Effective Phonetic Keyboard Arrangements for Touch Screen on Mobil Device

First Author
Yao-Te Chung.
Inst. Of Culture Industry and Innovation Design, JinWen University
New Taipei City 23154, R.O.C
athrunzhung@gmail.com

Second Author
Wen-Hao Yang
Inst. Of Culture Industry and Innovation Design, JinWen University
New Taipei City 23154, R.O.C
whyang@just.edu.tw

Third Author
A Chiming Huang
Department of Information Management, Hsuan Chuang University
Hsinchu 300, R.O.C
yalo.huang@gmail.com

CHI'13, April 27 – May 2, 2013, Paris, France.

Abstract
Social network websites and mobile devices are burgeoning in recent years. Users can share their information by typing into the words on touch screen, e.g. iPad or smart phone. Currently, there are many previous researches for input method, mainly in English and Latin. But, the Chinese traditional phonetic input scheme is seldom discussed, particularly on touch screen. In order to reduce the input time, this study proposes an effective phonetic keyboard arrangement (EPKA) to reduce the average moving distance while typing. The proposed method investigates the average moving distance by typing into phonetic symbols for words out of documents with respect to QWERTY (traditional phonetic keyboard arrangement) and EPKA respectively. Experimental results show that EPKA outperforms QWERTY by reducing 40-50% average moving distance. Moreover, the more characters input the shorter the average moving distance.

ACM Classification Keywords
Mobile Devices, Touch Screen, Phonetic Input.:

Introduction

Text entry remains slower and more errorprone on touch screen of the small devices. Therefore, there are many previous researches for input method, mainly in English and Latin.

The present work focuses on multilingual keyboard optimization for touch screens. Touch screen keyboards, also known as soft, virtual, touch, graphical, on-screen or stylus keyboards, are a common part of user interfaces of the increasingly popular touch screen devices. English keyboard is optimized for the touch screen keyboard (Aze, Shi, & Zhai, Sue, 2012) which, a user after learning, could accelerate his typing speed significantly. However, it is seldom discussed about the keyboard arrangement for Chinese character input, particularly on touch screen.

Since a Chinese word is pronounced by the combination of phonetic symbols, the interdependence among these symbols should be considered in the arrangement of keyboard.

Table 1. Classification of phonetic symbols

Classification	content
Initials	ㄅㄆㄇㄈㄉㄊㄋㄌㄍㄎㄏㄐㄑㄒㄓㄔㄕㄖㄗㄘㄙ
Medials	ㄧㄨㄩ
Vowels	ㄚㄛㄜㄝㄞㄟㄠㄡㄢㄣㄤㄥㄦ
Tones	˙ ˊ ˇ ˋ

Phonetic symbols, evolved through a century, are still the Chinese characters spelling tools. The primary phonetic arrangement on keyboard, namely Daqian, is the most widely used in Taiwan. However, the arrangement of keyboard is designed for ten fingers and the more frequent used keys are keyed by the more nimble one. While the mobile device is used by most of people, especially young people, keying is done always by only one finger. The arrangement of keyboard should be adjusted for the behavior. For people, it is comfortable to key in letters first from left to right and then from top to bottom. Since a Chinese word is typed by a sequence of phonetic symbols which belong to one of categories following the sequence of initial, medial, vowel and tone described in Table I and it is necessary to arrange the keyboard to make people comfortable to type, i.e. quick and easy, reducing the moving distance and keeping the movement of finger smooth could make it.

In order to reduce the input time, this study proposes an effective Phonetic keyboard arrangement (EPKA) to reduce the average moving distance while typing. First, by the property of phonetic symbols which can be divided into four types, i.e. the initials, referral mother, vowels and phonological, where a Chinese word is pronounced by the sequential combinations. Second, the arrangement need not only consider the using frequency of the phonetic symbols which is used frequently by previous researches, but also take the assistive ergonomic requirements and the wrist movement inertia into account such that the phonetic symbols on keyboard would be arranged concentrically to minimize the average moving distance for typing by a single finger on touch screen where most of people are used to.

