Supporting Effective Interaction with Tabletop Groupware

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Abstract

This workshop position paper describes our prior and ongoing research on horizontal computing systems, which is focused on understanding how interactive tables can effectively support co-located computer-supported collaborative work. We describe our recent contributions in the areas of multi-user coordination policies for interactive tables, using audio as a means of supplementing a tabletop display with private information, and exploring appropriate graphical layouts for horizontal interfaces. We also discuss our ongoing work in developing cooperative tabletop gestures and evaluating the potential of tabletop computing for educational activities.

1. Introduction

Our work with interactive tables at Stanford University has focused primarily on utilizing these unique devices to facilitate co-located collaboration, and on understanding the design issues involved in developing successful groupware for these devices. In this workshop position paper, we summarize the key points of this research, and we describe future directions we are pursuing in our study of horizontal computing.

2. Tabletop Groupware Research

The recent introduction of interactive table technology has enabled new types of co-located collaborative computing applications. For example, the DiamondTouch Table [1] can accept simultaneous touch input from up to four users and distinguishes which user contributed each touch, and the DiamondSpin tabletop interface toolkit [8] simplifies programming for multi-user horizontal applications by providing useful features such as arbitrary orientation of interface components. We have found DiamondTouch and DiamondSpin to be useful platforms for the development and evaluation of prototype tabletop systems.

Our early observations of tabletop use [2] revealed a need to provide software-level support to assist groups of users in coordinating their actions. As a result, we developed *multi-user coordination policies* [4], a set of interaction techniques that assist groups in avoiding and reacting to common mishaps, such as when multiple group members simultaneously try to manipulate a single digital item on the table's surface, or when one group member's action (such as clearing the screen) accidentally has a negative impact on the rest of the group. We also further explored a particular coordination policy, "sharing," by evaluating four interaction techniques that allow users to interactively control other group members' access to privately-owned documents on a shared surface [6].

Studies of traditional table use have found that people tend to reserve parts of the table for keeping personal items [7]. This need to keep some information private, even in the context of a collaborative group activity, led us to investigate means of supplementing tabletop displays to provide private data access channels. We explored the use of individual audio channels combined with a shared interactive table [3], and found this to be a promising interface configuration. In order to evaluate the impact of this new interface style on group collaboration styles, we identified several evaluation metrics [5] appropriate for tabletop and other co-located groupware systems.

We have also explored how the shared, horizontal nature of interactive tables impacts GUI design. Specifically, how should traditional interaction widgets, such as buttons and menus, be laid out to best accommodate tabletop usage styles? For example, should there be one copy of these widgets (perhaps centrally located, to maximize reachability by all group members), or should these interactors be replicated for each user seated around the table? We have explored this question in the context of a tabletop photo-labeling application that supports bio-diversity researchers' work needs, and we are currently analyzing this data.

3. Future Directions

We are further pursuing our research into the use of horizontal interactive surfaces as a platform for co-located collaboration by exploring additional collaborative interaction techniques for these devices. In particular, we are in the process of implementing a set of *cooperative gestures*, where the tabletop system interprets the input of two or more users as contributing to a single gestural command. We are interested in both the social science and computer science aspects of this novel gesturing technique.

From the social science perspective, we are interested to understand how the design of collaborative software can influence the social dynamics of a user group. By designing gestural interactions that require the explicit cooperation of multiple users to perform, we hope to stimulate group interaction and increase the sense of group cohesiveness experienced by users. We are also interested in the possible therapeutic benefits of requiring cooperative gesture performance for special-needs user populations, such as individuals with Asperger's Syndrome who can benefit from situations that allow them to practice social and communication skills. We are interested in exploring appropriate metrics and evaluation strategies to better understand the impacts of our interaction techniques in this regard.

From a computer science perspective, we are interested in analyzing the properties of cooperative gestures and understanding how these properties impact the efficiency, precision, learnability, and memorability of gesture performance. We are developing a taxonomy to describe the properties of cooperative gestures based on our experiences with our early prototypes. This includes properties such as whether users perform their roles in the gesture in parallel, whether their roles are symmetric, etc.

Additionally, another focus of our ongoing tabletop research is our exploration of the potential of interactive tables as a platform for collaborative educational software. We are particularly interested in how subtle variations in a tabletop interface can influence the equitability of participation among several students in a study group. We have incorporated DiamondTouch table activities into a language-learning class at our university, and are currently observing student interactions in this setting.

4. Conclusion

Our work on interactive tables has focused on exploring the novel opportunities these devices provide for co-located computer-supported cooperative work. In addition to exploring new interaction techniques (such as audio privacyware, coordination policies, and cooperative gestures) and identifying potential application areas for these devices (such as educational software and support for bio-diversity researchers), our observations of interactive table use have enabled us to identify some of the key design issues involved in developing software for these devices. We look forward to discussing our work on tabletop user interfaces with other attendees at the TabletopTop 2006 workshop.

5. Acknowledgements

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6. References

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