Around the Table

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1 Abstract

Tables are a familiar piece of furniture commonly found in homes, offices, cafés, design centers, show rooms, waiting areas, and entertainment centers. Tables provide a familiar and convenient physical setting for people to meet, chat, look over documents, and carry out tasks that require face-to-face collaboration. Digital documents, on the other hand, are commonly used only on desktop computers and handheld devices. Digital documents are much easier to share remotely than face-to-face, due to a lack of a physical media that contain the necessary computational support for face-to-face around the table applications. For the past two years, our group has studied, designed and built an initial prototype of a digitally augmented tabletop environment called DiamondSpin. Our objectives are to understand what are the new HCI mechanisms, UI metaphors and affordances that can enable fluid collaborative tabletop applications.

2 Research Vision

Making computation disappear into the architecture space is only one of the challenges in the design of a digitally augmented tabletop environment. At the same time, making the interactions with a digital user interface on the table disappear into and become a part of the human to human interaction and conversation is a bigger challenge. Studies on digitally augmented desks [4] support user activities that are focused tasks, such as writing, editing, calculation, design and drawing. On the other hand, people usually sit ***around*** a table, facing each other, rather than facing the display. A table setting encourages conversation, thus social informality and casualness.

The user interface and its realization as a tabletop environment should not be viewed as an extension of desktop systems. Tables predate computers, as such, tabletop computer interfaces should in part preserve much of the familiar and useful properties a physical tabletop affords. Physical tables today serve a variety of purposes and functions, including:

1. information display, as in waiting and reception areas in office buildings, train stations, schools, doctor's office, retail stores, as well as homes;
2. meetings in which discussions, designs, layout, reviews and annotations of documents take place;
3. playing games;
4. social interactions with photos, books, food and beverages.

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The above usage scenarios reveal that the interaction styles between the user and the objects on the table span from the table ***Push*** extreme (e.g., 1. above) to the user ***Pull*** extreme (e.g., 2. above). Opportunistic browsing in the study of community building using interactive tables in public spaces (e.g., cafes) [9, 10] is one instance of the Push style at work. These tables are designed to non-intrusively and automatically circulate (***Push***) information relevant to the locale of the interactive table while offering very few interactive functions to the user. At the other extreme, the Personal Digital Historian(PDH) table [3] is designed to provide the user with a rich set of UI functions to actively ***Pull*** digital collections onto the tabletop.

Given the variety of collaborative activities that interactive tables can potentially facilitate, we propose a common set of tabletop computational utilities:

- the ability to visualize documents naturally with continuous directional and angular orientations of materials on the table;
- visible controls for users to manipulate the orientation and size of documents;
- direct passing of objects around the table among multiple people;
- methods for spreading out, piling and shuffling documents.

3 Workshop Issues

Research on collaboration with interactive tables is still in its infancy. There is still much to be studied and understood. Together in this workshop, as a starting point, we hope to explore the following open areas:

- Import and export mechanisms for getting materials into and out of the tabletop, e.g., how do people create or bring up their own contents onto the tabletop as people join and leave the co-located group?
- As suggested in [5], a taxonomy of group oriented tasks that are appropriate for tables [6].
- User evaluation metrics and criteria for these tasks and affordnaces.
- Key application scenarios.

4 Current Research Direction: DiamondSpin, PDH and DiamondTouch

DiamondSpin is a circular tabletop environment that preserves the simplicity and informality of aro2und-the-table interaction, while at the same time provides a rich set of UI functions for interactive and collaborative document browsing, visualization, manipulation and navigation by small groups of people [2]. DiamondSpin focuses on the study of what affordances an augmented digital table should offer.

When multiple people gather around a table, there is no single directional viewing angle that is ideal for everyone present. We postulate that a polar-coordinate system, which is well suited to a circular display, can provide a user-controllable continuous orientation among multiple people and can allow sharing of documents by rotating and re-orienting individual items or by

rotating the entire display. The key research problems that the DiamonSpin architecture addresses stem from three unique characteristics of a user interface that is circular and is on a tabletop: (1) handling the polar location, orientation and deformation of documents on the table, (2) manipulating, displaying and refreshing large quantities of pixels from potentially many piled and overlapped documents, and (3) managing multi-user collaborative activities. The first application that we have experimented with using DiamondSpin is called PDH – Personal Digital Historian [1,3].

