How to Develop a User-Friendly Chinese Hand Input System for the Touch Device? A Case Study

Zhe Chen[1], Pei-Luen Patrick Rau[2], and Lin Ma[1(✉)]

[1] School of Economics and Management, Beihang University, Beijing, China
malin2014@buaa.edu.cn
[2] Department of Industrial Engineering, Tsinghua University, Beijing, China

Abstract. The purpose of this study is to find how to develop a user-friendly Chinese hand input system for the touch devices. A case is studied to discover the factors which influencing the users' experience in the Chinese hand input. In the case, three personas are developed to test the usability of Chinese hand input systems of three different touch devices (i.e. smartphone, tablet personal computer and all-in-one computer). The typical personas and process for Chinese hand input are established according to the result of the case study. This study also indicates the usability consideration for a Chinese hand input system. The results of this study can be applied to product design of Chinese hand input system and future research on Chinese hand input.

Keywords: Case study · Chinese hand input · Touch device

1 Introduction

Chinese input system is widely used in the touch-sensitive devices such as smartphones or tablet personal computers. People input Chinese characters by their fingers including the thumb, index finger and middle finger. Comparing to Chinese Pinyin (i.e. Chinese Phonetic Alphabets) input, hand input is friendlier to users who are not familiar with Chinese Pinyin. In fact, Chinese Pinyin is studied from 1955, authorized by Chinese National People's Congress in 1958 and became an international standard in 1982 (ISO 7098:1991 1991). This standard is revised in 2015 (ISO 7098:2015 2015). Thus, although Chinese Pinyin is the most frequently-used approach in Chinese input on the touch devices currently, it is difficult to input with Chinese Pinyin for many users who are not familiar with or even have never learned Chinese Pinyin. In this situation hand input provides a good alternative to those users who have difficulties in inputting Chinese characters with its Pinyin. Previous studies indicated that Chinese calligraphy (i.e. the beautiful handwriting of Chinese characters on paper) brought positive emotions (Kwok et al. 2011; Yang et al. 2010). Considering aesthetic aspects of hand input on mobile touch devices may improve the user experience (Chen et al. 2014).

Previous studies have made much effort on Chinese hand input but most of the researchers focus on the algorithms and their purpose is to recognize the handwritten Chinese characters. Chinese user in the hand input system doesn't attract enough attention. It is shown that input positions, fingers' dimensions, fatigue of fingers' movements

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and other factors related to the user of Chinese hand input system will have influence on the performance of the Chinese handwriting (Chen et al. 2013; Tu et al. 2012; 2015). Input positions, including one-hand held input, two hand-held input and on hand-held input depends on the dimension and weight of the touch devices. For the small size of mobile touch device such as smartphone, both of one-hand held and two-hand held positions are possible to the hand input users. For the large size of mobile touch devices such as tablet personal computers, two-hand held is the most appropriate position to input. And for the large size of touch devices such the KIOSK or touch screen on the automatic teller machine or library information center, no hand-held position is used when the touch device is fixed and supported. Fingers' dimensions, including the width of the fingers, the length of the fingers, the area of the fingers and etc., will also affect the Chinese handwriting (Chen et al. 2014). The width of the fingers and area of the fingers reflect the size of the input box as it difficult to input when the input box is smaller than the area of the input finger. The length of the finger affects the location of the input box especially when one-hand held position is adopted. As Chinese characters are composed of multiple strokes and radicals, a lot of fingers' movements are required to complete one character and consequently fatigue of fingers should be studied. The acceptable level of fatigue of fingers should be studied to improve the user's experience of handwriting. The thumb is used to input while one-hand held position is adopted and index finger or middle finger is used to input while two-hand held position is adopted. Current research studied the interface for thumb touch on the smart devices but thumb input on Chinese handwriting still need more attention (Park and Han 2010, p. 8; Parhi et al. 2006).

On the other hand, individual differences require more attention when developing a user-friendly touch device for Chinese handwriting. Users with different education backgrounds may have different cognitive process when handwriting a Chinese character into a touch device. Users with different ages may have different movement abilities to hand input Chinese characters. For example, the fingers' movements of the elderly people are quite slower than other people (Zhou et al. 2012) and meanwhile it should not be neglected that slow and clear handwritten scripts lead to higher accuracy.

