Emerging Input Technologies for Always-Available Mobile Interaction

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Emerging Input Technologies for Always-Available Mobile Interaction

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Abstract

Miniaturizing our computers so we can carry them in our pockets has drastically changed the way we use technology. However, mobile computing is often peripheral to the act of operating in the real world, and the form factor of today's mobile devices limits their seamless integration into real-world tasks. Interacting with a mobile phone, for example, demands both visual and manual focus. We describe our goal of creating *always-available interaction*, which allows us to transition between mobile computing and real-world tasks as efficiently as we can shift our visual attention. We assert that this could have the same magnitude of impact that mobile computing had on enabling tasks that were not possible with traditional desktop computers.

In this review, we survey and characterize the properties of sensors and input systems that may enable this shift to always-available computing. Following this, we briefly explore emerging *output* technologies, both visual and non-visual. We close with a discussion of the challenges that span various technologies, such as ambiguity, sensor fusion, gesture design, and cognitive interference, as well as the opportunities for high-impact research those challenges offer.

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1

Introduction

With recent advances in mobile computing, we have miniaturized our computers so we can carry them in our pockets (or bags or clip them on our clothes) and have relatively convenient access to information and computation even when we are not sitting at our desks. This has drastically changed the way we use technology and has impacted our work and life in profound ways. However, contrary to computing being the primary and only task in desktop scenarios, computing in mobile scenarios is often peripheral to the act of operating in the real world. We believe that there remain opportunities for more tightly infusing computational access into our everyday tasks.

At present, the form factor of typical mobile devices limits their seamless integration into real-world tasks: interacting with a mobile phone, for example, demands both visual and manual focus. For example, researchers have shown that users could attend to mobile interaction bursts in chunks of about 4–6 seconds before having to refocus attentional resources on their real-world activity [97]. At this point, the dual task becomes cognitively taxing as users are constantly interrupted by having to move focus back and forth. Unfortunately, when Ashbrook et al. measured the overhead associated with mobile

interactions, they found that just getting a phone out of the pocket or hip holster takes about 4 seconds, and initiating interaction with the device takes another second [5]. This suggests that the current status quo in mobile interaction will not allow us to integrate computing tightly with our everyday tasks.

In our work, we assert that augmenting users with always-available interaction capabilities could have impact on the same magnitude that mobile computing had on enabling tasks that were never before possible with traditional desktop computers. After all, who would have imagined mobile phones would make the previously onerous task of arranging to meet a group of friends for a movie a breeze? Who would have imagined when mobile data access became prevalent that we'd be able to price shop on-the-fly? Or resolve a bar debate on sports statistics with a quick Wikipedia search? Imagine what we could enable with seamless and even greater access to information and computing power.

We spend a majority of this review surveying the state of the art in novel input modalities that may allow us to transition between physically interacting with the mobile device and with the real world as efficiently as we can shift our visual attention back and forth between the two. We specifically assert that certain input technologies are more likely than others to play a role in this paradigm shift, and attempt to characterize the properties of sensors and input systems that render them promising for always-available computing. Although this article's focus is on input technologies, efficient micro-interaction will also require an approach to *output* that is less cognitively demanding than current mobile displays. We thus follow our input-technology survey with a brief exploration of emerging output technologies, both visual and non-visual. After surveying and characterizing these technologies, we close the review with discussion of challenges that span diverse technologies, such as systematically handling ambiguity, sensor fusion, gesture design and applicability, and cognitive interference associated with using them in the real world, as well as the opportunities for high-impact research those challenges offer.

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