EXHIBIT 2

Multi-User Multi-Touch Games on DiamondTouch with the DTFlash Toolkit

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Abstract

Games and other forms of tabletop electronic entertainment are a natural application of the new multi-user multi-touch tabletop technology DiamondTouch [3]. Electronic versions of familiar tabletop games such as ping-pong or air hockey require simultaneous touch events that can be uniquely associated with different users. Multi-touch two-handed gestures useful for, e.g., rotating, stretching, capturing, or releasing also have natural applications for entertainment applications built on electronic tabletops. Here we show a set of games that are illustrative of the capabilities of an underlying authoring toolkit we cal DTFlash. DTFlash is designed so that those familiar with Macromedia Flash authority tools can add multi-user multi-touch gestures and behaviors to web-enabled games and other applications for the DiamondTouch table.

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Abstract. Games and other forms of tabletop electronic entertainment are a natural application of the new multi-user multi-touch tabletop technology DiamondTouch [3]. Electronic versions of familiar tabletop games such as ping-pong or air hockey require simultaneous touch events that can be uniquely associated with different users. Multi-touch two-handed gestures useful for, e.g., rotating, stretching, capturing, or releasing also have natural applications for entertainment applications built on electronic tabletops. Here we show a set of games that are illustrative of the capabilities of an underlying authoring toolkit we call DTFlash. DTFlash is designed so that those familiar with Macromedia Flash authoring tools can add multi-user multi-touch gestures and behaviors to web-enabled games and other applications for the DiamondTouch table.

1 Introduction

DiamondTouch [3] is a touch technology suitable for electronic tabletops that affords simultaneous multi-user multi-touch events. Unlike other competing touch technologies, it can reliably associate touch events, including multi-finger or multi-handed events, with specific users. The way it works is that a two-dimensional antenna array is embedded in a surface emitting a small electric signal. Receivers embedded in chairs, table edges, floor sections, or batons receive the signal when a user "completes the circuit." A user touching the surface that is also making contact with a receiver causes an increase in capacitive signal strength that allows registration of the touched areas with the associated receiver. A computer display is projected onto the surface, providing visual content that is calibrated with the touches.

Previous research on tabletop computing has emphasized new forms of gestures and layouts as well as how such technology can be used for collaborative applications such as design, command and control, and story-telling [1, 4-6, 8-9]. Here we illustrate how tabletop games can take advantage of DiamondTouch and also introduce our new authoring environment called DTFlash.

2 Tabletop Games

Tabletop games, certainly competitive ones, on a touch surface require that the system distinguishes one participant's actions from another. One could of course associate a specific area of the surface with a specific player or else structure the interaction so that turn-taking was required. However, such constraints clearly inhibit the possible design space. Users interacting with multi-user single-display environments such as electronic tabletops naturally expect to be able to interact at the same time on the same or different areas of the surface. Here we illustrate a set of simple games that demonstrate some of the interaction possibilities enabled by our toolkit.

Ballpit (Figure 1) is a game in which players drag or flick balls out of the way to be the first to find a striped ball hiding underneath one of them. This was inspired by "Where's Waldo" puzzles. It is a simple illustration of the use of widgets with unique user IDs [5] that afford simultaneous interaction.
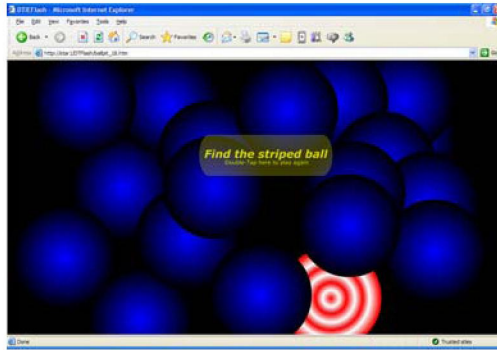
Fig. 1. Ballpit game—players drag or flick balls out of the way to reveal the hidden object.

SpaceBalls (Figure 2) is a more complex application where players use either their finger tip or the rectangle created by multiple fingers to delete colorful 3-D balls that bounce off the sides of the screen. There are a few "super" balls which can only be deleted if two or more players touch it at the same time. Interestingly, a super ball can also be deleted if one player touches the ball and then "high fives" another player, since the cross-coupling between the players is detected. Note that users touching each other as one of them touches the table completes a circuit that is distinguishable from the circuit created by a single user.
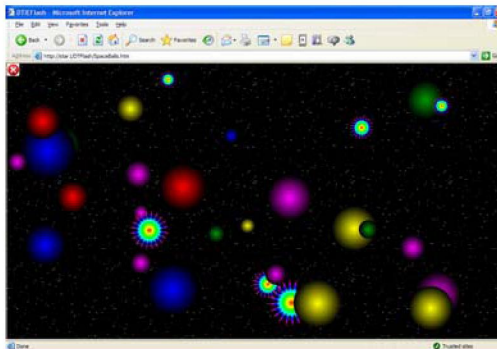

Fig. 2. SpaceBalls--players touch or swipe to delete colored balls.

