Designed with Older Adults to Support Better Error Correction in SmartPhone Text Entry: The MaxieKeyboard

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Abstract
Through our participatory design with older adults a need for improved error support for texting on smartphones emerged. Here we present the MaxieKeyboard based on the outcomes from this process. The keyboard highlights errors, auto-corrections and suggestion bar usage in the composition area and gives feedback on the keyboard on typing correctness. Our older adult groups have shown strong support for the keyboard.

Author Keywords
Text Entry; Older Adults; Touchscreen; Error Correction

ACM Classification Keywords
H.5.2 User Interfaces

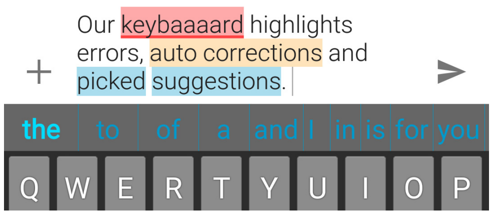

Figure 1: Highlighted suggestions in MaxieKeyboard

Introduction

Despite a wealth of research on context aware computing and indirect interaction techniques (e.g. [1][15][14]), text entry remains core to much of interaction with smartphones. There is a long history of research on developing new text entry methods (e.g.[12][11][16]) and of comparing mobile text entry solutions through formal evaluation (e.g. [10][13]). In our current project we are focusing on text entry needs of older adults with the aim of improving text entry for this under-researched group. As part of this research we have conducted a mix of participatory design sessions to inform our research and formal evaluation sessions to assess our potential solutions.

In this poster and demonstration we introduce our MaxieKeyboard (Figure 1) that was based on evaluation and development with older adults. We first present the background to mobile interaction design for older adults and text entry studies. We then present a novel keyboard designed to support error correction – a major theme that emerged from our design workshops with older adults. We finally present feedback on our fully functional keyboard from workshops ran with older adults.

Designing for Older Adults

Touchscreens are now considered to be the normal mode of input for mobile devices. As a result, an increasing number of older users find themselves using one or more touchscreen devices. Some have used touchscreen smartphones for a number of years while others are now transitioning from older physical keyboard devices, allowing access to apps that support independent living and social connectivity, both key elements of wellbeing. On large surfaces, e.g. ATMs, touchscreen keyboards have been shown to be preferable to physical keyboards for older adults (e.g. [3][7]), yet there has been surprisingly little research on smaller touchscreen devices. Work that has focused on the physical dimensions of keys and their spacing has recommended onscreen buttons that are much bigger than modern smartphone buttons (e.g. [6][7]) where buttons are often only 5 mm apart. As we grow older, we experience motor and vision impairments that can affect their ability to use touchscreen keyboards [2]: typically our visual acuity declines and our movements become somewhat slower and less accurate. The role of hand tremor can exacerbate these problems and has been investigated for older adults on smartphones and tablets [8] who found, amongst other findings, that input speed and accuracy was better on tablets (attributed to the larger keys) and that speed was dependent on familiarity with QWERTY, but this did not affect accuracy. Hand tremor was also found to be linked to making errors on smartphones mainly due to poor aiming. Unexpected touchscreen responses (either unregistered or unintentional touches) are a major cause of frustration for older users [7]. Many unintentional touches occur due to the way the device is held and because of multi-touch support. Older adults were also observed to continuously focus on the keyboard instead of the text being input and to tend towards continuously typing until finished, then to review their input to check for mistakes [7].

Our Workshops

In the course of a 2 year project investigating text entry for older adults we conducted a series of sense-making workshops (e.g. Figure 2) and both lab and longitudinal studies to investigate the mobile text entry

Figure 2: Participants in early design workshop

behaviour of older adults and to explore the challenges this group encounters related to entering text on such devices [9]. We recruited older adults through our Centre for LifeLong Learning and ran workshops with at the University. Our participants ranged in age from early 50's to late 70's with a typical workshop participant being in their mid 60's. As we wanted to support the general older adult population, none of our subjects had specific mobility, uncorrected vision or other individual conditions that would affect their text entry usage. All participants were smartphone owners (approx. split evenly between iOS and Android).

