Hybrid Widgets on an Interactive Tabletop

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Abstract. We introduce the concept of *hybrid widgets*, which consist of a digital object on an interactive display surface, and a physical handle attached to it. We describe two implementations of this concept, both for the interaction with digital photo collections on an interactive tabletop, and discuss how the combination of a physical and a digital part in the hybrid widget supports interaction and solves some typical problems of multi-user tabletop interfaces.

1 Introduction

The vision of Ubiquitous computing describes everyday objects which assume new capabilities through digital technology. From the beginning, research in Ubiquitous Computing has dealt with display capabilities and new form factors of computer displays. One particularly promising class of displays are interactive tabletops. This is reflected in the large body of work in this field which also spawned its own conference, the IEEE workshop on Tabletop Interfaces. Research prototypes of interactive tables are available for a while, and after HP announced a commercial interactive coffee table last year, also Microsoft picked up this area and announced its first "surface computer" for later this year. The surface of an interactive table makes it particularly easy to mix physical and digital artifacts, since gravity holds physical objects conveniently on the same surface, on which the digital objects appear. It therefore becomes possible to investigate hybrid interaction scenarios, in which a user interacts with both physical and digital artifacts at the same time. Since most tables by nature accommodate multiple people interacting from different directions, multi user interaction is not the exception, but rather the standard situation at digital tables, and the different orientation for different users is a standard problem.

A very popular scenario for tabletop interfaces is the manipulation of digital photo collections, which is motivated by two aspects: On the one hand, digital photography has largely replaced analog photography in many contexts. On the other hand, we still haven't found adequate interaction concepts which would allow us to handle digital photos in an equally convenient way to paper photos. This includes the activities of filing, browsing, selecting and sharing photos. In this paper, we describe two applications, the PhotoHelix and the PhotoLens, which aim at supporting different phases of handling photo collections on an interactive tabletop through hybrid interaction.

2 Related Work

For the sake of brevity, this section will only give a very short overview of the main publications which have inspired this work or are related to it. A much more thorough discussion of related work is included in the separate papers about each of the two demos described here, which are currently under review.

The groundbreaking work on the digital desk by Pierre Wellner [3] has, of course, laid the foundations about mixing digital and physical artifacts on a table surface. It specifically describes various ways of transition between these two worlds. In terms of interaction, our concept of hybrid widgets has been inspired by Bier's Toolglasses and magic lenses [1]. They point out a way for two-handed interaction with an adequate distribution of tasks between dominant and non-dominant hand. The work, which is closest to our own, are Rekimoto's data tiles [4]. They describe physical tiles which are moved on a computer display and provide physical affordances, such as groves, for pen-based interaction with the screen content. In terms of tabletop interfaces for photo collections, Hinrichs' interface currents [2] describe a way to deal with the orientation problem and also include the notion of shared and private space on the desk surface. The Personal Digital Historian [5] describes a system to share photos on a tabletop and also deals with the orientation problem.

3 The concept of Hybrid Widgets

In classical graphical user Interfaces, the concept of a widget has been established to channel interaction with the screen content. It serves two tasks by providing a recognizable point for interaction for the user, and at the same time a reusable construct for the programmer. GUI widgets are purely digital artifacts by nature and are used with a mouse or pen. Tangible User Interfaces use physical objects for interaction with data. These objects are linked in various ways to digital objects. They can represent those objects or provide a tool to manipulate them. TUIs reclaim some of the physical qualities of our interaction in the real world. They give us a "grip" on digital information.

Our concept of hybrid widgets is a mixture between GUI widgets and tangible Interfaces. Hybrid widgets are recognizable and reusable interface objects, but also provide a physical handle. Interaction with them takes place in a very physical way, by manipulating the handle with the hand, but they also contain a digital part, which is closely coupled to the physical handle. Like a digital shadow, this digital part follows the physical handle wherever it is positioned on the interactive surface. Hybrid widgets are directly manipulated in the true sense of the word, not remotely via a mouse or pen. This combination of a physical and a digital artifact provides a haptic quality to interaction with the screen content, but at the same time uses the digital shadow to provide functionality which goes far beyond the capabilities of the physical object alone. These capabilities are leveraged by interacting with an additional pointer, such as a pen or a finger. The widget itself is usually manipulated with the non-dominant hand to provide a reference frame for fine-grained interaction with the dominant hand.

