The technology evolution and future improvements for mobile text input

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INTRODUCTION

With the development of technology, cell phones have gradually become an indispensable part of people's lives. People use cell phones to carry out necessary daily communication and leisure and entertainment activities. The difference from the face-to-face conversation is that text is the primary way people use cell phones to communicate, and users input what they want to express into the phone in the form of text. As a result, text input has become an essential feature of cell phones.

As the performance of cell phones has improved, input methods have also become more convenient. In the days before touchscreen phones, people could only enter text through the phone's hardware keyboard, and there were only one means of input. Since the advent of touch screen cell phones, numeric keypad input methods have become more diverse and intelligent. Users can input text directly by touching the screen and can hide the text input box at any time. More and more text input methods are available for people to choose from. Users can switch languages to input at the same time, which makes the communication around the world more convenient and fast. For example, 12 key input, 26 key input, handwriting input, voice conversion and other input methods give users more choices.

In this paper, we will investigate the relevant user experience to learn the advantages and disadvantages of various mobile phone input methods. This paper will understand the prominent researchers in the field of mobile phone input method and analyze their research results accordingly. The article will look at new technologies that have been proposed or are under research to understand better how these new technologies can improve typing accuracy and text recommendations. At the same time, the article will look at ways to enhance keystroke accuracy to reduce the likelihood of user error.

SYNOPSIS OF KEY RESEARCHERS

Ian Scott MacKenzie has made significant contributions to the study of patterns of cell phone input, and his main research interests include mobile computing and text entry. In 1991, he began publishing research on HCI and has published 117 research papers over the past 29 years. According to Mackenzie's research content, he focuses on optimizing the existing mobile phone input mode and tries to put forward more input methods to improve the speed and accuracy of the user's text input. Mackenzie proposed in 1999 that the handwriting input method can make it easier for new mobile phone users to input text. However, for those who are proficient in desktop computers, QWERTY's input mode can greatly improve their typing speed. Therefore, MacKenzie believes that both input modes should be retained in future mobile phone production (Mackenzie et al., 1999). In the next five years, he has studied three key input method, 12 key input method and QWERTY input method. Through experiments, he calculated the input speed and accuracy of each mode, and summarized the advantages and disadvantages of each input mode. Subsequently, he presented the first model of two-thumb text entry in 2002. By dividing the key area between two thumb keys, people could enter more quickly with a miniature keyboard. He also proposed to optimize the input layout so that each text entry can be evenly distributed among the fingers on different sides of the keyboard.

Hugo Nicolau is also one of the leading researchers in the field of cell phone input. Between 2008 and 2020, he has published 44 research reports. Unlike MacKenzie, he has focused on optimizing text input patterns for the blind and elderly. Because blind and elderly people have weaker finger movement and vision, cell phone text input needs to provide more haptic feedback and motor stability. Also, the elderly and the blind have a higher error rate than healthy young people. Nicolau ensures the speed of text input by researching various methods of text correction to ensure correct input (Nicolau & Jorge, 2012). He researched the current cell phone input patterns of the blind and suggested ways to improve them. For example, he found that the text input speed of the multi-press input mode was significantly faster than that of Nav-tap, but that Nav-tap was easier for inexperienced blind people to learn and use. Therefore, Nicolau believes that the current two input modes should coexist, and researchers should also objectively understand the performance differences between the two input modes, so as to provide enlightenment for future input methods (Nicolau et al. 2010). At the same time, he also believes that we still need to study a simpler text input method for the elderly and blind users to use.

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Letter:  t h e _ q u i c k _ b r o w n _ f o x
Thumb:   L R L R L R R L R L L L R L R L L R L
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Figure1. An example phrase and thumb assignment

KEY RESEARCH RESULTS

Development process

With the development and progress of science and technology, mobile text input has become an important topic in the HCI field. The text input mode is also developing more and more diversified. How to improve the speed and accuracy of text input has become an important research goal of researchers.