The Flick Documents application (Figure 3) illustrates the capability for users to drag or flick objects on the table that require specific orientations. A player could pass a document or an image to another player through flicking or dragging. It's possible to specify whether content should always face the center of the table or a particular side.
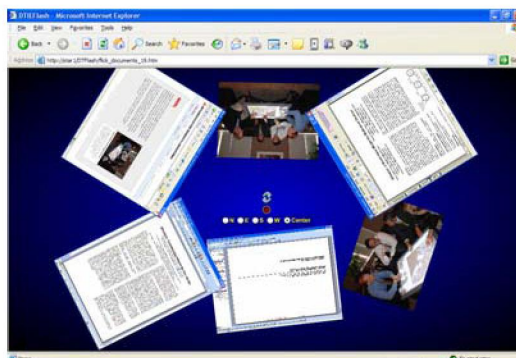

Fig. 3. Flick Documents—players drag or flick objects that can have varying orientation.

The Collaborative Rotating application (Figure 4) lets players simultaneously manipulate the same object. One player's finger determines the location of the upper left corner of the image and the other

player's finger determines the location of the lower left corner. The image is rapidly rotated and resized accordingly.
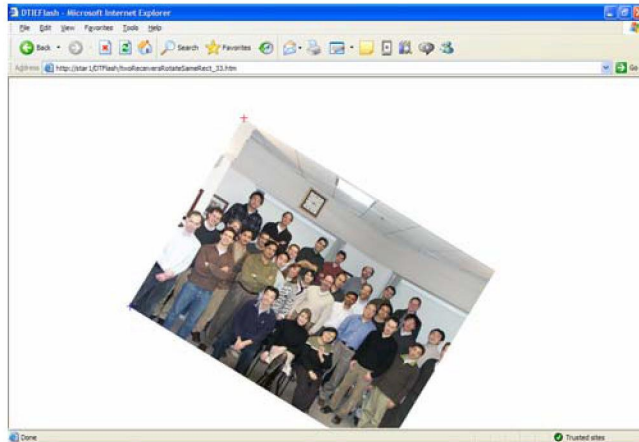

Fig. 4. Collaborative Rotating--players simultaneously interact with the same object.

Ice-scraper (Figure 5) is an interactive image un-masking application where players use multi-finger touches to unmask ("scrape the ice off") an image underneath. The distance between the fingers determines the width of a tool's effective area. This functionality was illustrated also in SquiggleDraw from U. Calgary [2].
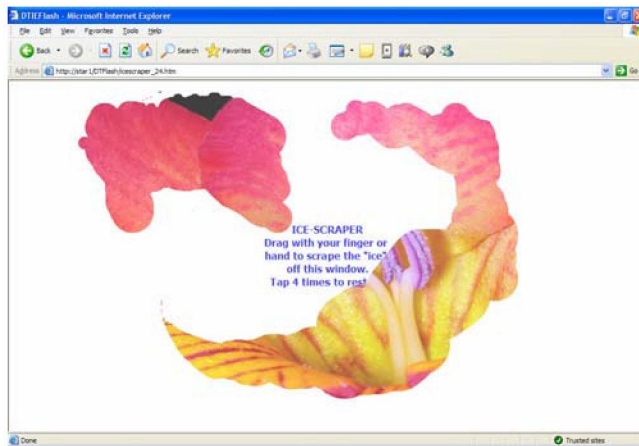

Fig. 1. Ice-scraper—players use multi-finger touches to reveal an image underneath.

The interactions and gestures shown above are only just a glimpse at the possibilities of multi-touch multi-user interactions that are enabled by DTFlash. Of course the games we show are very simple. Their primary purpose is to illustrate the interaction possibilities afforded by our toolkit.

