AttrActive Windows:
Dynamic Windows for Digital Bulletin Boards

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ABSTRACT
In this paper we describe AttrActive Windows, a novel interface for presenting live, interactive, multimedia content on a network of public, digital, bulletin boards. Implementing a paper flyer metaphor, AttrActive Windows are paper-like in appearance and are attached to a virtual corkboard by virtual pushpins. Windows can therefore appear in different orientations, creating an attractive, informal look. Attractive Windows can also have autonomous behaviors that are consistent with the corkboard metaphor, like fluttering in the wind. We describe the AttrActive Windows prototype, and offer the results of an initial evaluative user study.

Keywords
Active interfaces, adaptive behaviors, digital bulletin boards, gestural interaction, paper metaphor

INTRODUCTION
The Plasma Poster Network (PPN) is a network of large screen, interactive, digital, bulletin boards. The PPN offers community members a simple means to publish live, digital content (e.g. Web pages, text, images, animations, movies) to public spaces [see also 3, 4, 6]. AttrActive Windows is an experimental interface to the Plasma Posters. This novel interface moves away from the desktop metaphor of the PC screen, implementing a visually interesting and inviting metaphor that is more appropriate for public bulletin boards: windows resemble paper flyers posted on a virtual corkboard using virtual pushpins. Figure 1 shows an arrangement of AttrActive Windows on a plasma display. Dynamic window behaviors, such as movement in a wind, can be specified by content authors through a web-based posting interface, or can be inherited automatically from pre-specified parameters associated with the virtual corkboard to which content is sent. Passers-by manipulate windows (e.g. dragging at the edges to "lift" corners and rotate them [see also 1]), and move windows by removing and replacing virtual pushpins. They can also interact with the live content, e.g. following hyperlinks, viewing animations and creating digital "scribbles".

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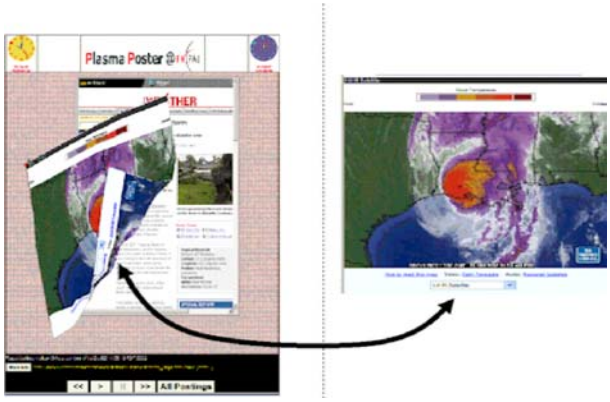

Figure 1: This shows a screenshot of our interactive plasma screen where one AttrActive Window is folded. Its content originates from a standard GUI window displayed elsewhere.

IMPLEMENTATION
The AttrActive Windows prototype utilizes cloth animation techniques to simulate interactive sheets of paper [5]. What users see is a 3D interactive simulation of sheets of paper where the rectangular image content of each window is streamed from a server process and mapped onto a 3D mesh as a texture (Figure 1).

Each window is modeled by a grid of particles linked by springs to their neighbors (Figure 2). This provides a representation of the window image that may be re-shaped efficiently in three dimensions and react with a cloth-like flexibility to actions applied to the particle grid. We update the position of all grid points for all windows, taking into account forces such as spring tensions, gravity, wind, and user actions. To simulate virtual pushpins, some particles are simply constrained to a specific location.

The visual presentation of content is made by covering each supporting grid of particles by an OpenGL texture. The texture bitmap data originates from a server where standard GUI windows are open and actively running (on the same computer as the AttrActive Window display or remotely). Every 100ms, the server captures the content of each GUI window and sends it to the OpengGL client for animated display. This content is mapped onto the corresponding grid of particles through OpenGL's texture mapping procedures. Our prototype provides a simple form-based interface that selects GUI windows running on the server for display as AttrActive Windows with the desired physical properties

(e.g., wind, aging). Our implementation uses OpenGL in C++ and provides realistic simulations for about 20 AttrActive windows at 30 frames per second.

Mouse events occurring on the edges of an AttrActive Window are used to manipulate the mesh of particles. When a user grabs an edge, the closest particle is found and its Z position is incremented, as if the user lifted the particle out of the screen. The physics-based simulation automatically updates the rest of the particles, achieving very realistic folds. Mouse and keyboard events occurring inside an AttrActive Window are trapped and mapped back to the rectangular coordinates of the original content. We do this by encoding a second OpenGL texture map with the original X-Y window coordinates that allows the OpenGL event processing to quickly report the coordinate value. We send each event back to the server where it is regenerated onto the corresponding GUI window. This allows users to fully interact with the original content of each window, e.g. following links in web page (see VNC for more details [2]).

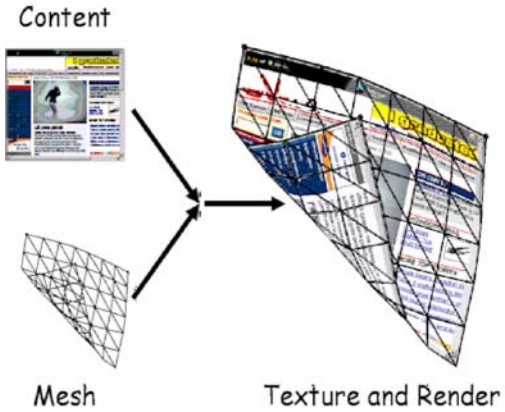

Figure 2: Image content and 3D mesh model are combined to render an AttrActive window.

We have found that gravity alone provides very realistic effects. For example, if an AttrActive window is attached by one pushpin, users can rotate it and leave it swinging by itself. Dynamic behaviors such as movement in the wind have also been implemented by adding a force to the bottom row of particles of each AttrActive Window.

INITIAL REACTIONS TO ATTRACTIVE WINDOWS

During the development and testing of AttrActive Windows interface, many researchers and staff from our organization approached the bulletin board and commented on its appearance, offering anecdotal evidence that paper flyer metaphor and the animation effects were successful as attractors.

An informal user study was carried out using a touch screen plasma display and a pre-created set of posted web pages. Six people carried out set tasks that required manipulating AttrActive Windows and interacting with content. A semi-structured interview on the design ideas and usability followed. Results indicated that the paper flyer metaphor was popular. We were careful to allow a large area (0.75 inch) around each window for edge selection, and users did not have problems manipulating and rotating the windows. Although people were impressed that windows remained fully interactive, two problems were identified. First, delays caused by our polling mechanism on the server side were frustrating, and secondly, some content interaction proved difficult, e.g. locating and accurately selecting hyperlinks. Two participants suggested using multi-finger touch screens; this would be easily accommodated with our underlying real-time 3D engine.

It became apparent that more design work on the physics of the virtual corkboard itself; one user was embarrassed when a window "dropped" off the screen after she removed its last pushpin.

CONCLUSION AND FUTURE WORK

AttrActive Windows appears to be visually appealing and intriguing to our user population, encouraging us to further study this new metaphor on public displays. However a number of design improvements are needed. To make the system more responsive to content changes, we will poll the content more intelligently, as done in VNC [2]. Additional behaviors like aging with time (i.e. yellowing and crumpling) are being implemented. We are also considering re-representing the content of windows and not just the windows themselves. In this regard, we are investigating content-related, 3D layouts. Finally, we are implementing synchronous, multi-finger manipulations.

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