Tangible Tracking Table: an interactive tabletop display

Chih-Sung (Andy) Wu, Ali Mazalek
Digital Media
Georgia Institute of Technology
Atlanta GA, USA
{andywu, mazalek}@gatech.edu

Abstract

We developed Tangible Tracking Table (TTT), an interactive tabletop display that allows both fingertip and tangible object tracking. Multiple users can simultaneously control a variety of tagged objects that can perform different tasks. We also introduce several applications on TTT that utilize the advantages of this tangible user interface.

1. Introduction

Tables have provided convenient work places for individuals or collaborative workers (e.g. a meeting table), pleasant environments for people to play games (e.g. a chess table) or a comfortable space for social activities (e.g. a coffee table). Since we are in a digital era, the idea of bringing digital technologies to tables to extend possibilities of tabletop applications is of our interest. Therefore, we designed an interactive table, Tangible Tracking Table (TTT) to realize our vision. TTT is an interactive tabletop display that can track multiple objects and fingertips at the same time. Moreover, TTT is part of the Responsive Objects Surfaces and Spaces (ROSS) API, which integrates several tangible user interface (TUI) projects. In other words, TTT can interact with other TUI applications

2. Related work

Researchers have developed several different sensing technologies that can be used for tabletop applications (e.g. [3, 5, 6]). Recently, many researchers and application developers have created low-cost multi-touch displays based on the frustrated total internal reflection (FTIR) approach described in [2]. FTIR-based multi-touch displays provide force-sensitive inputs of surface contacts and have been proved to have good resolution and scalability. However, the approach shows poor discrimination capabilities in detecting details of small and complicated patterns, such as fiducial markers.

Another popular computer vision based sensing technology for interactive tables has the advantage of detecting small and complicated patterns. The diffused illumination (DI) technology is easier to setup and has been used for music applications, e.g. reacTIVisioin [4] and Xenakis [1]. Both of these software packages are open source and have the capability to detect multiple finger touches and fiducial markers.

3. Design

TTT includes the software design and hardware construction of an interactive table. The software design is based on the Responsive Objects Surfaces and Spaces (ROSS) API project, which is a cross-platform software infrastructure that helps to manage multiple layers of communications between applications and tangible devices. Currently, a simplified ROSS model is running on TTT. Since TTT emphasizes more on tabletop applications than the sensing technology, we adopted reacTIVision [4] as a bridge to communicate physical devices and applications. Consequently, we concentrated on the development of client side applications, such as multi-user games, educational applications, storytelling applications, collaborative working spaces, geographical navigation and information visualization.

One objective of designing this tabletop interface is to create a large interactive projection surface that allows multiple users to work together at the same time. Therefore, we planned on creating a 50-inch table in the beginning. To create a 50-inch projection screen in a 39-inch tall table, we put two parallel mirrors inside the table. When these two mirrors placed in the right positions, they can create a 72-inch optical path, which results in a 60-inch projection area (see Figure 1). The tabletop is a 36-inch by 48-inch acrylic sheet with tracing paper on top of that acts as a diffuser. In order to detect fiducial markers and fingertips, we use

978-1-4244-2897-7/08/$25.00

the setup of DI to light up the bottom surface of the acrylic sheet. The appropriate combination of IR lamps, IR filter for the camera lens and visible light filter on top of the projector allows the camera to capture the wanted part of the spectrum, which contains the interaction data on the tabletop.

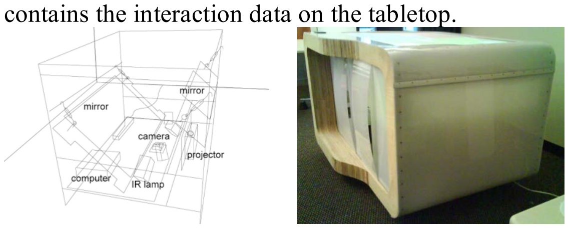

Figure 1. The perspective view and appearance of TTT.