In 1999, MacKenzie et al. studied two different text input modes for cell phones: handwriting mode and QWERTY mode, which is similar to desktop input. They investigated the input speed of these two types of soft keyboard separately. The results showed that touchscreen handwriting was easier for novice users. Users could easily write what they wanted (Mackenzie et al., 1999). Although QWERTY mode can result in low input speed for novice users, experienced desktop users can become proficient at using this input mode. Also, the handwritten interface requires a prolonged display of the soft keyboard, which can take up a lot of screen space. Text input is a process in which the eyes interact with the soft keyboard, so MacKenzie argued that prolonged use might cause eye strain. Therefore, their research suggests that both handwriting and QWERTY input modes should be retained and that the simplicity of the interface's keyboard display layout should be further optimized (Mackenzie et al., 1999).

In the earliest cell phone keyboards, most were 12-key keyboards. The keypad had the numbers 0-9, *, and # distributed across the keyboard, with each number corresponding to three letters of the alphabet. The user had to enter the corresponding text in multi-press mode, and by pressing the same number key continuously, the text would cycle through the letters of the corresponding number. For example, pressing the number 2 once would correspond to the letter A, and pressing the number 2 twice would correspond to the letter B (Butts & Cockburn, 2001). However, this input method is less tolerant of errors, e.g., the user presses 2 three times to enter the letter C, but the user actually wants to enter the text as ABC. In order to solve this problem, researchers have designed two new input modes based on multi-press mode: multi-press method with timeout and multi-press with next button. The multi-press method with timeout sets the corresponding timeout time for each key. If the user presses the same button continuously before the timeout, the input will cycle through the three letters corresponding to the button. Multi press with next button provides the user with the next button. When the text circulates to the letter that the user wants to input, the user can select the letter by pressing the next key (Butts & Cockburn, 2001).

Based on the 12 key input method, Mackenzie developed a more convenient input method: prefix-based disambiguation for mobile text input. This input method can guess the text content that the user wants to input by inputting prefix. Compared with the traditional dictionary-based input mode, this input mode takes less memory and allows users to input non-dictionary words (Mackenzie et al., 2001). Users are freer to enter the text they need. Through the test, the user input speed of this mode is about 7.3 words per second, and the error rate is about 5.2%. Compared with the multi-press input mode, the input mode reduces the number of keystrokes by 50% and increases the input speed by 36%. Therefore, the initial based input mode is very efficient.

Immediately after, in 2002, MacKenzie et al. worked on the first two-thumb text input model. This model uses a physical keyboard and therefore, does not take up space on the system display. This text input method only supports the QWERTY input mode and encourages users to use two thumbs to input text on the keyboard. In order to reduce typing time and increase accuracy, they obtained a word usage frequency table from the language database and included in the model the 9022 most frequently used words in English-speaking countries. By dividing the key areas between the two fingers, the keyboard distribution was rationalized so that each sentence was distributed evenly between the two fingers (see Figure 1). And the space bar was adjusted so that the number of space bar presses for both the left and right hand was about 50% (MacKenzie & Soukoreff, 2002).

Since then, cell phone keyboards and input modes have basically taken shape. However, with the advent of touch screen phones, the layout of cell phone keyboards and input modes have become more and more flexible. The soft keypad will appear when text input is needed, and the cell phone input method also includes a variety of input methods such as handwriting input, 12-key input, and QWERTY input, so that users can choose different options. The built-in thesaurus has also been optimized and expanded, enabling users to input at a much higher speed.

Existing problems and future improvement measures

As the use of cell phones has become more widespread, their users are no longer limited to the young and middle-aged. Today, more and more elderly people and people with disabilities are learning to use cell phones to communicate with each other. Besides, text input is being used in a variety of mobile applications, such as web browsing, leisure and entertainment. Therefore, research is now focused on how to make it easier for the elderly and people with disabilities to use cell phones for text input, reduce input errors, and improve haptic feedback and motor stability.