Figure 3: Sample paper prototype from workshop

In our participatory design workshops support for error correction and concern for sending error-ridden messages came through as a major concern of our older adult groups. Sending text messages containing input errors, or errors arising from auto-correction, is an issue that has caused extreme frustration for our participants. In an observational study we filmed users as they composed and submitted text messages and noted that, as in [7], they tended to enter a "review mode" before committing to sending i.e. they paused on reaching the end of a message and read back through it before sending it either in its current state or making the necessary changes before sending.

Having explored different types of errors, referring to these as "bloopers" to avoid the language of mistakes, and failure, we discussed with our participants the types of situations when bloopers arise and the consequences of these. We went on to explore together the types of solutions or "blooper support" currently available for error correction, asking participants to discuss the merits of these. In subsequent sessions participants generated paper-based designs to offer further or improved blooper support, e.g. Figure 3. A common theme that arose in designs was using highlighting to clearly point out where bloopers had occurred and where automatic corrections have taken place.

The MaxieKeyboard

Based on the desire for better error correction support and the strong highlighting theme emerging from our participatory design, we designed a new input method for Android, building on the inbuilt spell-checking framework and the OpenAdaptxt [4] predictive text system to offer context-sensitive suggestions and a highlighting scheme to help support error correction. We have also incorporated the open-source ASpell engine for spell-checking to address the lack of OS spell-checking support on some popular devices.

The keyboard consists of four primary areas of interest: the text composition area in which we highlight various words, the suggestion bar, the colour bar for typing accuracy feedback and a standard QWERTY layout keyboard, as shown in Figure 4. The keyboard attempts to raise user awareness of input errors by drawing the user's attention to spelling errors using highlights in the text itself and a coloured status indicator bar between the suggestion bar and the keyboard. Highlights are

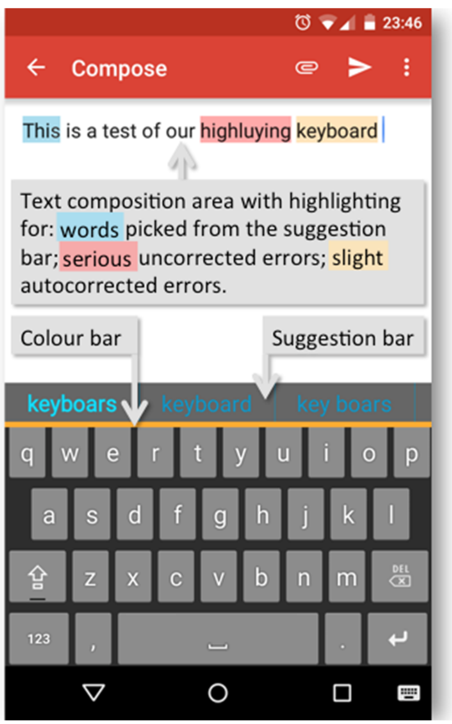

Figure 4: Overview of the MaxieKeyboard features

designed to emphasise errors and support post-typing review of entered text; the coloured status bar to support awareness of errors while keeping the users' gaze focussed on the keyboard. This function was designed to reduce the need for pausing input to check spelling mid-word.

When finished typing a word, the keyboard automatically checks spelling of the last word with feedback as follows:

- Red highlight and red bar: When a word appears to be very badly spelled and the system cannot be sure of offering good correction it is highlighted red (a *serious* mistake) and the bar glows red;
- Orange highlight and orange bar: When a word has been autocorrected the corrected text is highlighted orange and the bar shows orange to indicate that this action has taken place (a *slight* mistake);
- No highlighting and green bar: Word was spelled correctly leading to normal insertion in the text but a green confirmation bar colour.

