Mobile-Based Tangible Interaction Techniques for Shared Displays

Ali Mazalek, Ahmed Sabbir Arif
Synaesthetic Media Lab
Ryerson University
Toronto, Ontario, Canada
{mazalek, asarif}@ryerson.ca

ABSTRACT
This tutorial explores the possibility of using touchscreen-based mobile devices as active tangibles on an interactive tabletop surface. The tutorial starts with an open discussion about various aspects of tangible interaction, including an overview of different approaches and design principles. It then guides participants through the design and development of innovative interaction techniques, where mobile phones are used as active tangibles on a shared tabletop display. The intent is to encourage the mobile HCI community to further explore the possibility of using everyday devices such as mobile phones as tangibles.

Author Keywords
Tangible interaction; mobile device; shared displays; interactive tabletops; rapid prototyping; user interface.

ACM Classification Keywords
H.5.2 User Interfaces: Input devices and strategies (e.g., mouse, touchscreen), interaction styles (e.g., commands, menus, forms, direct manipulation).

General Terms
Design; Experimentation.

INTRODUCTION
Multi-touch has become the dominant interaction technique on shared displays such as interactive tabletops [2]. Alternative techniques include interactive pens and wands [8], in-air gestures [1], and conventional pointing devices such as a mouse. A theoretically appealing but less explored approach is tangible interaction. Tangibles are physical objects that act as both control and representation for the underlying system, allowing users to create, access, and manipulate digital information [7]. Tangibles can offer a comparatively richer interaction experience by providing users with additional sensory information, such as pressure and friction. Active tangibles, which are powered objects that can be equipped with sensors and actuators/displays, can further extend the interaction and display space and provide off-screen content control and feedback.

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Yet, researchers and designers are often discouraged to further explore this possibility, as they usually need to develop additional hardware as tangibles. This not only increases production cost but also requires users to learn a new technology. An obvious solution to this is to use consumer electronic devices as tangibles. Towards this, we explore the possibility of using touchscreen-based mobile devices as active tangibles. Touchscreen-based devices are rapidly becoming an integral part of our everyday life. A recent survey showed that about 68% mobile users in the U.S. own a smartphone and about 84% of the new buyers chose smartphones for their new handsets [5]. Utilizing these devices as tangibles could partly eliminate the need for developing new hardware as active tangibles. This could also reduce learning cost, as users are already familiar with basic interaction approaches used with these devices.

The purpose of this tutorial is to explore how touchscreen-based mobile devices could be used as tangibles to interact with/on a shared tabletop display in a useful manner, enabling cross-device interactions between display devices of different scales [10]. The goal is to familiarize participants with the concept of tabletop tangible interaction. We hope that this tutorial will encourage them to further explore this promising interaction paradigm.

Audience and Background
This tutorial is intended for mobile HCI enthusiasts who are interested in exploring mobile-based tangible interactions. Participants must have experience developing with Android SDK, HTML5, and JavaScript. In addition, a basic understanding of gesture recognition and touch-based interaction approaches is useful. Participants are expected to bring their own laptops for development.

STRUCTURE
The tutorial begins with an overview of the concept of tangible interaction based on recommended reading materials, provided by the organizers ahead of time. Open discussion addresses design possibilities and practices for mobile-based tangible interactions. Participants then divide into groups of four, and each group is provided with two Android mobile devices, a development toolkit containing a gesture recognizer [9], JavaScript libraries, and sample source code. They are also provided with several example scenarios, where the use of mobile devices as active tangibles may benefit users. We include three examples below.

Example 1: Viewing and Copying Images
Placing a mobile device on the interactive surface launches a marking menu [4] in close proximity to the device, with several available options. The user selects the "Display Images" option. The images from the device are displayed around the device, on the tabletop surface. The user can drag an image away from the device to a particular location of the surface to make a copy, or move the entire collection around the surface by moving the mobile device. Mobile device movements can be tracked using fiducial markers [3]. Multi-touch gestures can be used to manipulate the images on the surface, e.g. to zoom or rotate. Similar techniques can be used to view/copy other kinds of files such as documents.

Example 2: Common Music Playlist
Two users put their mobile devices on the table and select the "Show Music" option from the menu. A list of songs contained on each device is shown on the table, near the device. When the two devices are moved close together, the system displays only the common songs from the two devices' playlists. In this way, the users can enjoy listening to music they both like.

Example 3: Receiving Messages
When receiving a phone call, a user places his/her mobile phone on the table. This launches the caller's contact card, along with a marking menu with options such as "Accept", "Reject", "Hold", and "Speaker". The user selects an option to perform the corresponding task. While talking to the caller, the user may share a file with him/her. S/he does that by simply dragging the intended file from the surface to the caller's contact card.

The above scenarios are only examples and do not limit participants from designing new and innovative interaction approaches. They are encouraged to use the mobile devices' internal sensors, i.e. accelerometer, gyroscope, and compass, to design new approaches. Upon completion of the design and development activity, there is a short debriefing discussion of each group's work.

SUMMARY AND CONCLUSION

By the end of the tutorial, we expect participants to have a better understanding of the concept of tangible interaction and of how mobile devices can be used as active tangibles on shared tabletop displays. Through an open discussion, participants first learn how tangible interaction can complement and enhance mobile device interactions on tabletop displays. They are then guided through the implementation of example scenarios or their own new designs. This tutorial thus teaches them not only how to use mobile phones for tangible tabletop interaction, but also how to implement these designs quickly and efficiently using simple languages, such as HTML5 and JavaScript.

Our hope is that this tutorial will encourage the mobile HCI community to further explore the possibility of using everyday devices, such as mobile phones, as active tangibles for interacting with shared displays, and, more broadly, we hope it will encourage further exploration of interactions that cross display devices at different scales, from small mobile displays to larger shared surfaces.

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BIOGRAPHIES

Ali Mazalek is an Associate Professor and Canada Research Chair in Digital Media at Ryerson University, an Associate Professor at Georgia Tech, and director of the Synaesthetic Media Lab. Her research focuses on tangible and embodied interactions for creative practices in both arts and sciences. She holds a Ph.D. from the MIT Media Lab.

Ahmed Sabbir Arif is a Postdoctoral Research Fellow at Ryerson University, working under the supervision of Dr. Mazalek. His primary research interests are in the area of human-computer interaction. As a researcher he has worked on a wide-range of projects, both independently and in collaboration with academic and industrial research labs. He holds a Ph.D. in Computer Science from York University.