To study the factors that affect the speed of older people's typing, Nicolau invited 15 right-handed users aged 67-89 to participate in the experiment. According to the experimental results, it is found that the input speed of the elderly using tablet is 5.07wpm, which is slightly higher than that of mobile phone users (4.73wpm). In terms of error rate, the error rate of tablet users is 16.55%, while that of mobile phone users is 25.97%. The main reason for the errors of the elderly is omission error because they tend to forget the letters that have been input or need to be input or have a wrong understanding of the experimental requirements. Moreover, the stability of the hand of the elderly is relatively weak, so it is easier for the elderly to have a wrong touch when using the mobile phone input (Nicolau & Jorge, 2012). Through this experiment, Nicolau believes that older people's cognitive ability for mobile phone text input is not as good as young people's, and they often make input errors. Moreover, the elderly are lack of strength and unstable hand activities, so they need a more stable input environment and a more intuitive keyboard (Nicolau & Jorge, 2012).

Based on the existing problems, Nicolau also suggested ways to improve the keyboard. By analyzing the keystroke habits of the participants, he found that the keyboard keys should be wider, and the space bar should be narrower to reduce substitution errors and better fit the user's typing habits. The researcher can further improve the keyboard layout by analyzing different users' touch positions, key durations, and other operating habits in order to improve the accuracy of the input. To address the differences in typing habits among users, future keyboards should enhance the personalized design of cell phone keyboards. Nicolau suggests that current keyboards are not yet able to adapt to the different hand tremors of users, so future keyboards should learn the tremors used and make adjustments to reduce typing errors (Nicolau & Jorge, 2012).

In the future, research on text input should no longer be limited to basic keyboard typing. Researchers can increase the mode of text input, such as voice input.

DISCUSSION

The results of my research include a history of the evolution of text input on mobile devices, as well as current shortcomings and possible directions for improvement. By understanding this research, I believe that there is still room for optimizing the user experience with mobile soft keyboards.

Unlike other interactive interfaces such as the usual website interface, the cell phone soft keypad is aimed at a very large group of users. Healthy young people, children and the elderly, and even people with disabilities all use mobile soft keyboards for necessary text input. All users have their own unique habits of use, and the layout of the soft keyboard can not meet the input habits of all people at the same time. Therefore, I believe that the future of mobile keyboards can allow a more personalized design.

The choice of multiple text input modes is also one of the personalization features of the input method. Handwriting, 12-key, and QWERTY input modes all have their advantages and disadvantages, and all have some differences in input speed and accuracy. But these input modes are reserved, and users can switch at any time because they can adapt to different user groups and input habits. For cell phone users who are not accustomed to 12-key and QWERTY keyboards, they can choose handwriting input, while skilled computer users can choose QWERTY input, which is the personalized embodiment of the soft keyboard. While retaining the different input modes, the researcher also optimized the input modes to improve the user experience of selecting a specific input mode. For example, the 12-key input mode evolved from multi-press to prefix-based, which significantly increased the user's input speed.

OPEN AREA RESEARCH

Based on the results of my research, I envision two other research directions. These are: soft keypads for cell phones should provide more personalized settings for users, and blind typing on the back of the phone should be available.

As for me, soft keyboard personalization is different from the personalization options offered by a variety of input modes. In my view, each input mode should allow the user to distribute the settings differently to suit his or her input habits. For example, a soft keyboard should allow the user to set the size of the keys, the spacing between the keys, the sound of the keys, and the touch feedback. Besides, self-learning features could be