As the user types, suggestions for auto-completions, corrections and next word suggestions are offered by the OpenAdaptxt framework on a suggestion bar residing at the top of the soft keyboard. Based on our design workshop feedback we added a fourth highlighting colour to maintain awareness of selections from this bar:

- Blue highlight: When a suggestion is picked from the suggestion bar, it is highlighted blue.

All highlighting has 60% opacity so as to render a good contrast between the black text and background colour. Red underlining of erroneous text is maintained, as per the default Android KitKat and Lollipop style.

Multimodal feedback features

Haptic feedback has been shown useful in text entry to raise awareness of errors while typing [5]. In addition to the visual feedback, our keyboard also multi-modal feedback: haptic and audio feedback that the user can enable through settings to augment or completely replace the visual feedback. In our current design, we indicate the detection of serious errors through two short tones played in rapid sequence, or with two short vibrations, again in rapid sequence. Slight (autocorrected) mistakes are indicated with a single tone or vibration. The tone and vibration duration (and in-between pause, in the case of serious errors) have been timed to coincide, providing an equivalent stimulus on both senses simultaneously.

Pre-Launch Testing

We are starting a longitudinal study of our keyboard through Google Play Store release. This study will investigate long-term effects of using the keyboard and will be promoted through groups specifically targeting older adults.

Before launching the keyboard we ran workshops (see Figure 2) with older adults to get their impressions and have refined the keyboard. In the latest workshop looking at the pre-release version and installation process we gained strong support for the keyboard and

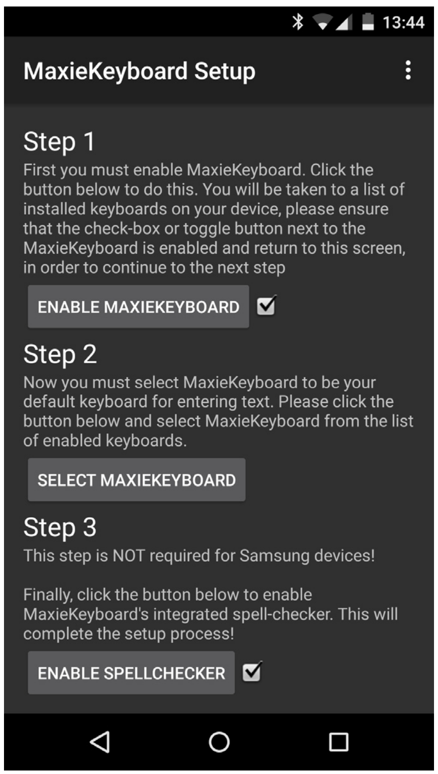

Figure 5: Installation explanation guide

for the process that we have followed in working closely with them on its design: "*It is nice to say that I helped, [that I was] involved in its development*".

Keyboards are not as simple to install as standard apps on Android due to the higher permission requirements. Additionally our keyboard requires our own spelling platform, depending on the OEM and Android version. To simplify installation we developed an installation application (Figure 5) and paper-based installation guide for our workshops. The participants succeeded in installing correctly but recommended that the manual be shortened and simply included in the Google Play listing.

Limitations to our planned study were, however, raised as many felt that their friends would be more conservative over their phones and, confirming market information, that many of them had not installed apps before.

Release Prototype
The release prototype of our highlighting keyboard is available for download from Google Play: search for MaxieKeyboard. Alternatively it can be installed directly from our project website at https://mobiquitous.cis.strath.ac.uk/?q=node/6

Summary
Through a series of participatory design workshops a theme of supporting error awareness emerged. We developed this theme into a new keyboard for Android that makes users aware of any errors through highlighting text in the body of the message and through a colour bar at the top of the keyboard. Initial pre-launch studies showed strong support from our older adult user groups. We are now starting a longitudinal study based around a Google Play Store launch of the keyboard.

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