Creating a new type of interface requires addressing many issues. One of PDH's primary focuses is on developing content organization and retrieval methods that are easy and understandable for the users, and can be used without distracting them from their conversation. Rather than a folder&file mechanism, PDH organizes the contents along the four W's of storytelling (Who, When, Where, and What) and allows users to design new contexts for organizing their structures. A second issue we have focused on is affording casual and exploratory interaction with data by combining a multiplicity of user interaction mechanisms including in-place query and in-place pop-up menus, direct manipulation, natural visual query formulation with minimal menu-driven interaction and freeform digital ink strokes. Finally, in order to support the multi-threaded and non-linear progression of group conversation, PDH provides tools to help people navigate a conversation as well as their content.

We have carried out an initial set of user studies on the DiamondSpin table with PDH as the application. The results are formally reported in [3]. Some of the interesting observations include:

- One of the most used operations by the user is resizing a document of interest – this resizing entails enlarging the image to the largest possible size that the table allows.
- As observed also in [8], when two people are viewing and discussing a set of documents, they often position a document of interest or the UI control panel itself at a position that is oriented in between themselves so that they can view and operate collaboratively.

Recently, we have ported DiamondSpin onto the multi-user touch technology tabletop surface of DiamondTouch [7]. DiamondTouch provides significantly more interactions than conventional input technologies. Most noticeably, two or more users can **simultaneously** operate on the table. Additionally, each user is not limited to a single point of contact. This is drastically different from the sequential turn taking that arises when people use traditional input devices. We thus have started to develop a taxonomy of task elements with respect to the semantics of control sharing, ranging from fully concurrent multi-input to sequetial sharing. The affordances of a digital tabletop are new territory; we have much exploration ahead of us.

Bios

Chia Shen (the attending author) is Associate Director & Senior Research Scientist at Mitsubishi Electric Research Labs, Cambridge Research. Her research spans from non-traditional off-the-desktop interactive user interfaces and HCI for multi-user applications, to distributed real-time systems and multimedia systems in wired and wireless networks. Her long term research

interest is to facilitate and enrich our communication from both the network level and the HCI perspective. Her most recent research projects include DiamondSpin, Personal Digital Historian(PDH) and MidART (Middleware for Distributed Real-Time Systems).

Neal Lesh research efforts aim to enhance (or at least ease) cooperation between people and computers. His current research projects include interactive optimization (the Human-Guided Search project), collaborative interface agents (the COLLAGEN project), and systems for collaborative navigation of digital data (the Personal Digital Historian project). Before coming to MERL Cambridge Research Lab, he studied with Oren Etzioni at the University of Washington and completed a thesis on scalable and adaptive goal recognition and worked as a postdoc with James Allen at the University of Rochester on the TRIPS collaborative planning project.

Frederic Vernier has conducted research in many fields of HCI from Information Visualization to augmented Reality. His main current research project is systems for collaborative navigation of digital data (the Personal Digital Historian project). His other on-going projects are related to fisheye views, web search engines interfaces, huge spreadsheet interface, improved treemaps algorithms and semi-mirror digital interfaces for presentation system and remote collaboration using combined gaze, gestures and documents. Before coming to MERL Cambridge Research Labs, he studied with Laurence Nigay at University of Grenoble (france) and completed a PhD thesis on output multimodality applied to information visualization. After his Postdoc et MERL Frederic Vernier vernier has accepted a professor assistant position at University of South Paris (Paris XI - Orsay) starting september 2002.

Clifton Forlines is an independent user interface designer working in Boston, MA. Current and past projects include: Alice, an interactive 3D authoring tool for non-programmers; Jam-O-World, a multi-person musical gaming platform currently on display at Ars Electronica in Lenz, Austria; and StudyCards, a study tool distributed by Texas Instruments with their line of graphing calculators for middle and high-school students. Clifton has both a Masters of Entertainment Technology and a Masters of Human-Computer Interaction from Carnegie Mellon University in Pittsburgh, PA.

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