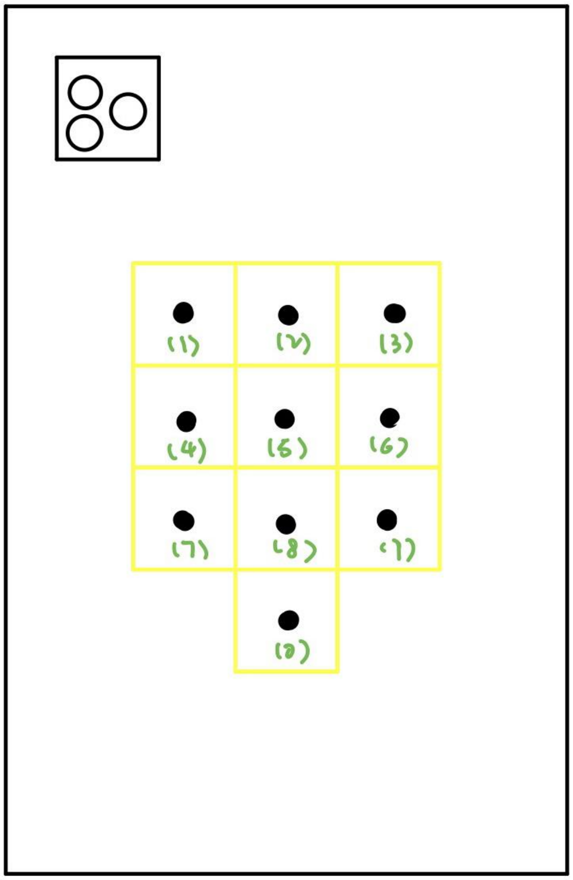

Figure 2. An example for back-touch sliding input method

added to the soft keyboard. Similar to Nicolau's proposed improvements, future soft keyboards could monitor and learn the user's different keystroke habits (e.g., hand jitter, touch range of keys, etc.) and make their adjustments to suit the user's typing habits.

Although personalization is not difficult to achieve, the overall layout of the soft keyboard needs to be adjusted accordingly for this technology to work. For example, after the user adjusts the corresponding size of the buttons, one needs to consider how the overall keyboard should be resized to fit the screen without changing the layout and size of the keyboard. At the same time, the researcher needs to consider whether the layout of the keyboard will become irrational after the user changes the button size and button spacing and whether the key distribution needs to be further adjusted. The researcher needs to analyze, through surveys and research, the magnitude of the personalization values that apply to each keyboard. Thus, the ability to personalize a soft keyboard still requires more analysis and learning in the future.

Another research idea is the back-touch sliding input. Based on the current keyboard sliding input proposed for the iPhone and the phone's back-touch mode, I propose an idea of using back-touch to input text. This input mode is a bit more restrictive than the other modes and is only suitable for users who are proficient with the phone's soft keyboard. It offers a 12-key input mode and provides the user with corresponding touch feedback on the back of the phone (e.g., a bulge at the centre of the button sensor) to inform the user of the keys touched. If the user selects this input mode, the soft keyboard will not appear on the screen after the text input box is selected. The user can enter text by sliding the back of the phone, or by touching the back. Although the soft keypad no longer appears on the screen, buttons will still appear to allow the user to switch between input modes. Buttons are also provided on the phone screen to allow users to switch between text input and numeric input. The user can use the index finger to enter text on the back and the thumb to select the correct text on the front screen.

While this input method provides the user with a larger input and display interface, it may lead to more misuse because the buttons cannot be viewed visually. The layout of the buttons and how to adapt this input method to more people need to be studied further.

CONCLUSION

This article summarizes the evolution of the soft keyboard on cell phones and presents what is still being optimized and what the future might hold. The article focuses on two researchers who have made major contributions to the field: Ian Scott MacKenzie and Hugo Nicolau, both of whom have worked to optimize the speed of text input on cell phones and have proposed ways to improve it. Starting with 12-key input methods, soft keyboards have become increasingly diverse. Both the QWERTY mode and handwriting input mode have become alternative input methods for users. Researchers are beginning to understand how to make cell phone input work for a broader age group, and are constantly optimizing page layouts and features with this goal in mind. Two new areas of research have also been proposed, namely, soft keyboard personalization and back input on cell phones. However, due to the lack of relevant research in these two research areas, the principles presented in this article are only the basic principles and prototypes, and the relevant settings and feasibility still need further analysis and investigation in the future.

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