APPLICATIONS OF A COMPUTERIZED WHITEBOARD

Brent Welch, Scott Elrod, Tom Moran
Xerox Palo Alto Research Center, Palo Alto, CA
Kim McCall, Frank Halasz, Richard Bruce
Xerox LiveWorks, Palo Alto, CA

Abstract

A computerized whiteboard has been built using an infrared pen technology in combination with a 67" display. The image is formed from a rear projected liquid crystal light valve. The system was designed to support several different applications: a whiteboard that enables both capture and organization of information for informal creative meetings, a group station where computational tools can be used through the white board metaphor, a communication device employing a remotely shared work surface, and a multimedia presentation tool.

Background

As computational and communication capabilities become increasingly more powerful, the advantages for use become more compelling. A major barrier to general implementation is the user interface.

To date most of the interface design effort has been directed toward use by individuals with very little focus on the needs of workgroups. Consequently groups are forced to use interfaces that are keyboard and mouse centric with display screens designed for the desktop.

Unlike desktop computers which can be personalized for the individual user, displays supporting group work become a "shared appliance" which should be designed to be immediately usable by even the most casual and inexperienced user. Operation must be obvious from inspecting the appliance or from casually watching others use it. To allow the user to focus on communicating to the group, operation of the system must fit naturally requiring a minimum of the user's attention.

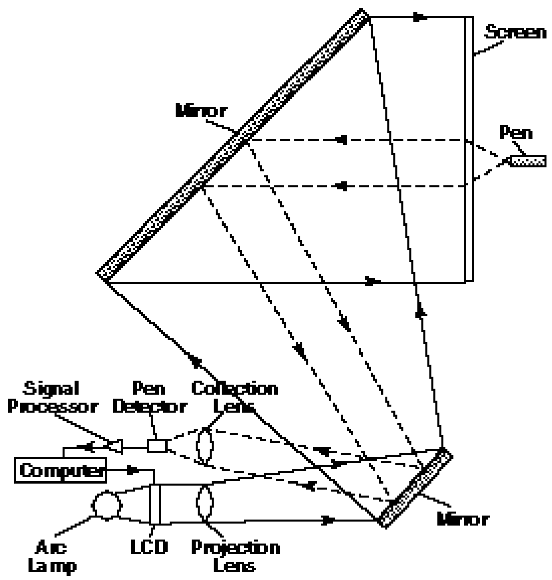
While both groups and individuals are often involved in similar tasks, the natural working medium used by groups is writing with a pen on shared surfaces[1]. Shared surfaces commonly found in today's meeting rooms include: overhead projectors, whiteboards, and flip charts. The important elements of the shared surface are the image which must be large enough to be seen by the entire group and the pen input which can be easily accessed by all participants.

One recent attempt to bring computational technology to workgroups employs a computer driven LCD display panel on an overhead projector. While this approach provides a large image, the keyboard input does not fit naturally into the way groups work. Several of the difficulties encountered include: barriers to universal direct participation due to limited typing skills of some group members, reduction of creative emphasis needed for persuasion in directing the "typist" to enter information , and, most importantly, without a leader at the shared surface, the group's attention is often defocused.

This deficiency can be addressed by integrating a pen input device with the large image, to form an interactive display surface. The integration allows participants to access, input and control all the software tools currently used on their individual computers but using a pen on the shared surface. This paper will address the design and use of such a system, the LiveBoard™, for several functions including: computational tools normally used by individuals but in a workgroup setting, computerized whiteboard with organizational as well as capture functionality[2], remote conferencing with direct interactive access to a document based shared working surface, and multimedia presentations.

Technology

The display and stylus input are the two key subsystems for computerized whiteboards. Infrared technology was chosen for the pen in LiveBoard[3]. In addition to the necessary accuracy (1/5000), response time (0.1s), size independence, and sample rate (200/sec) the infrared approach offers additional features useful for group work. The pens can be used at a distance as well as in direct contact with the board. Such operation allows the leader to stand outside of the viewing path while directing the group. Some of the key functions such as select, write and erase can be controlled by "mouse like" buttons on the pen. Such a position-independent interface is important for working on large surfaces where the distance a user may need to reach across the board to press an icon may be large. The technology also supports independent input devices so that several individuals can work simultaneously.

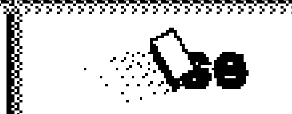


The image is formed by a rear projected, single element, liquid crystal light valve with VGA (640x480) resolution. The liquid crystal light valve provides an image with sharp, stable edges for viewing in close proximity by the operator in contrast to CRT projected images where the edges are "fuzzy" and exhibit jitter. By using a single image element, the LiveBoard needs no alignment and can be used as a mobile system to be rolled about a location. A low gain screen was chosen to provide an image at oblique angles to the operator as well as to the group. The display has a luminance of 10.5 fl, and a contrast in the dark exceeding 20:1. The luminance variation from center to corner is less than 40%. By using a projection screen which reduces the scattering of ambient light, a contrast of 4:1 has been maintained in ambient lighting exceeding 35 fc.

