Front Projection for Large Displays

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1 Virtual Rear Projection can reduce the expense of large displays

When you have a chance encounter in a hallway with a colleague or friend, it can sometimes be difficult to refer to data stored on your computer. In the future, computer displays will be ubiquitous, and such informal collaboration will be supported through access to your data via any wall or tabletop.

Technology will advance to the point where walls and tables can be covered with printed, flexible displays as cheap as wallpaper, or nanotech paint will convert all surfaces into cheap touch sensitive displays. To properly prototype such interaction spaces of the future, researchers need to saturate their research areas with displays, providing output potential on all of the surfaces in the environment[3].

However, large LCD, LED, and plasma screens are expensive[1]. Rear projection, while slightly more cost effective for large displays[2], has an associated space cost which makes it unsuitable for some applications such as tabletops or exterior walls.

Front projection is currently the most economical method of output enabling large planer surfaces. Using re-taskable projectors with pan-tilt mirrors such as the Everywhere Displays[2] allows many surfaces to be potentially output enabled with a lower expense than fixed projectors. The largest problem with front projection is occlusion of the display beam by users. Other subproblems include users being blinded by the projection beam they are occluding (if looking at the projector) and the projection of graphics onto occluders, which may be distracting. Because of this, front projection is generally used to enable displays on non-interactive surfaces, which are not approached too closely, stood in front of, or leaned over by users.

The occlusion problem can be effectively solved by using multiple redundant projectors. Because the output of each projector is aligned using a perspective transform (using standard 3D hardware), the projectors can be mounted at acute angles to the display surface (e.g. above or to the side, instead of directly

[1] At the time of writing, a 43 inch plasma monitor (Pioneer PDP430HD) had a street price of $6,350, while a 61 inch model (NEC 61MP1) cost $15,150.

[2] At the time of writing, a 3.9ft by 8.1ft (1.2m by 2.5m) plastic rear projection screen (BlackScreen from Jenmar Visual Systems) was quoted at $1,400. Projector(s) and installation are extra.

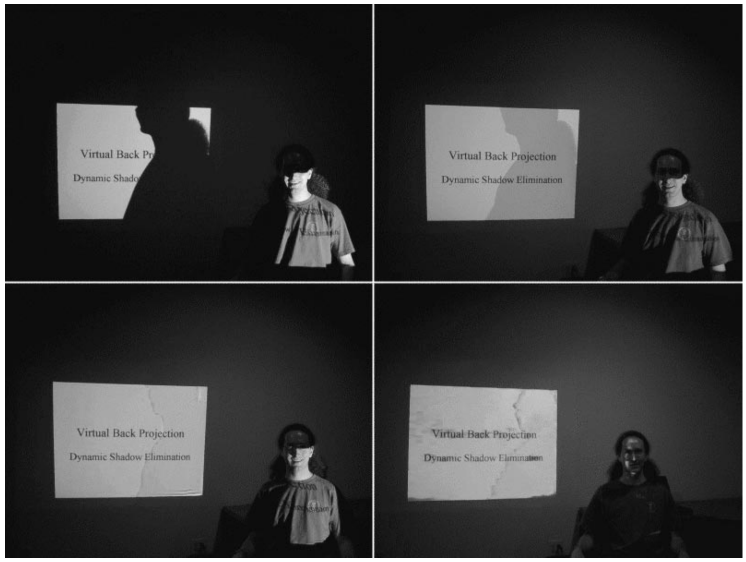

Fig. 1. Virtual Rear Projection: Single projector (top left). Dual redundant projectors (top right), with dynamic compensation (bottom left) and occluder light suppression (bottom right). A video and more detailed figures are available at: http://www.cc.gatech.edu/~summetj/research.html

perpendicular) which means that the output of each projector is less likely to be occluded. Additionally, because all projectors contribute to the image, only one must remain unoccluded, on a per-pixel basis, for the output of the display to remain visible. With a passive setup, users may still cast partial shadows (Figure 1 top right) but the display remains comprehensible. Dynamic modification of the output levels of each projector can be used to alleviate the effects of these partial shadows[5] (Figure 1 bottom left), and to reduce the light projected onto the occluder[6] (Figure 1 bottom right).

2 Future Work

Virtual rear projection allows us to create individual display surfaces which can support interaction. The next problem we want to tackle is the lack of an easy application programming model and system architecture and infrastructure to support application development for, and deployment in, an environment saturated with multiple output surfaces and input devices.

Examples of output surfaces are mobile tablets, traditional monitors, and projected wall sized displays. Each of these output devices may or may not support direct (touch or gesture) input. Input devices such as mice, keyboards, and wands may not be associated with a specific output device. The resolution of output surfaces does not have to be homogeneous. Applications should be able to take advantage of Focus+Context displays[1], which support hi-resolution pockets in lower resolution output surfaces, without having to explicitly manage the resolution conversion and synchronization. In the same manner, input resolution may not be homogeneous. A camera based hand tracker, touch sensitive screen, and mouse all provide different levels of input resolution, potentially for the same output surface.

Rekimoto demonstrated an interaction technique for a spatially continuous work space called HyperDragging[4]. Allowing pointing devices to jump to other displays in the physical world is one solution to the general problem of user input devices being separated from the output devices. A general purpose environment which provides support for such techniques, allowing the application developers to concentrate on user needs instead of implementation details is still needed before general research on applications for such an environment can flourish.

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