In this paper, we do not only consider the interdependence and frequency of phonetic symbols, but also the smoothness and quickness of finger movement to arrange the keyboard such that the input of Chinese words on touch screen of smart devices could be comfortable and quick for people.

Literature Review

Phonetic symbols are presented by the Ministry of Education of the Republic of China in 1918 as the standard Han phonetic sound symbols which amount to a total of 37 symbols.

There are many different arrangements of keyboard for Chinese input like Daqian, Eten, the Systex style IBM type. Daqian type in Microsoft Windows is the standard Chinese keyboard arrangement shown in Figure 1. Its characteristics are to direct the phonetic symbol table, from top to bottom, left to right in order of the phonetic symbols on the keyboard. Phonetic symbols must occur in accordance with the order, i.e. initial, medial, vowel and tone. The benefits of the keyboard arrangement described below.

1. Chinese Traditional input as the main way to share is high.
2. Familiar with the phonetic symbols order to learn quickly
3. Some commonly used initials and vowels are arranged in central area such that it is convenient to use.

Its shortcomings, on the other side, are listed below.

1. Typing by a single finger is more time-consuming.
2. Some of the commonly used symbols arranged in the corner of keyboard would lengthen the moving distance of finger.
3. Tone is the last input symbol for a Chinese word which is arranged above the keyboard would make finger move back and forth frequently such that the moving distance and the time for input could increase.
4. Correlation between phonetic symbols is not considered in the arrangement of Daqian keyboard.

Clearly, it is not designed for one finger moving on touch screen.

Since phonetic symbols are more than English letters, researchers (Guan-Hua Chen, 2012) take a two-page set which make the switching of keyboards frequent such that prolong the input time. Yanshen reduces frequent switching between the two-page sets by increasing fingers moving distance. This design does not take the thumb moving inertia into consideration.

Apple's mobile product switches its double-page keyboard layout to a single page configuration to enhance its input efficient

In this paper, we arrange the keyboard on touch screen as one page. To enhance the efficiency of input Chinese words, phonetic symbols are arranged from top to bottom by the four categories described in Table I. As noticed, for the reoccurrence of each word, the tones could be arranged in the center of keyboard to turn the direction of finger movement such that the moving distance could be decreased and the inertia of finger could also be kept. The detail design of the keyboard arrangement could be shown in the next section..

Effective Phonetic Keyboard Arrangement

Please use an 8.5-point Verdana font, or other sans serifs font as close as possible in appearance to Verdana in which these guidelines have been set. (The "Normal" style for this document automatically gives you this font setting.) Arial 9-point font is a reasonable substitute for Verdana as it has a similar x-height. Please use serif or non-proportional fonts only for special purposes, such as distinguishing source code text.

The conventional phonetic input keyboard lays the 42 phonetic symbols letters in a rectangle shape with 4 rows and 11 columns, which is well suited for two handed typing. Such a constraint is not necessary for touch screen keyboards. If the keyboard is not constrained to any particular shape, the objective function of minimizing one point travel (by a stylus or a single finger) would tend to result in a rounded keyboard (Zhai, et al., 2000). Our experience is that a more practical square shape (or near square such as a 7 rows by 6 columns grid) is more practical for graphic design and still gives sufficient flexibility for optimization (Zhai, Hunter, et al., 2002). As shown in Figure 2, in practical product designs the keys on the edge unused by the alphabet letters can be filled with auxiliary characters and functions.