The fact, that users place and manipulate their own physical handle on the desk, solves the identification problem in multi user interaction in a very elegant way, since the handle can be identified by the surface, and interactions can then be clearly attributed to users. This also solves the orientation problem on a desk surface, since each user can position and orient the handle in a way that suits him or her best. At the same time, the physical parts of several hybrid widgets on a desk surface provide landmarks and reference points for social interaction between users. Hybrid widgets can in principle be used on any interactive surface, such as walls or floors, if the corresponding technical problems, such as keeping the handle on the wall, or tracking it on the floor, are solved adequately.

4 Our Implementation of Hybrid Widgets

In this paper, we describe two different hybrid widgets, both dealing with the organization of digital photo collections, and both working on the same interactive tabletop surface. They also use the same object as a physical handle.

4.1 The Interactive Tabletop

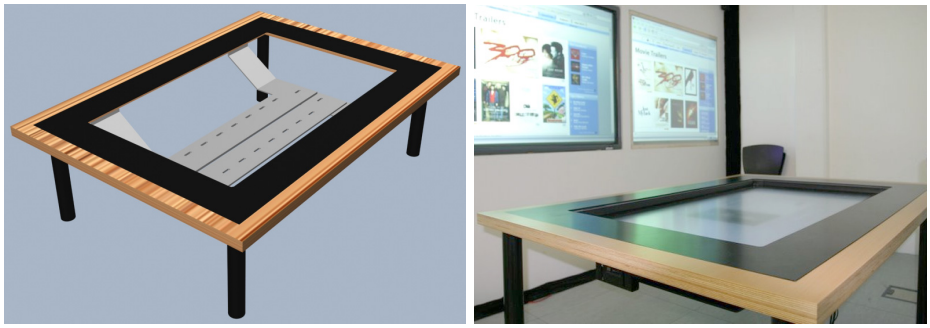

Fig. 1. Left: Construction drawing of our interactive table frame, built to hold a 42 inch LCD screen with a DViT overlay panel. Right: The actual table, integrated in our interactive environment

Our interactive table is a custom wooden frame resting on four legs, with a hole accommodating a 42 inch LCD screen with a DViT overlay for interactivity (see figure 1). The screen has a resolution of 1260x768 pixels and provides accurate tracking for two input points at a time. Since one input point is used to track the physical handle of the hybrid widget and the other one for pen or finger input, only one hybrid widget can be used on the table at a time. Nevertheless, our interaction concepts are designed for multi user interaction.

4.2 PhotoHelix

The first hybrid widget, which we intend to demonstrate, is called the PhotoHelix. It builds on the idea of the circular aztec calendar and is a fundamentally round widget. Its physical handle is a metal knob of about 2 inches diameter, whose upper part can be rotated in order to rotate the widget. The digital shadow basically represents a time line which is wound up in the shape of a helix around the central knob. On this time line, the photos of a collection are arranged according to the date when they were taken. Photos can also be grouped into stacks, if they belong to a common event.

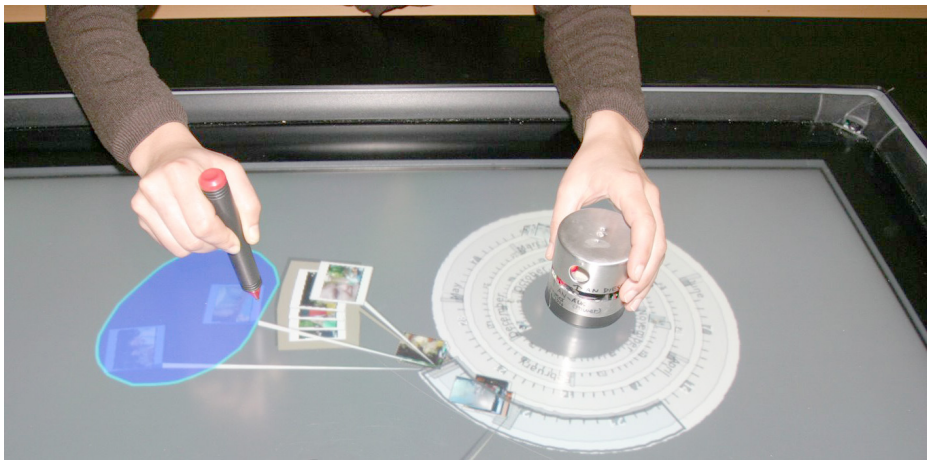

Fig. 2. PhotoHelix in use on our interactive Tabletop: The non-dominant hand holds the physical handle of the helix and turns it to scroll through time. The dominant hand uses a pen or a finger to select, group, or manipulate photos.

