Crossmodal Audio and Tactile Interaction with Mobile Touchscreens

Eve Hoggan, University of Tampere, Finland

ABSTRACT

This article asserts that using crossmodal auditory and tactile interaction can aid mobile touchscreen users in accessing data non-visually and, by providing a choice of modalities, can help to overcome problems that occur in different mobile situations where one modality may be less suitable than another (Hoggan, 2010). By encoding data using the crossmodal parameters of audio and vibration, users can learn mappings and translate information between both modalities. In this regard, data may be presented to the most appropriate modality given the situation and surrounding environment.

Keywords: Crossmodal Interaction, Mobile Interaction, Non-Speech Audio Feedback, Tactile Feedback, Touchscreen Devices

INTRODUCTION

As mobile touchscreen technology has become more widespread, there have been many technological advances but one key feature remains the same; touchscreen mobile devices often use cut-down versions of desktop user interfaces placing high demands on the visual sense that may prove awkward in mobile settings. Mobile device users could be considered to be situationally impaired because it is possible to lose the use of different senses temporarily at different times, locations and other situational contexts. Currently, many available devices support audio and tactile feedback for simple alerts such as incoming call notifications through the use of standard built-in vibrotactile actuators and audio speakers. These may be leveraged to provide user feedback to different sensory modalities when the visual sense is overloaded or unavailable.

Mobile phones are personal devices, always on and always with us, which means that whether it is in our bag or pocket, or we are in a meeting, at a party, or listening to music, we still want to be able to interact with our device. In these situations, visual feedback is not always appropriate. Although a user’s eyes may be busy focusing on the primary task, many activities do not otherwise restrict users from attending to information using their remaining available senses. This is when multimodal interaction is of benefit so that, for instance, messages can be presented through the audio modality and warnings can be presented through the tactile.

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Unfortunately, these modalities can also be inappropriate at times. For example consider this typical usage scenario: Sam is walking to a meeting with her mobile phone in her bag when she receives an important calendar reminder. As her phone is not in contact with her body, a tactile alert would probably go unnoticed so the reminder would be best presented in audio. Next, Sam boards a train to continue her journey and downloads some music for her phone. Given that the train is noisy and the phone is in her pocket, audio alerts alone would be insufficient to inform her of her completed download. At the same time, tactile alerts would be slightly masked, as the phone is not in direct contact with her skin. At this time, a combination of audio and tactile feedback could let her know when her song has been downloaded. Finally, Sam arrives at her meeting and receives an urgent email from her husband. It would be rude for Sam to disrupt the meeting with audio feedback informing her of the incoming email. In this case, a tactile cue would be much more subtle and socially acceptable. This scenario is an example of the need for mobile devices to provide alternative presentation modalities through which information may be presented if the context requires.

As mentioned, multimodal feedback is often used to reduce the visual load on mobile device users. The possibilities of communicating information and enhancing interaction through senses other than vision, e.g., sound and touch, has generated a rich body of research (Brewster, 2002; Cockburn & Brewster, 2005; Fukumoto & Sugimura, 2001; Gaver, 1987; Hall, Hoggan, & Brewster, 2008; Kaaresoja, Brown, & Linjama, 2006; Lee & Zhai, 2009; Mereu & Kazman, 1996; Poupyrev & Maruyama, 2003). The existing research has demonstrated that audio and tactile feedback can be beneficial to mobile touchscreen users, increasing typing speeds and reducing errors with some training. However, as the scenario above has demonstrated, users need to be able to switch effortlessly between different modalities depending on the situation. Users also need the option of several different modalities. Much of the research so far does not give the user a choice of modalities but simply provides one output modality, resulting in unimodal interaction.

This research addresses the problem by using crossmodal interaction to exploit the abundant similarities between the audio and tactile modalities through crossmodal icons (Hoggan & Brewster, 2006a). These are abstract icons that can be instantiated in one of two synonymous forms (Earcon (Blattner, Sumikawa, & Greenberg, 1989) or Tacton (Brown & Brewster, 2006)). These can be used in interfaces as a means of non-visual output and allow this research to investigate user performance in different situations (in users’ everyday lives) to establish whether one modality is more suited than the other and whether crossmodal audio and tactile feedback could be effective in real world applications in different contexts, under different degrees of workload.

This research involves the very first formal investigations into crossmodal icons and the design of crossmodal audio/tactile feedback for mobile touchscreens with an aim to address the following questions: what are the parameters of vibration and non-speech audio that can be manipulated to encode data in crossmodal icons? What levels of performance can be achieved when these parameters are used to create multidimensional crossmodal icons? Can crossmodal icons be incorporated into the design of real-world mobile touchscreen applications and improve the usability of such applications? And lastly, given different contexts and situations, what type of feedback (audio or tactile) is most appropriate?

**WHAT IS CROSSMODAL INTERACTION?**

There is a growing consensus in current research that fixed allocations of modalities to specific tasks or types of information (i.e., multimodal interaction) is not practical (for example (Reeves et al., 2004)). Instead, interfaces should be flexible and allow for potential changes in the needs
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