In this study, the phonetic input method keyboard settings optimized in accordance with the following principles:

* Mobile device users are accustomed to single finger input, taking into account the finger to move the distance to the center of the keyboard as the main development direction

* Phonetic symbols in accordance with the phonetic symbols, initials the Vowels Finals and phonological structure level, in accordance with the statistical frequency of occurrence decide the arrangement of the design, symbolic structure + frequency of occurrence for a major consideration

* According to research, the combination of high coupling symbol frequency of occurrence, re-adjust symbol position, in order to reduce the moving distance

* According to human factors engineering theory fingers moving inertia, and in line with the structure of phonetic symbols, decided top-down keyboard design structure, and placed in the central part of the last tone boot successive input goals

* The goal of this study is proven experimental input, compared with Daqian keyboard to reduce the moving distance of assessment standards

The study ios6 environment design environment, ants tracing method to calculate the distance of the keyboard to move as evaluation methods, comparing objects including standard phonetic input method with improved 42-key keyboard, this configuration is applicable to all mobile devices.

Figure 1. Standard Daqian keyboard arrangement

Figure 2. Effective Phonetic Keyboard Arrangement (EPKA)

SIMULATION RESULTS

The basic methodology used is to average the total distance of typing a character across multiple in the present study.
Experimental options: the Chinese Tang Dynasty, Du Fu's " The Everlasting Regret " Song Dynasty Su Shih's " Lyrics to Remembering Your Charm ", as well as Taiwan's elementary school sixth grade Chinese textbook.

Experimental (1): The Everlasting Regret

Daqian travel distance : 9302 and EPKA Travel distance: 7903

Total character : 2681 The total number of words: 840

Table 2. Experimental (2)

Experimental (1)	Average character distance	The average distance of text
Daqian Keyboard	4.4696	11.0738
EPKA Keyboard	2.9477	9.4083

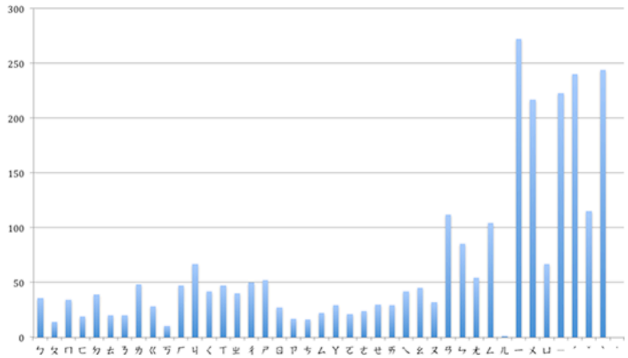

Figure 3. The frequency of the phonetic symbols (1)

Figure 4. Daqian Keyboard : distribution of phonetic symbols (1)

Figure 5. EPKA Keyboard: distribution of phonetic symbols (1)

Experimental (2): Lyrics to Remembering Your Charm

Daqian travel distance: 1335 New Travel distance:1097

Total characters: 327 The total number of words: 100

Table 2. Experimental (3)

Experimental (2)	Average character distance	The average distance of text
Daqian Keyboard	5.0825	13.35
EPKA	3.3547	10.97

Keyboard		

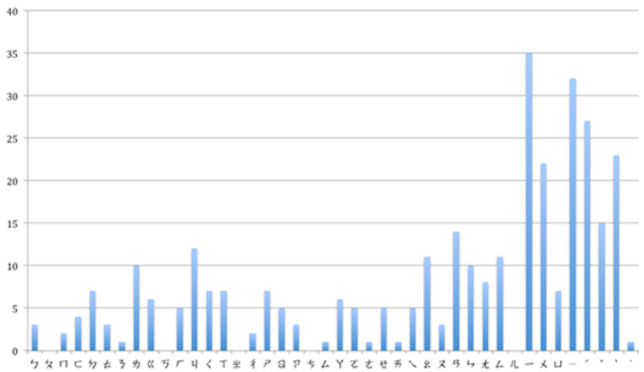

Figure 6. The frequency of the phonetic symbols (2)

Figure 7. Daqian Keyboard: distribution of phonetic symbols (2)

Figure 8. EPKA Keyboard : distribution of phonetic symbols (2)

Experimental (3): Chinese textbook

Daqian travel distance: 6771 and EPKA Travel distance: 5412

Total characters: 1597 The total number of words: 533

Table 2. Experimental (4)