On one side of the helix, a window (see figure 2) over the helix specifies a time interval which is currently under closer inspection. Its photos are represented around the helix on the table, connected to their stack on the time line by an umbilical cord. Turning the handle rotates the helix with the window held fix and hence moves different time intervals under it. Photos can be grouped into so-called "events" by circling multiple photos with the pen (see figure 3). Events can be dissolved again by cutting their connections to the helix. Single photos can be moved, rotated and scaled on the table and thereby shared between users. In our concept, other users can the include these pictures into their collections by dragging them into one of their events, but as stated above, the current implementation is limited to one widget due to hardware limitations.

Turning the handle of the PhotoHelix scrolls through time. Turning it very fast and letting it spin freely hence moves through time very quickly. This way of interaction is provided by the physical affordances of the handle, not by special

Fig. 3. Interaction with PhotoHelix from left to right: Opening a picture collection by placing the physical handle. Organizing images into events. Inspecting images in an event. Detail view and manipulation of one individual image.

measures in the software. The entire PhotoHelix can be positioned freely on the table. For a few moments after its initial placement on the surface, the helix remains semi-transparent and its overall orientation can be adjusted in order to move the detail window to a convenient side. Since the entire widget has a round structure, there is no other orientation preference and it can be used equally well for right- and lefthanders. We have evaluated the use of PhotoHelix with good results, which are, however, beyond the scope of this paper.

4.3 PhotoLens

Fig. 4. PhotoLens in use on our interactive Tabletop: The non-dominant hand holds the physical handle of the lens and moves it over piles of photos. Turning the handle zooms in and out of the pile's content, sliding the handle along the side scrolls through the content. The dominant hand uses a pen or a finger to select and move photos.

Our second hybrid widget, the PhotoLens, builds on the concept of a Toolglass [1], but uses a physical handle. Although the handle is the same physical object as in PhotoHelix, it is used with very different interaction mappings. The digital part of this hybrid widget is a rectangular semi-transpareent area with two solid borders on the left and on the bottom sides. It is used to display a thumbnail view of a photo collection (see figure 4). The handle is initially attached to the lower left corner of the lens, but can be slid along its left border to scroll through the entire collection. The bottom side contains a grid which acts as a temporary storage area, onto which photos can be dragged.

Coarse positioning of the handle again moves the entire hybrid widget to different locations on the desk. Multiple parts of the photo collection (for example, corresponding to the events in PhotoHelix) are arranged on the desk surface as multiple piles. Moving the lens over a pile unfolds its thumbnail view (see figure 5) and allows interaction with it.

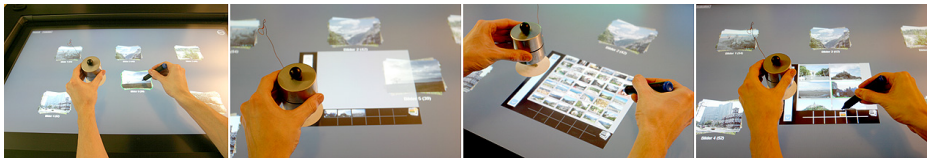

Fig. 5. Interaction with PhotoLens from left to right: Moving piles freely on the table. The digital lens appears when the physical tool is placed on the table. The pile unfolds into a thumbnail view. The view can be zoomed in and out by rotating the upper part of the tool and selected pictures can be copied onto a temporary tray.

Lifting up and placing the lens on an empty area of the table creates a new stack there, containing the photos which were dragged onto the temporary storage area before. For a few moments after initial placement, the entire lens remains transparent and its initial orientation can be adjusted by turning the handle. We have also evaluated the use of PhotoLens with good results, which are, again, beyond the scope of this paper.

5 Summary and Future Work

in this paper, we have introduced the concept of hybrid widgets and presented two implementations of this concept, both on an interactive tabletop display. Although more implementations exist, these two are the two most feasible for demonstration at the Ubicomp conference.

In our ongoing work, we explore other forms and application domains for hybrid widgets, as well as the design principles which guide the design of hybrid interaction. We are eagerly awaiting the availability of robust multi touch interactive tables, which will allow us to apply our concepts in a true multi user

setting and thoroughly evaluate their influence on collaboration. From these experiments, we expect interesting observations which may guide the design of future multi user tabletop interfaces.

6 Acknowledgments

This work was funded by the Bavarian Government and by "Deutsche Forschungsgemeinschaft" under a young investigator award to Andreas Butz. We thank Gianni Ciotola for the table construction, and Sebastian Krämer for implementing PhotoLens.

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