



How to design finger input of Chinese characters: A literature review



Zhe Chen, Pei-Luen Patrick Rau*, Cuiling Chen

Institute of Human Factors and Ergonomics, Department of Industrial Engineering, Tsinghua University, Beijing 100084, China

ARTICLE INFO

Article history:

Received 27 December 2012

Received in revised form

4 November 2013

Accepted 27 November 2013

Available online 13 March 2014

Keywords:

Finger input

Chinese character

Human–computer interaction

ABSTRACT

A comprehensive literature review is conducted on the considerations of the human finger and Chinese character in finger interaction for Chinese input. The results of this study indicate the importance and influences of characteristics of the human finger and Chinese characters on Chinese handwriting. Moreover, fifteen design guidelines are developed based on the literature review to improve the Chinese handwriting performance (i.e. input time, accuracy, error rate, mental workload, satisfaction and physical fatigue) and subjective ratings. Seven guidelines are developed regarding properties of the human finger (i.e. finger size, contact area, motor skill, texture perception and input position). Another eight guidelines are related to characteristics of Chinese characters (i.e. direction, structure, script style, complexity and semantics). These results are in great help of improving the Chinese handwriting performance and user experience. The guidelines are going to help product designers develop a user-friendly Chinese handwriting system.

Relevance to industry: The literature review results give the theoretical support on developing a user-friendly Chinese handwriting system. Fifteen practical design guidelines based on the literature review are beneficial to improving handwriting performance and subjective ratings and consequently product design.

© 2013 Elsevier B.V. All rights reserved.

1. Introduction

Smart devices users can handwrite Chinese characters with thumb or index finger due to the development of touch technologies. Finger input has many advantages than stylus input. First, finger input is necessary when only one hand is available for input. For example, only one hand is probably available to send a text message when users are standing in a bus or subway. Secondly, lower learning cost and direct input mode make finger input favored by more and more people especially those not familiar with digital devices. However, the new challenge is the interface design for finger input since fingers such as thumb are extremely different compared to stylus. Therefore, it is necessary to consider fingers' properties such as size, contact area, motor ability and texture perception. Besides, users have different input positions or input scenarios in finger input, for example, one hand input with thumb and two-hand input with index finger. So it is essential to include input position in finger input for Chinese characters. On the other side, unique characteristics of Chinese character have effect on the Chinese handwriting and consequently require more attention in

the interface design for finger input. Chinese character is hieroglyphic, composed of strokes and radicals, and different with alphabetical letter. Stroke direction has certain effects on the finger input performance, as fingers' motor abilities are different in each direction. Character structure is also a vital factor matters as it describes how strokes and radicals are organized in one character. Script style such as regular or cursive style influences character recognition. The complexity of Chinese character has a connection with mental workload in handwriting. Semantics of Chinese character (i.e. words, sentences and error correction) are not only essential to character recognition but also to handwriting experience.

This study conducts a comprehensive and thorough literature review on factors that have influences on the finger interaction for the Chinese input. Moreover, design guidelines are developed based on the literature review to improve the Chinese handwriting performance with fingers. The results of this study shed light on future research direction and product design on Chinese handwriting.

2. Characteristics of human finger

Handwriting with fingers or called as finger writing is executed by index finger, thumb and middle finger. Thumb is greatly

* Corresponding author. Tel.: +86 10 62776664.

E-mail address: rpl@mail.tsinghua.edu.cn (P.-L. Patrick Rau).

different from other two fingers in terms of size, degree of freedom, flexibility and motion range while other two fingers are similar. As middle finger is similar to index finger, the major concern is given to the thumb and index finger in this study. For investigating the influence of the human fingers on Chinese handwriting, the characteristics of the human fingers such as finger size, contact area, motor skill, texture perception and input position should be reviewed and summarized.

2.1. Finger size

Finger size varies not only in different fingers of a person but also in individuals. Since the human fingers have no regular shape, lots of indices such as the finger length, joint width and joint circumference are used in finger movement studies to describe the finger size, summarized in Table 1 (George, 1930). To better understand these indices, a briefly description of finger joints are illustrated in Fig. 1.

Finger length and DIP width are especially important to Chinese handwriting among these indices. Finger length is critical to handwriting performance because finger length has a close connection to finger motion range and consequently to handwriting range (Elkoura and Singh, 2003; Napier and Tuttle, 1993). The other important index is the width of DIP joint because it reflects finger input size while direct contact area is difficult to measure. This difficulty is raised as the contact area of finger changes when writing pressure increase, as shown in Fig. 2.

Thumb and index finger are different in finger size of length and DIP joint width. Generally thumb is larger and shorter than the index finger. The standardization of human hand size shows the finger size of Chinese people, as shown in Table 2 and Table 3 (China National Institute of Standardization [CNIS], 1988, 1996). However, these statistics have two shortcomings. First, the data was collected in the years of 1998 and 1996 and the latest statistics have not been released. So the human dimensions of Chinese probably change in these years. Second, there is no direct report of width of DIP joint of thumb. These two shortcomings increase the difficult of design for the Chinese handwriting system, for example the input box size.