3 DTFlash Authoring Environment

Our previous research revealed significant shortcomings of traditional tools and development environments for DiamondTouch applications. The DiamondTouch SDK [10], released with DiamondTouch prototypes by MERL, provides a low-level C API for accessing data to determine which users are touching a surface at which places. Early research into building on top of this SDK focused on providing an API based on a general purpose programming environment such as Java [7] or .NET [2]. DTFlash takes a different direction by leveraging the Macromedia Flash authoring environment to

emphasize authoring over programming. For example, the standard Flash authoring tool can be used to create arbitrary shapes or objects which can then simply be marked with our extensions as being draggable or rotatable. Literally no coding is needed, yet the new content is "multi-toucher-aware," allowing multiple people to interact with different shapes or objects at the same time.

Through our earlier work, we found that a rapid prototyping tool for multi-user/multi-touch applications requires fundamental low-level support for a variety of items: simultaneous users; multiple points of input from each user; an authoring environment for creating "multi-touch aware" content; multimedia support; the ability to simulate multiple touchers and touch points with a mouse and keyboard; and debug-mode overlays for visualizing toucher information. DTFlash provides all these capabilities, in part by defining primitive touch events, enhanced primitive events, and methods for semantic operations.

Also of note, DTFlash applications can also work as regular web pages, allowing for simple deployment and ushering in a new dimension of multi-user enabled web pages that eliminate the need to take turns with the mouse. Flash is also based on vector graphics and optimized for small downloads, so DTFlash applications have a small memory footprint. But it is the reliance on weak static typing and it's "expressiveness" which make Flash particularly well-suited for exploring drastic changes without breaking existing applications and for facilitating the creation of complex and novel visual interfaces.

4 Conclusion

An electronic tabletop is a natural for games and other entertainment applications. Many such applications can take advantage of the multi-touch multi-user capabilities that DiamondTouch affords. DTFlash is the latest toolkit to emerge for building applications on DiamondTouch, and we hope that it will make DiamondTouch development accessible to a larger audience of authors, rather than programmers, who are already familiar with Macromedia Flash.

References

1. Cappelletti A.; Gelmini, G.; Pianesi, F., Rossi, F.; and Zancanaro, M.: Enforcing Cooperative Storytelling: First Studies, In Proceedings of International Conference on Advanced Learning Technologies (ICALT), September 2004.
2. Diaz-Marino, R.A., Tse, E, and Greenberg, S. (2003) Programming for Multiple Touches and Multiple Users: A Toolkit for the DiamondTouch Hardware. Demonstration in Companion Proceedings of ACM User Interface Software & Technology (UIST), 2003, ACM Press.
3. Dietz, P.H.; Leigh, D.L., "DiamondTouch: A Multi-User Touch Technology", ACM Symposium on User Interface Software and Technology (UIST), pp. 219-226, November 2001, ACM Press.
4. Rekimoto, J.: SmartSkin: an Infrastructure for Freehand Manipulation on Interactive Surfaces, Proceedings of ACM Conference on Computer Human Interaction (CHI), pp. 113-120, 2002, ACM Press.
5. Ryall, K.; Esenther, A.; Everitt, K.; Forlines, C.; Ringel Morris, M.; Shen, C.; Shipman, S.; and Vernier, F.: iDwidgets: Parameterizing Widgets by User Identity. In Proceedings of Interact, Rome, Italy, September 2005.
6. Shen, C.; Lesh, N.B.; Vernier, F.; Forlines, C.; Frost, J., "Building and Sharing Digital Group Histories", ACM Conference on Computer Supported Cooperative Work (CSCW), pp. 3, November 2002, ACM Press.
7. Shen, C.; Vernier, F.D.; Forlines, C.; Ringel, M., "DiamondSpin: An Extensible Toolkit for Around-the-Table Interaction", ACM Conference on Human Factors in Computing Systems (CHI), pp. 167-174, April 2004, ACM Press.
8. Tandler, P.; Prante, T.; Mueller-Tomfelde, C., Streitz, N.; and Steinmetz, R.: Connectables: Dynamic Coupling of Displays for the Flexible Creation of Shared Workspaces, ACM Symposium on User Interface Software and Technology (UIST), pp. 11-20, November 2001, ACM Press.
9. Wu, M.; Balakrishnan, R.: Multi-Finger and Whole Hand Gestural Interaction Techniques for Multi-User Tabletop Displays, ACM Symposium on User Interface Software and Technology (UIST), November 2003, pp. 193-202, ACM Press.
10. Esenther, A.;Forlines, C.; Ryall, K.; Shipman, S.: DiamondTouch SDK: Support for Multi-User Multi-Touch Applications, ACM Conference on Computer Supported Cooperative Work (CSCW), November 2002.