Mobile Text-Entry: the Unattainable Ultimate Method

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ABSTRACT
There is no such thing as an ultimate text-entry method. People are diverse and mobile touch typing takes place in many different places and scenarios. This translates to a wide and dynamic diversity of abilities. Conversely, different methods present different demands and are adequate to different people / situations. In this paper we focus our attention on blind and *situationally blind* people; how abilities differ between people and situations, and how we can cope with those differences either by varying or adapting methods. Our research goal is to identify the human abilities that influence mobile text-entry and match them with methods (and underlying demands) in a comprehensive and extensible design space.

Categories and Subject Descriptors
H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *Input devices and strategies, User-centered design.*

General Terms
Design, Experimentation, Human Factors.

Keywords
Text-Entry, Touch typing, Individual Differences, Situational Disabilities, Capabilities, Demands, Blind.

1. INTRODUCTION
Text-entry pervades our lives in different scenarios and devices. With the advent and increasing use of mobile technologies we now can enter text even when away from the comfort of our home or workplace. This practice lead to growing efforts to develop and improve new text input methods and devices. This still poses interesting challenges as text-entry is a visually, cognitively and physically demanding task.

While touch-based devices present many novel possibilities, they pose a comparable number of new challenges. Indeed, these devices have incrementally decreased the number of tactile cues and simultaneously amplified the interaction possibilities, thus posing increased visual demands on their users.

We focus our research on the demands placed by text-entry and on how we can input text in the absence (either continuous or intermittent) of visual feedback. Assistive screen reading software, like Apple's VoiceOver, enables blind people to use touch-based devices by offering auditory feedback on the visual elements presented onscreen. However, mobile interfaces are extremely visual and much useful information is lost in this visual-audio replacement. Examples of this include the requirement of users to possess a good spatial ability to have a notion of the device layout and the interface components available, or cognitive capabilities to memorize letter placement on screen. While visual feedback makes these attributes dispensable or less pertinent, its absence makes them relevant and worthy of consideration [1].

Conversely, the use of mobile devices has moved from the static and quiet environments of our offices to more variable and heterogeneous contexts, leading to an obvious paradigm shift [2]. These contexts pose new challenges to mobile users since they compete for the same human resources needed to fully control electronic devices. Problems arising from context are called situationally-induced impairments and disabilities (SIID) [3]. For instance, texting while walking on a busy street can be quite a challenge, since visual resources are both required to monitor the surrounding environment and interact with the device. Users can become *functionally blind* as visual resources are overloaded and visual feedback is inadequate [4].

In what follows, we present our current research agenda on text-entry for blind and situationally blind people. As to blind people, we call the attention to individual differences and how current methods fail to address them. Regarding situationally blind people, we try to understand how abilities are affected by context, and propose a *technology transfer* approach, where solutions initially created for blind people can be applied by sighted people in mobile contexts. Our ultimate goal is to understand mobile text-entry methods as challenges which may be overcome by user's abilities, be they either individually- or situationally-impaired.

2. THE BLIND
In the past five years, several manufactures have included basic screen reading software in their touchscreen devices. Apple's VoiceOver is a successful example. Users can explore the interface layout by dragging their finger on the screen while receiving audio feedback (selection is made either by split-tapping or double tapping). Nonetheless, users still face some several problems when interacting with touch interfaces [5]. One major issue is text-entry, since it is one of the most visually demanding tasks, yet common to numerous mobile applications. While there have been efforts to provide blind and visually impaired users with alternative touch-based text-entry methods, there is no knowledge of which methods are better suited to each individual. Thus, most approaches neglect the differences among blind people and how they relate to individual user performance.

In [1], we experimented with different text-entry methods that could highlight different users' capabilities. This set included fixed and adaptive layouts, different target sizes, varying number of on-screen keys, scanning and gesture approaches, and multiple selection mechanisms.

