Toolglass and Magic Lenses: The See-Through Interface

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VIDEO ABSTRACT

In current interfaces, users select objects, apply operations, and change viewing parameters in distinct steps that require switching attention among several screen areas. Our See-Through Interface™ system addresses this problem by locating tools on a transparent sheet that can be moved over applications with one hand using a trackball, while the other hand controls a mouse cursor. The user clicks *through* a tool onto application objects, simultaneously selecting an operation and an operand. Tools may include graphical filters, called Magic Lens™ filters, that display a customized view of application objects. Compared to traditional interactors, these tools save steps, require no permanent screen space, reduce temporal modes, and apply to multiple applications. In addition, magic lens filters provide rich context-dependent feedback and the ability to view details and context simultaneously. These tools and filters can be combined by overlapping to form operation and viewing macros.

INTRODUCTION: CLICK-THROUGH TOOLS

We introduce a new style of graphical user interface, the See-Through Interface™ system [1]. This interface includes semi-transparent interactive tools, called *click-through tools* [2], that are used in an application work area. They appear on a virtual sheet of transparent glass, called a *Toolglass™ sheet*, between the application and a traditional cursor. The user positions a sheet over desired objects and then points through the tools to apply them to application objects. The user can move a toolglass sheet in two ways: by dragging it with the mouse or by connecting it to a trackball operated with the other hand. Using both input devices, the user can move a sheet and a mouse cursor simultaneously [3]. For example, a set of simple tools called *click-through buttons* can be used to change the color of objects below them, as shown in figure 1. The user positions the tool in the vicinity and indicates precisely which object to color by clicking through the button with the cursor over that object, as shown in figure 1(b).

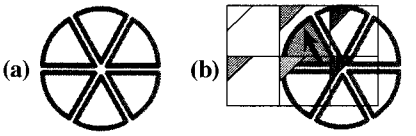

Figure 1. Click-through buttons. (a) Six wedge objects. (b) Clicking through a color-setting button.

Many tools can be placed on a single sheet, as shown in figure 2. The user can switch from one command or viewing mode to another by repositioning the sheet. In addition, one sheet can have many layers, called *tiles*, where each tile displays a different set of tools. The user can select which tile should be displayed next.

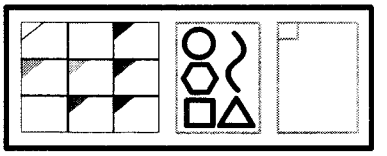

Figure 2. A tile of tools, including (left to right) a color palette, a shape palette, and a clipboard.

TOOLGLASS: CLIPBOARDS

Other see-through tools act as *clipboards*. Clipboards pick up shapes and properties from underlying objects, acting as visible instantiations of the copy and paste keys common in many applications. Clipboards can pick up entire objects or specific properties such as color, dash pattern, or font. They can hold single or multiple copies of an object. The objects or properties captured on the clipboard can be copied from the clipboard by clicking on them.

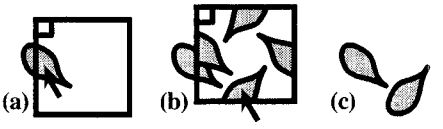

Figure 3. Symmetry clipboard. (a) Picking up a shape. (b) Rotated copies. (c) A copy is pasted.

Figure 3 shows a symmetry clipboard that picks up the shape that the user clicks on (figure 3(a)) and produces all of the rotations of that shape by multiples of 90 degrees (figure 3(b)). Moving the clipboard and clicking on a particular shape, the user drops a translated copy of that shape (figure 3(c)). Clicking the small square in the upper left corner of the tool clears the tool so that new shapes can be clipped.

MAGIC LENS FILTERS

Click-through tools can include graphical filters, called Magic

Lens™ filters [4] that modify the appearance of the objects beneath them. One simple filter is a magnification lens. Unlike traditional magnification lenses, which simply replicate the pixels of the displayed image, magic lens filters work on the underlying graphical representation to create a true scaled image. Next to our magnification filter is a slider tool that changes the filter's scaling factor.

In addition to their role in user interfaces, magic lens filters provide a new tool for computer graphics and scientific visualization. When integrated into drawing tools, these filters enable a new set of effects and speed the production of traditional effects. Figure 4 shows a magnifying filter and a wireframe filter used to produce a logo.

Figure 4. A logo incorporating two filters.

TOOLS AND GRAPHICAL FILTERS TOGETHER

Tools and filters can be composed by overlapping them, allowing a large number of specialized tools to be created from a small basic set. For example, selection is difficult in graphical editing when objects overlap or share a common edge. Our selection tools address this problem by modifying the view of shapes seen through them. For example, figure 5 shows a tool that makes it easy to select a shape vertex even when it is obscured by other shapes. This tool contains a wireframe filter that reveals all vertices by making shape interiors transparent. Clicking through this tool selects the vertex nearest to the cursor.

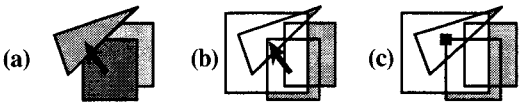

Figure 5. Vertex selection tool. (a) Shapes. (b) The tool is placed. (c) A selected vertex.

GRIDS

Figure 6 shows a line being drawn using a grid tool. Although the grid appears only within the tool's interior, the grid lines stay fixed relative to the picture, even as the tool moves. By moving the tool, the user draws precise shapes that are larger than the tool. This tool can be moved from one application to another to align an object in one window with an object in another.

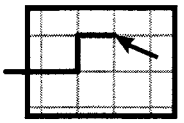

Figure 6. A movable grid tool.

TEMPORARY COMPOSITION

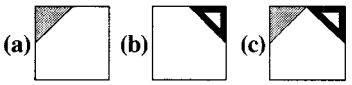

Figure 7. Composing color-changing tools.

When several sheets are used, tools can be composed temporarily by moving the sheets so that the tools overlap. For example, figure 7(a) shows a tool that sets the fill color of graphical shapes. Figure 7(b) shows a tool that sets the line color. The tools can be overlapped to form a tool that sets both fill color and line color simultaneously as shown in figure 7(c).

MORE EFFECTS USING GRAPHICAL FILTERS

In graphical editing, a filter can be used to modify the visual properties of any graphical object, to provide a preview of what changing the property would look like. Properties include color, line thickness, dash patterns, typeface, and drop shadows. For example, the drop shadow filter in figure 8 shows what objects would look like with drop shadows. The user can move the filter to preview drop shadows on different shapes.

Figure 8. A drop shadow filter.

Magic lens filters can be parameterized. For example, the drop shadow filter has parameters to control the color and displacement of the shadow. These parameters can be set by graphical controls on the sheet near the filter, by input from devices such as a thumbwheel, or by other tools.

IMPLEMENTATION IN X WINDOWS

While the tools shown so far were implemented in the Cedar programming environment, other tools have been created in X Windows. X Windows tools shown in the videotape include a map browsing application and a tool for visualizing the Gaussian curvature of a three dimensional shape.

CONCLUSION

We have introduced a new design space for user interface tools, the see-through interface system. These tools can be used on their own or in combination with existing user interfaces. On a movable transparent sheet, they provide a standard interface across multiple applications, different display sizes, and different tasks. These tools effectively employ the non-dominant hand, using it, as in the physical world, to bring tools to the work. The see-through interface can be applied to almost any application, from word-processing and spreadsheets to scientific visualization and computer-aided design.

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