Applications

Workgroups engage in many activities that require a "shared surface" for capturing and organizing ideas. Problem solving processes provide a good example. Here, the first step is brainstorming where all participants are encouraged to contribute ideas in order to collect various perspectives. Ideas are usually captured spontaneously and later organized into categories, evaluated and summarized. While conventional shared surfaces provide a medium for capturing information, there is very little support for the organizational steps. A whiteboard application, MeetingBoard™, has been designed for the LiveBoard in part to address this need. The architecture allows captured information to be easily manipulated for organizing. Treating the "electronic ink" as an object, not a bit map, allows the properties of the marks such as: position, color, and line width, to be easily changed. Users move information around on the surface during the categorization step. Color and line width coding are used during evaluation.

The user interface to these operations was designed to be natural and intuitive so that participants can learn to use the tool by watching during a meeting. The number of button icons and pull down menus are minimized to provide the user with relatively clean surface and maximum visibility of controls. Working on a large surface is assisted by position independent control techniques where the user can access important controls at any point on the surface. These operations are performed through simple gestures which address their operands directly and immediately and are quickly learned by imitation.

Operation	Gesture
Draw	
Erase	
Wipe	
Select	
Move	

The simplest of all MeetingBoard commands is erasing. By pressing a button on the stylus the pen-shaped drawing cursor is converted into an eraser. Then wiping across any mark will erase that object in its entirety. This object-level granularity of erasing usually corresponds much more closely to user intent than does pixel-level erasing. This immediate addressing of the object to be operated on is very natural in a pen-based large area interface. The concept has been extended with "generalized wiping" where the cursor is viewed as an applicator to which many operations can be attached. For instance, color and line width changes can be made by first selecting the wiping operation and activating the cursor with a property by touching that property and then moving the "activated" wiper cursor across the mark whose property is to be changed.

Objects are selected by the simple gesture of encircling them. They may then be moved to a new location by "dragging" them across the display surface. To minimize confusion to users, the number of gestures has been restricted to include only the most important and necessary ones. Other implemented gestures are for scrolling and specifying an insertion point for typing.

MeetingBoard has an image transfer feature to effectively embed images from other applications into the background of the whiteboard. The group can annotate the embedded image just as if they were working with an empty whiteboard. This feature has been used effectively in training and education applications where a lesson image can be transferred from a supporting application and annotated in front of the class. Images such as maps, artwork, mathematical functions and chemical structures have been transferred for LiveBoard lessons.

With a computerized whiteboard, workgroup leaders can use the stylus to control and enter data in applications that they traditionally use on their desktop PCs. With gesture controls and handwriting recognition, data can be directly entered and removed. For example, financial planning is done with the entries made directly with the pen in an active spreadsheet. The pen entry keeps the group focus on the issue at hand and the immediate reconciliation of the application enables the group to view the resultant changes to the bottom line. Program planning is be done by directly moving the finish or start times in GANT charts with the pen. When an entry is made, the chart reconciles and the group can immediately visualize the overall effect of the change. Design tools can be used by a group to visualize chemical structures, electronic circuits, and mechanical layout. Groups used the LiveBoard for these activities primarily for the immediate feedback which often affects further considerations. An updated file was stored as a permanent record created stored and printed copy was available at the conclusion of the meeting. In addition support time was reduced by eliminating the need to prepare transparencies and reenter the group input in the application file.

Two or more LiveBoards can be connected to provide remote groups a common working surface with all the MeetingBoard functionality available to the local group. The connection can be made over ordinary phone lines or local area networks running standard protocols. Multiple users can share the surface through a data bridge connection. The shared work surface is completely interactive so that all participants can write, erase and organize as desired.

Using a video window, video conferencing can be integrated to provide additional information. In this mode, one communication link handles the video, data and audio. The user can size and position the video window depending on the focus of the conference. For parts of the conference which are rich in information, the video window can be reduced and placed in a corner of the display. In this mode the user can still see the remote participants to anticipate questions and gauge whether the information has been understood. For those parts of the conference requiring more direct interpersonal communication, the video window can be expanded to fill the screen. Here participants can more effectively view nonverbal communications to judge level of commitment to an agreement or degree of understanding.

As a computational tool, LiveBoard can run any presentation application compatible with the Windows operating system. With integrated video and audio, the LiveBoard supports multimedia presentations. These presentations can be controlled and annotated by the stylus. Annotated copies can be saved and referenced for future alterations.

(1) Pedersen, E. R., et. al., Proceedings of 1993 INTERCHI, ACM, 391

(2) Shrage, Michael, <u>Shared Minds</u>, Random House, 1990

(3) Elrod, Scott, et. al., Proceedings of the 1992 SIGCHI, ACM

KEYWORDS: WhiteBoard, Interactive, Stylus

References

Draw	point to draw	mark screen
Erase	point to erase	Erases marks on screen
wipe	select erase then point to a property	activates wiper to change property
Select	point to select	select mode
Tear	draw across screen in select mode	stretches or contracts space
move	circle mark in select mode	