The ***QWERTY*** method is identical to VoiceOver and consists in the traditional keyboard layout with a screen reading software (Figure 2-a). Users can focus the desired key by touching it (*painful exploration*), and enter the letter either by split-tapping or double tapping anywhere. On the plus side, this method enables blind users to input text similarly to a sighted person with a

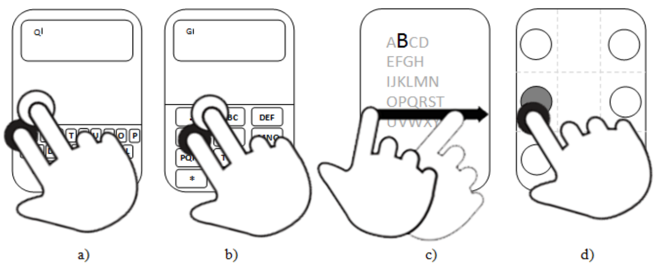

Figure 1. From left to right: QWERTY, MultiTap, NavTouch, and BrailleType.

simple screen reading approach. However, it features a large number of small targets which can be difficult to find, particularly for those who are not proficient with the QWERTY layout.

The ***MultiTap*** approach uses the same exploration and selection mechanism of the previous method. However, the layout presented is similar to keypad-based devices. We chose this method since its letter arrangement is familiar to most users. Twelve medium-size buttons, each featuring a set of characters, reduce the number of targets on screen. To enter a letter, users must split or double tap multiple times, according to the character position in that group (Figure 2-b).

NavTouch [6] is a gesture-based approach with adaptive layout, i.e. users can perform gestures anywhere on the screen. This method is based on a navigational approach: gestures to left and right navigate the alphabet horizontally (Figure 2-c); while up and down gestures navigate vertically (i.e. between vowels). Vowels serve as shortcuts to the intended letter, thus users can choose whatever path they feel more comfortable. Spoken feedback helps users navigate the alphabet. To select the current letter users can either perform a split or double tap.

BrailleType takes advantage of the capabilities of those who know the Braille alphabet. The touch screen serves as a representation of the Braille cell, with six large targets. Users can perform *painless exploration*, while receiving auditory feedback about each dot they are touching. A long press marks / clears a dot (Figure 2-d). After marking all the necessary dots for a Braille character, in whatever order the user desires, a double-tap on any part of the screen accepts it. As ***MultiTap***, this method seeks to provide a less stressful first approach by reducing the number of different targets.

Results in a comparative text-entry method evaluation with 15 blind people showed that different methods pose different demands. How these demands are overcome depends on specific individual attributes, as different designs suit different blind people. Results also showed that interfaces with a large number of onscreen elements, like QWERTY and MultiTap, pose more demands on spatial ability. Users with low spatial skills likely perform poorly or are even unable to use those methods. On the other hand, NavTouch and MultiTap, are more demanding on both memory and attention, as users have to keep track of the history within a selection. Also, results suggest that users with low fingertip sensitivity have problems with repeated multi-touch interactions (e.g.,multi split-tapping).

3. The Situationally Blind

As people are different, so are situations. Thus coping with demands posed by touch typing methods in particular circumstances can be quite a challenge. We are faced once again with a scenario where the user's abilities (as a sum of all Human and Environment context dimensions [7]) are asserted against the Application's (the third dimension) demands. Our first take at dealing with SIID in text-entry, particularly to aid situationally *blind people*, builds on knowledge acquired with blind people. Therefore, we propose a technology transfer approach [8], where solutions initially created for blind people can apply to sighted people in mobile contexts. While we agree that both users' capabilities are different, there seems to be a good overlap of requirements to interaction.

In [4], we reported a comparative user study conducted with 23 sighted volunteers who performed text-entry tasks with three methods, to wit regular QWERTY, VoiceOver and NavTouch in three mobility conditions: seated, straight line corridor, and circuit navigation. Results show that the users compensate the difficulty of the mobility conditions sacrificing walking speed. With this compensation, the regular QWERTY keyboard outperformed the remaining methods, speed and text-quality wise, suggesting that audio-based methods are ineffective, at least, when in presence of visual feedback. Indeed, when debriefing participants they preferred graphical interfaces and tend to overlook audio feedback. Assistive technologies and their interaction processes revealed to be cognitively demanding and thus inadequate in mobile contexts. These findings suggest that technology transfer should be performed with caution and adaptations must be done to account for differences in users' capabilities.

4. Capabilities and Demands

In this paper we framed text-input challenges as a matter of user's abilities *versus* methods' demands, which require a two-stage approach. First, we must seek to understand both the demands and abilities we are dealing with. Second, we should strive to provide methods and adaptations that are able to cope with different individual abilities and situations. This multi-dimensional design space is a huge challenge but poses new opportunities as it unveils the need for different and variable approaches and adaptations.

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