PhoneTouch: Seamless Cross-Device Interaction

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Figure 1. A novel cross-device interaction style that seamlessly bridges the gap between handheld devices and interactive surfaces.

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Abstract
Mobile devices (e.g., smart phones) and interactive surfaces (e.g., digital tabletops) represent two distinct device classes: One is personal and portable, the other shared and stationary. They excel at different tasks, and are less suited for others. Combining their distinct characteristics can realize various synergies. In doing so, we recently introduced PhoneTouch, a system that allows users to directly touch a digital surface with their phones, much like a stylus, for immediate cross-device interaction. The purpose might be to seamlessly transfer photos in both directions, for example. We developed a series of compelling interaction techniques and applications to illustrate the fluidity of our approach. Throughout our design iterations, all test users exposed to the system were enthused by the nature and simplicity of interaction.

Author Keywords
Mobile devices, smart phones, interactive surfaces, tabletops, synergies, integration.

ACM Classification Keywords
H5.2 [Information interfaces and presentation]: User Interfaces. – Input devices and strategies.

General Terms
Design, Human Factors.

Introduction

Already before the wider spread of multi-touch technologies, researchers have identified the potential that lies in combining mobile devices and shared displays. Their complementing characteristics (e.g., private versus shared spaces, or portable versus large display) can realize various synergies through combined usage. Early approaches (e.g., [1, 2]), however, allowed users to interact and exert control only indirectly. In contrast, current multi-touch tables or whiteboards are characterized by the directness and fluidity of touch interaction, often with multiple users interweaved in simultaneous collaboration.

With the goal of developing an approach that fluidly integrates mobile devices and shared multi-touch surfaces, we recently introduced PhoneTouch [3]. Its essence is that a mobile device is used for selection of targets on a surface by direct touch, much like a stylus (Figure 1). For example, to pick up and transfer a file displayed on the surface, users simply touch the file's representation with the corner of their phone. The selected file is instantly transferred to and available on the phone. In doing so, PhoneTouch seamlessly extends the common modality of direct touch interaction.

Interaction Style & User Experience

While the system's fluidity is best conveyed in action[1], we briefly describe a usage scenario to illustrate the underlying interaction concept in the following:

[1] Video demonstrating PhoneTouch: http://www.youtube.com/watch?v=oJphq22HdCY

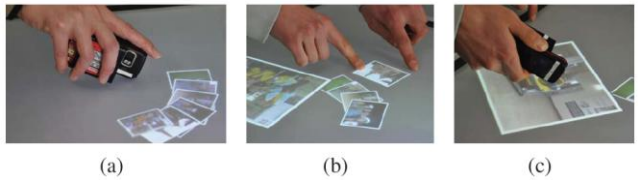

Figure 2. Usage scenario. (a) Andy transfers a collection of photos onto the surface. (b) With his friends he is browsing the collection. (c) Chris copies a photo to his phone by touching it.

Andy, Bart and Chris meet around an interactive tabletop. One of the friends, Andy, wishes to share a collection of photos he has taken on a recent trip. He takes out his phone, starts the picture sharing application, selects the photos, and then touches the tabletop. The selected photos immediately appear on the table, spread out around the point of contact (Figure 1(a)). He pockets his phone and the three friends start browsing the photos, using their fingers on the multi-touch table (Figure 1(b)). The friends enlarge several of the photos for a closer look at them and arrange them by interest. Bart and Chris take out their phones, also start the picture application, and pick up photos they would like to take home by touching them with their phones (Figure 1(c)).

User Exposure & Reaction

Throughout our development efforts, and especially while exploring the surrounding interaction design space, we demonstrated and let users try the techniques and applications that we developed. This was done during several "Open Days" held at our university for prospective students, two conference demo sessions (UIST 2010 and ITS 2010), as well as in an informal user study with six users.

In general, after demonstrating picking up and dropping files, the users readily understood the concept. Particularly the data flow through direct touch appeared to be self-evident. While the technical details are rather complex[2], they are hidden from the users. Not rarely our demonstration was accompanied by comments referring to its ”coolness”. Users seemed to be fascinated by the ease of data transfer, which appeared to happen almost magically directly where touched. This is a stark contrast to the experience many users seem to be accustomed to, consisting of target device and file selection from abstract lists (e.g., using Bluetooth).

(a) Touching a web browser... (b) ...to transfer personal bookmarks.

Figure 3. Instantly providing personal data from the mobile device to an application on the shared surface.

Besides basic file (e.g., photo) transfer, the PhoneTouch interaction style readily extends to more advanced usage scenarios. For example, the same interaction of touching the surface with the phone can be used to provide personal data to a surface application (Figure 3) or to implement games that combine private and public spaces (Figure 4).

[2] For details about the distributed sensing and time-based matching approach please refer to [3].

(a) Users arrange words in private on their phone to then... (b) ...drop them onto the shared word game board.

Figure 4. Scrabble-clone using both the shared surface and mobile phones, integrated through PhoneTouch.

Discussion

While possibly not obvious in the first place, using the phone like a stylus for interaction on the surface is immediately understood after shown once. As the resulting actions (e.g., transferring a file) are easily comprehensible, users seem to form a mental model quickly, and are often fascinated by the interaction. We believe that the following aspects play an important role with respect to the “wow-effect” that we repeatedly observed.

- *Seamless cross-device interaction.* Formerly unconnected and unrelated devices suddenly interact and exchange information in a predictable and comprehensible manner. We combine two known concepts, data exchange (formerly cumbersome and abstract) and touch interaction (formerly limited to finger touch) to seamlessly span interactions across multiple devices.

- *Spontaneity & fluidity.* No preparation or setup steps are needed. Users take out their phone

and can start interacting immediately. Switching between the phone as private device and input stylus is fluid. Similarly, finger touch interaction can be effortlessly interwoven with PhoneTouch.

- *Visibility & aesthetics.* Feedback is provided visibly at the location of interaction, using the output capabilities of both mobile device and shared surface. For example, photos seem to be "flowing out" of the phone onto the surface, hence providing an aesthetic experience.

- *Physicality & control.* Through the physically grounded interaction of direct touch, the user is in full control of any data exchange to take place. At the same time, this tangible interaction arguably adds a certain playfulness.

Interaction techniques that did not obviously use data provided by the phone were perceived less convincing. For example, we moved toolbar menus from the surface to the phone. This frees space on the surface and menus are always at hand. It was less apparent to the users, however, why we integrated the phones in this scenario. After all, the same goals could be achieved using multi-touch interaction on the surface directly. This indicates that some of our approaches' appeal stems from the apparent and comprehensible interaction across devices.

We further noted the importance of instantaneous feedback. In early implementations, visual indication of a detected PhoneTouch could take up to a few hundred milliseconds. Oftentimes, this was sufficient for users to assume that their touch did not work. Therefore, they repeated the touch, causing multiple activations with an undesirable outcome. We successfully addressed this issue by providing instantaneous visual indications. As we use physical touch interactions, users arguably expect reactions to occur immediately, as they would in the real world as well.

Conclusion

While not yet a commercial product, our functional prototype allowed the exposition of PhoneTouch interactions to a large base of users. It served to gain valuable insights into its usage and, particularly relevant in this context, the user's reactions. We believe that already at this early stage the gathered experiences can help to inform a discussion about practical heuristics, thus contributing to a better understanding of the factors that make a product pleasurable, fun, and appealing.

References

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