Experimental (3)	Average character distance	The average distance of text
Daqian	4.2398	12.7035

Keyboard		
EPKA Keyboard	3.3888	10.1538

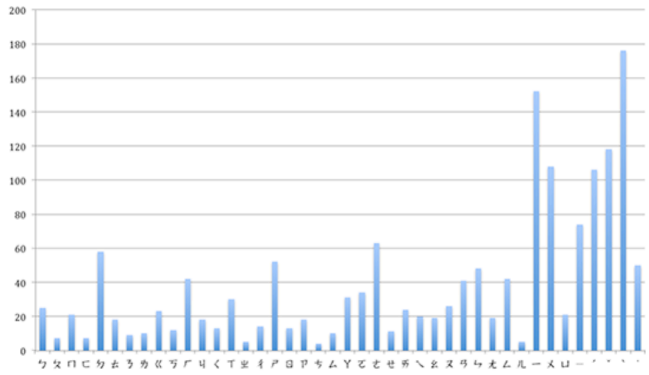

Figure 9. The frequency of the phonetic symbols (3)

Figure 10. Daqian Keyboard: distribution of phonetic symbols (3)

Figure 11. EPKA Keyboard: distribution of phonetic symbols (3)

Having examined the arrangements in terms of moving distance. Now, let us to evaluate these three sets of data.

Frequency data from the three sets of phonetic symbols, a higher frequency of characters are very close to having Credits

From the average character the distance Daqian ‘s keyboard 5.08, 4.46,4.23: New keyboard 3.35,2.94,3.38, or words from Daqian‘s keyboard 11.07,13.35,12.70: New keyboard 9.40,10.97, 10.15, show the new keyboard design optimization results Concentrated in the center of the keyboard, from a distribution diagram of phonetic symbols, the three experimental results showed a higher frequency of characters to reduce the moving distance of the input.

REFERENCES

1. 李再長, 中文電腦注音符號輸入鍵盤的研究設計,National Cheng Kung University,1986.
2. Guan-Hua Chen, A Two-pages Keyboard Arrangement for Touch Screen of Mobile Devices from Optimization Perspectives – A Design of Zhuyin Input Method, Tatung University,2012.
3. 陳詩捷 ; 陳立杰, 觸控式螢幕上注音符號軟體鍵盤之研究, 2002中華民國設計學會設計學術研究成果研討會論文集(上)429-434.
4. Ming-Jer Hsieh, 適用於數位學習輔助性人因需求之基因演算行程最佳化單指鍵盤, 2004年台灣網際網路研討會論文集,5p.
5. Xiaojun Bi ; Barton A. Smith ; Shumin Zhai , Multilingual Touchscreen Keyboard Design and Optimization , University of Toronto , 2012
6. Shiri Azenkot ; Shumin Zhai , Touch Behavior with Different Postures on Soft Smartphone Keyboards , University of Washington, 2012.
7. Anne Roudaut ; Stéphane Huot ; Eric Lecolinet , TapTap and MagStick: Improving One-Handed Target Acquisition on Small Touch-screens , 2008.
8. Ivan Poupyrev ; Shigeaki Maruyama , Tactile Interfaces for Small Touch Screens , Interaction Lab, Sony CSL, 2003.
9. Balakrishnan, V., & Paul, H. P. Y. (2007). Hand-size variations effect on mobile phone texting satisfaction. Ubiquitous Computing and Communication Journal.
10. Amy K. Karlson ; Benjamin B. Bederson , Studies in One-Handed Mobile Design: Habit, Desire and Agility , Proceedings of the 4th ERCIM Workshop on User Interfaces for All UI4ALL '98 , 2006.
11. Shumin Zhai & Per Ola Kristensson , The word-gesture keyboard: reimagining keyboard interaction (CACM Research Highlight) , Communications of the ACM, vol. 55, no. 9 (2012), pp. 91-101