The influence of finger size to handwriting performance is due to its close connection to input box size, demonstrated in three aspects. First, it is shown that adequate input box size can increase the handwriting accuracy (Downey and Anderson, 1915). Target size of 9.2 mm for discrete tasks and targets of 9.6 mm for serial task is efficiently enough with soft keyboard input for thumb on small devices (Parhi et al., 2006). An empirical study indicates the optimal input size for Chinese Characters on PDA are 14×14 mm and the optimal shape is square (Ren and Zhou, 2009). Second, user satisfaction is affected by the input size that is dependent on the three finger size. The results of a study on thumb validate the effects of thumb size on text entry satisfaction on mobile phones (Balakrishnan and Yeow, 2008). Third, physical fatigue relies on the input box size. Users tend to write bigger characters in bigger input box and it increases physical fatigue level because users have to write longer strokes and spend more time (Chan and Lee, 2005; Djioua and Plamondon, 2009; Phillips et al., 2009).

Assuming that the joint of the human finger is a circle, the diameters of thumb (the width of thumb) are approximately 20.5 mm

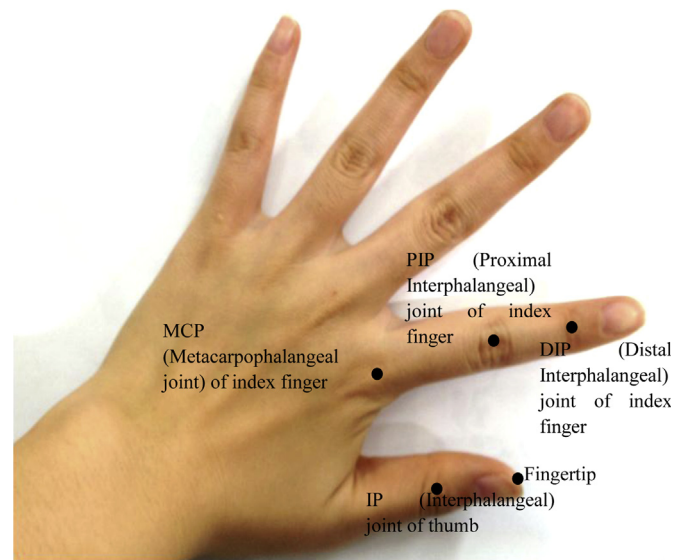


Fig. 1. Descriptions of finger joints.

for Chinese male and 18.7 mm for Chinese female. The diameters of the index finger (proximal joint of index finger) are 19.7 mm for male and 18.0 mm for female calculated from the data in GB/T 16252-1996 (CNIS, 1996). Nevertheless human finger is not a regular circle, so the actual width of the human finger should be larger than these values.

The optimal input size probably changes in future research. As discussed previously, optimal input box size for the human finger varies from 9.2 mm on 14 mm on small touch devices such as smart phones or PDAs. These optimal sizes are limited to devices' size since most touch devices are smaller than 5 inches at that time. Chinese standardizations suggest the average width of the human fingers for Chinese adults is around 18 mm (CNIS, 1996). The input box size should be larger than the average width of the human fingers. Thus the optimal input size probably should be larger than 18 mm to acquire higher performance.

Guideline One: make input size larger than 18 mm to avoid negative effect of input size to finger input performance.

Previous studies have no implication that input box sizes for thumb and index finger are different since both finger sizes are considered equally in the optimal input size. However, since there is at least 1 mm difference between sizes of the two fingers it needs more exploration to find if there is any difference on input size between thumb and index finger, especially for Chinese characters. Adjustable input box maybe one of the solutions to bridge the fingers size gap.

Guideline Two: use adjustable input box for thumb and finger input to have equal performance

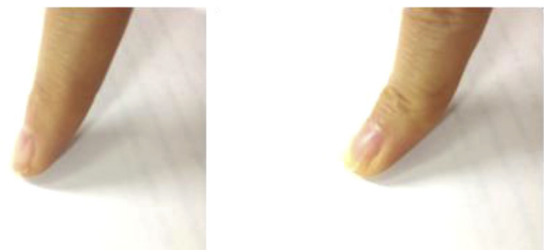


Fig. 2. Increase of contact area in handwriting.

Table 1
The indices for human finger size.

Index	Description
Length	The length from MCP joint to fingertip
Width	The width of DIP/IP joint
Circumference	Circumference of finger joints, including MCP joints, PIP joints and DIP joints.

Download English Version:

<https://daneshyari.com/en/article/1096105>

Download Persian Version:

<https://daneshyari.com/article/1096105>

[Daneshyari.com](https://daneshyari.com)