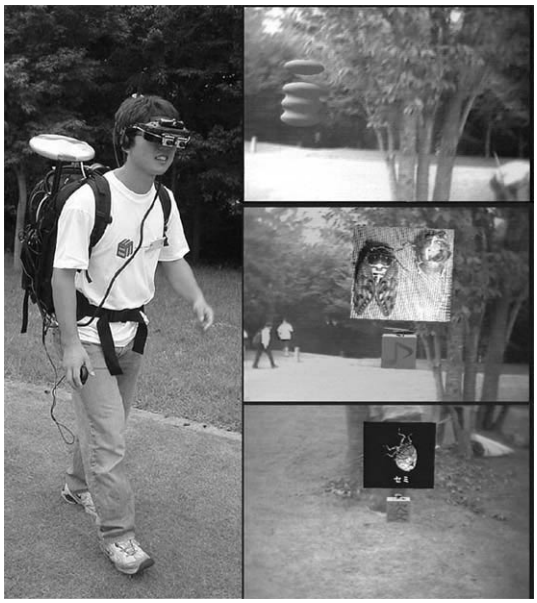

Figure 1 Left: Mobile user with "wearable environmental media" system showing stereoscopic headset, 3d input device, and GPS antennae. Right: Examples of 3d icons, menus, and images embedded in the site.

6 Acknowledgments

This research is supported in part by the Ministry of Education's Center of Excellence at Keio University and by NTT DoCoMo, Inc. Additional support for GPS hardware has been provided by Open Network Co, Ltd., and for software by Kawashima Lab Co., Ltd. Also thanks to Prof. Kenji Kohiyama for his support and research collaboration.