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Pinwheels: Visualizing Information Flow in an Architectural Space

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ABSTRACT

We envision that the architectural spaces we inhabit will become an interface between humans and online digital information. We have been designing ambient information displays to explore the use of kinetic physical objects to present information at the periphery of human perception.

This paper reports the design of a large-scale Pinwheels installation made of 40 computer-controlled pinwheel units in a museum context. The Pinwheels spin in a "wind of bits" that blows from cyberspace. The array of spinning pinwheels presents information within an architectural space through subtle changes in movement and sound.

We describe the iterative design and implementation of the Pinwheels, and discuss design issues.

Keywords

ambient media display, tangible user interface, peripheral awareness, background, visualization, information flow

INTRODUCTION

Current personal computing interfaces squeeze vast amounts of digital information into small rectangular screens. Information is presented as pixels on flat screens that must be in the center (foreground) of a user's focus of attention to be processed. The interactions between people and digital information are currently almost entirely confined to a conventional GUI (Graphical User Interface) comprised of a keyboard, screen, and mouse.

To explore an alternative approach, we are moving information off the screen into the physical environment, where it is manifested as subtle changes in form, movement, sound, color, smell, temperature, or light. We call such displays "ambient displays." We feel that ambient displays are well suited as a means of keeping users aware of people, weather, or general states of large systems.

BACKGROUND

The Pinwheels evolved from the idea of using airflow in the ambientROOM project [2]. We found that the flow of air itself was difficult to control and to convey information.

Figure 1 Overview of the gallery with 40 Pinwheels in the NTT-ICC museum in Tokyo

As an alternative, we envisioned that a visual/physical representation of airflow based on the "spinning pinwheels" could be legible and poetic. The Pinwheels spin in a "wind of bits" at different speeds based upon their input information source.

The first prototype of one array of 5 pinwheels was implemented in 1997 [3], but the system architecture was not extendable and flexible enough to implement a large scale system to explore a variety of spatial and temporal visualization designs. We decided to re-design the pinwheels system with the following three goals: 1) scalable and technically robust architecture, 2) exploration of application contents, and 3) exploration of various mappings of contents for temporal and spatial visualization.

This paper presents the design of a large-scale installation of Pinwheels to achieve these goals.

DESIGN OF PINWHEELS

Pinwheels explore the idea of physical movement caused by invisible information flow as new form of information visualization. We explore the bridging of architectural space and online digital space through the design of a large-scale installation of Pinwheels in a museum context.

Hardware and Software Infrastructure

Our aim was to make the electronic unit for each pinwheel (motor and circuit board) small and robust, and the overall

system easy to scale up and reconfigure. For this reason, we implemented an architecture that allows users to daisy chain a large number of pinwheels, and control each of them from a computer via a serial port. The pinwheels are driven by instructions from a Java program, and information can be relayed from the internet or other networked information sources and routed to the appropriate fixture. The pinwheels are made from folded fiberglass mounted on the shaft of a small DC motor. Pulse width modulation controls the speed at which the motors spin.

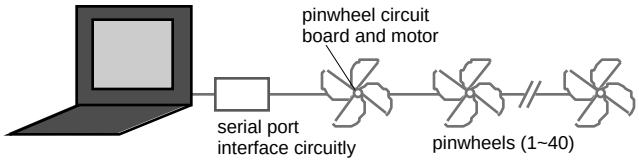

Figure 2 Setup of the Pinwheels system

Application Contents

Ambient information displays are envisioned as being all around and suited to the display of a) people's presence (awareness of remote people's status / activities), b) atmospheric and astronomical phenomena, or c) general states of large and complex systems (e.g. atomic power plant, computer network system).

Among a variety of possible application contents for the installation of 40 pinwheels at a museum in Tokyo, we concluded that the awareness of people's activities would be the most significant application because people have a strong desire to feel connected to others.

We thus explored the mapping of the following information that represents people's activities onto spinning pinwheels:

1) People's movement in a physical space, such as traffic of people at a subway station, car traffic on a street and at an intersection, and movements of elevators in a high-rise.
2) People's activity in cyberspace, such as e-mail exchanges and stock market transactions.

We gathered raw data of traffic from a camera pointing at streets and intersections. We also collected data of elevator operations from the building management sections of the building where the museum is located. Finally, we monitored people's activities in cyberspace through e-mail management systems and e-commerce web sites.

Mapping of Information to Physical Motion

A designer of ambient displays must transform digital data into a meaningful pattern of physical motion that successfully communicates the information. Determining how to give the ambient display coherent spatial meaning in a large gallery space (24m x 16m x 5.8m) was a tremendous design challenge.

We mounted five pinwheels onto each of 8 supporting rods, and spatially distributed the rods across the gallery space (diagonally from the entrance to the back), with equal intervals between them. We decided to interpret this line of

Figure 3 Pinwheels spinning in Tokyo in a wind of e-mail traffic at MIT

rods as a "time axis." The rod nearest to the entrance represents the present time, and wind blows from this rod based on discrete events, and travels through the 8 rods towards the past. For example, an e-mail message with a large attachment will generate a blast of wind that spins several pinwheels on each rod as it travels down the time axis. A short message on the other hand will create only a light puff of wind.

The Pinwheels were installed at the NTT-ICC museum in Tokyo from June 22nd to July 9th, 2000, where they were seen by thousands of visitors. We ran them using a variety of data representing people's activities, and we explored a number of different algorithms and parameters for mapping the data into coordinated motion of the pinwheels in a legible and aesthetically pleasing manner.

CONCLUSION

Visitors at our exhibition felt that in addition to being meaningful displays of information, the Pinwheels acted as kinetic sculptures that are beautiful and poetic in and of themselves. We hope that by integrating them in our architectural spaces, Pinwheels will be able to create informative reactive environments that are both subtle and aesthetically pleasing.

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