Through the Looking-Glass

Mirror Worlds for Augmented Awareness & Capability

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ABSTRACT

We demonstrate a system for supporting *mirror worlds* - 3D virtual models of physical spaces that reflect the structure and activities of those spaces to help support context awareness and tasks such as planning and recollection of events. Through views on web pages, portable devices, or on 'magic window' displays in the physical space, remote people may 'look in' to the space, while people within the space are provided information that would not otherwise be obvious. For example, by looking at a mirror display, people can learn how long others have been present, or where they have been. People in one part of a building can get a sense of activities in the rest of the building. The system can be used to bridge across sites and help provide different parts of an organization with a shared awareness of each other's activities. We demonstrate viewers for several mirror worlds we have created, including for the ACM conference venue in Nara.

Categories and Subject Descriptors

H.5.1 [**Information Systems**]: Artificial, augmented and virtual realities

Keywords

Augmented Reality, 3D applications, virtual tours

1. INTRODUCTION

Humans have always sought to create models and maps of our world. These models serve as a foundation for shared understanding and communication. With modern technology, these models are becoming manifest online as mirror worlds that reflect physical space, and act as a 'communal looking glass' to support activities and awareness of people. These mirror worlds may be updated so that they reflect both dynamic and static aspects of the physical world.

We demonstrate how mirror worlds can support a variety of tasks. We have experimented for several years with a mirror world of a research lab, which provides live or recorded views of the activities there. Through this mirror world, local or remote users may see the entire lab, get a sense of its layout, see who is present in their office, who has visitors, where there are gatherings or talks, etc. Users may zoom in on an area for details, read the contents of mirrored displays

Figure 1: Lab mirror world overview.

or whiteboards, or follow a presentation. These views may be seen through applications running on portable devices, web pages, or on large public displays located throughout the lab. The viewers act as 'magic windows and mirrors', letting people at one location see into other parts of the building, or letting them see the space they are in augmented with additional information.

Recently, we began running mirror worlds at multiple sites within this organization, and are exploring their use to support mutual awareness and connection within the organization. We also describe the application of our tools to tasks, such as the use and management of conference venues. Visitors to conferences and trade shows are often in an unfamilar environment, and benefit from tools which show maps and floorplans. This is heightened by the fact that these spaces are typically reconfigured for different parts of an event.

Just as the web helped integrate the world's information source and repositories, it is natural to integrate mirror worlds into a geoweb viewable by geobrowsers such as Google Earth. All of the mirror worlds and applications described here can be run through Google Earth using its Web plugin API. They can also be run as Android Apps built using the Unity game engine.

2. RELATED WORK

Mirror worlds were described by Gelernter in 1991 [3], and have also been referred to as dual reality or cross reality as realized in the mirror world built of the MIT Media Lab [4]. While digital mapping applications such as Google Earth can fall into this category, and include exterior models of

buildings, more detailed mirror worlds are often at the scale of a building or complex. Examples are IBM's 3-D data center designed for monitoring large numbers of computers [5], factory monitoring [1], or the real estate management and smart building systems built by Eolus One [2].

3. TECHNIQUES FOR MIRROR WORLDS

At the core of a mirror world is a model of the physical space being mirrored. Views of this core model may give a somewhat literal sense of what that space looks like. These views may be elaborated with information such as labels, insets, paths, highlights, etc. Both the core model and augmented information are structured as *layers* which may be enabled or not for any particular task. In addition to layer visibility settings, views may be manipulated by scripts which control the virtual viewpoint, animations, etc.

The types of layer augmentation, and scripting control we have implemented include:

Avatars: We use the term *avatar* to refer to any depiction of a person in the mirror world. Depending upon the task, and tracking capabilities, an articulated jointed humanoid model may be used, or a simple shape such as a cylinder.

Auras & Trails: Special regions can be highlighted by translucent coloring which we refer to as *auras*. These may be shown around avatars or fixed spaces, to depict status such as whether a room is occupied, or how long a person has been present in a space. Trails can also be shown for tracked people indicating where they have been.

Virtual Posters: Virtual posters or signs may be shown above rooms to indicate such things as the slides of a talk in progress, or pictures of people associated with the rooms.

Video Insets & Projections: Video from cameras may be shown as insets, placed and oriented to give an indication of the camera placement. In some of our viewers, the video can also be seen as projected from the camera positions.

Timelines & Temporal Controls: Some tasks involve seeing into the past or future. For these, an interactive timeline allows control of playtime.

Tours and Camera Motions: Virtual viewpoints can be bookmarked, and scripts may adopt particular views. Sequences of views can be chained to provide site tours. Views can also be attached to tracked people, to produce a first person sense of the view for that person.

Mirror world application consists of a viewer, and a set of available task specific *application modes*, which are defined by layer visibility and script configuration. These modes include:

Building Directory: This mode is for the entry lobby mirror. It presents users with a list of names of people and rooms. Selecting an entry from the list shows a path from the current position at this mirror to the desired location.

Region Closeups: In this mode the view is zoomed in to show more details about a region. Typically these are public spaces such as meeting rooms with large displays, and have more cameras and better tracking capability.

Site Tours: Virtual walk-throughs that give a sense of what it is like to be at another location can help provide a shared sense of understanding. In the Google Earth viewer, this can also provide some of the ambiance of the geographical context of the sites.

3.1 Venue & Event Management

The mirror applications described above fit naturally with tasks of managing a venue for events such as conferences or workshops. For example the mirror views can be used by prospective clients to choose a conference venue, and once a venue is chosen can be used to plan for the event. In advance of the conference, it can be used by attendees to gain familiarity with the space, and even to potentially preview their presentations.

During a conference, kiosk or mobile viewers can help attendees know what is going on where, and web viewers can allow remote participants to see what is happening at the conference. Presentation slides, posters & bulletin boards can be viewed through the mirrors during the conference, but also recorded and made available afterwards as a record of the conference.

We are developing a model of the Nara venue to experiment with using our system for a real conference setting.

Some additional application modes we have experimented with and plan to apply to the Nara model include:

- Venue Selection. The capability to tour a site as well as its surroundings may be helpful to event organizers in choosing a venue. They may also be helpful in marketing the event to prospective attendees. While a touring capability is a common use of 3D worlds in building design and architecture, mirroring can add dynamic data such as room cost and availability.

- Room Layout. Different configurations for furnishing and seating in a room can be defined and chosen by planners. For example, conference rooms on each of the two levels can be configured as either one larger or two smaller rooms. Our tools lets users select and view the different configurations.

- Presentation Previewing. Our system includes scripts for importing PowerPoint slides or folders of slide images, and mapping them to displays at specified times.

- Schedule Awareness. The virtual posters shown above rooms may be used to show session information associated with different rooms. This is done in the spatial context of the venue, to aid attendees in choosing their sessions and navigating between them.

4. ADDITIONAL AUTHORS

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