4. Applications

Our colleagues have helped us develop many applications on TTT. There are several storytelling applications that utilize the advantages of multiple object tracking and multiple touches. This new nonlinear and multi-user experience is different from other digital narrative projects. Users can also navigate Google maps with their fingertips on this table. Furthermore, they can put predefined location stamps on the map to move to a city immediately. There is also a card-sorting program that digitalizes and records card-sorting procedures. With the help of this tangible user interface, users can review, analyze and classify items more efficiently than ever. Tangible visualization is another domain that exploits the benefits of TTT. Several users can manipulate and compare data together on this table (see Figure 2).

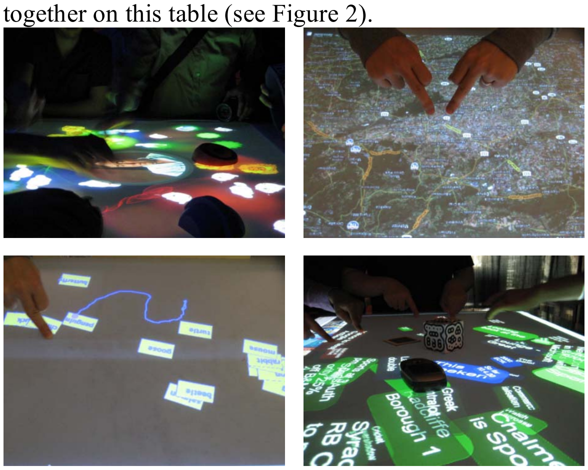

Figure 2. Types of applications running on TTT: storytelling, geographical navigation, collaborative working, and information visualization.

5. Discussion and future work

Although the original plan of this interactive furniture is founded on the functionality of a working table, there are many possibilities to expand this technology, e.g. turning the table 90 degrees along a horizontal axis can make it a tiltable display or a wall display. TTT tracks multiple fingertips and fiducial markers at the same time. Yet, in the ROSS infrastructure, it's possible to communicate with other tangible devices, such as Bluetooth, RFID tags or Wifi.

6. Acknowledgment

We thank the Synaesthetic Media Lab and Xmedia group who helped shape our ideas, and Manvesh Vyas for developing the news visualization application. This work is supported by funding from Steelcase Inc. and NSF-IIS grant #0705569.

7. References

[1] Bischof, M., Conradi, B., Lachenmaier, P., Linde, K., Meier, M., Pötzl, P., and André, E., "Xenakis: combining tangible interaction with probability-based musical composition", *Proceedings of the 2nd international Conference on Tangible and Embedded interaction*, ACM, Bonn, Germany, February 2008, pp. 121-124.

[2] Han, J. Y., "Low-cost multi-touch sensing through frustrated total internal reflection", *Proceedings of the 18th annual ACM symposium on User interface software and technology*, ACM, Seattle, WA, USA, 2005, pp. 115-118.

[3] Ishii, H., Ratti, C., Piper, B., Wang, Y., Biderman, A., and Ben-Joseph, E. "Bringing Clay and Sand into Digital Design - Continuous Tangible User Interfaces", *BT Technology Journal, Vol. 22, No. 4,* Kluwer Academic Publishers, October 2004, pp. 287-299.

[4] Kaltenbrunner, M., and Bencina, R., "reacTIVision: A Computer-Vision Framework for Table-Based Tangible Interaction", *Proceedings of the 1st international conference on Tangible and Embedded Interaction*, ACM, 2007, pp. 69-74.

[5] Patten, J, Ishii, H., Hines, J., and Pangaro, G., "Sensetable: a wireless object tracking platform for tangible user interfaces". *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, Seattle, WA, USA, 2001, pp. 253-260.

[6] Underkoffler, J., Ullmer, B., and Ishii, H., "Emancipated pixels: real-world graphics in the luminous room", *Proceedings of the 26th Annual Conference on Computer Graphics and interactive Techniques International Conference on Computer Graphics and Interactive Techniques*, ACM, Los Angeles, CA, USA pp. 385-392.