Interface design is the key issue in the interaction of Chines hand input. The size of the input box, the location of the input box, display of handwritten script, display of alternative recognized characters and so on will have a possible effect on the user experience of Chinese handwriting. It is examined that an optimized interface can improve the input time and accuracy of Chinese handwriting (Chen et al. 2013; 2014; Ren and Zhou 2009; Tu et al. 2013). A good interface design lead to higher performance and users' satisfaction.

2 Method

The purpose of this study is to discover how to design a user-friendly hand input system for Chinese character on the touch devices. The method of persona is developed to find the usability design considerations of Chinese hand input systems on three devices.

Persona is created through the result of open interviews of 5 Chinese users. The descriptions of the interview participants are shown in Table 1.

Table 1. Description of the interview participants

Participants	Age	Education level	Job	Touch devices experience
1	22	College	Student	8 years
2	30	Ph.D	Professor	10 years
3	18	Middle school	Student	8 years
4	50	Middle school	Housewife	6 years
5	54	Middle school	Operator	3 years

The interview questions focus on the following items.

- Background (age, education level, job, years of using touch devices).
- Description of the situations of using hand input for Chinese on the touch devices, including mobile phones, tablet personal computers, all-in-one computers.
- Difficulties of using Chinese hand input systems.
- Suggestions for Chinese hand input systems.

Persona 1: JIANG Yu is a housewife. She is 54 years old. She had a middle school educational experience. She comes from Hujiang Providence in the south of China and she has some accent, so she is not good at Pinyin of Chinese characters. She enjoys in playing iPhone and iPad. She send the text message directly and send the message via online chatting platforms including Tencent QQ. She likes cooking very much so she usually searches recipes on iPad to help her cooking. In her spare time, she also likes watching TV shows on All-in-one computer. The romantic story is her favorite type. So she searches the keywords of opera type or star name in online TV websites.

Persona 2: ZHANG Ming is an operator in a steel factory who is responsible to making molds. He is the husband of Yu, 57 years old. He also had a middle school educational experience. But he took a computer skills training for three years in his 30 s and he is proficient in using CAD, Photoshops, and other graphics software. He uses touch mobile phone to send short e-mails to his colleagues. He spends most of his time in the all-in-one computer for his work and entertainment. He makes short comments when he read news on websites.

Persona 3: ZHANG Hua is now a senior college student who major in software engineering. Hua is the son of Yu and Ming. He almost has his smartphone with him no matter where he is. His social life is through his mobile phone. He comments on the photos and status of his friends. He uses mobile search engineering to look up interesting things. He also likes pop songs and he always has a long song list on his music applications and he likes to make personal tags to these songs. Labels he used is “Shower song” (i.e. 洗澡歌), “to my girlfriend” (i.e. 女友爱听), “study times”(i.e. 学习时间), “keep silent for moment”(i.e. 冷静一下), “think alone” (i.e. 独自思考). He often uses his mobile phone with his right hand.

Three touch devices are used in this study, which are a 4.7-in. mobile phone, a 9.7-in. tablet personal computer and a 21.5-in. all-in-one computer with touch screen (Fig. 1).

Fig. 1. Three touch devices in this study

A focus group including four experts and three real users is established to discuss the usability problems in hand input systems of three touch devices. Two experts are professors in the college school who study human-computer interaction. One expert is a professor who studies human behavior modeling. One expert is a software engineer. Table 2 shows the decryptions of participants in the focus group.

Table 2. Participants in the focus group

Participants	Age	Education level	Job	Touch devices experience
1	30	Ph.D	Professor	8 years
2	34	Ph.D	Professor	10 years
3	32	Ph.D	Professor	8 years
4	40	M.D	Engineer	11 years
5	50	Middle school	Worker	3 years
6	54	Middle school	Housewife	6 years
7	25	College	Student	9 years

3 Results and discussion

Based on the persona and their stories the focus group creates three typical scenarios for Chinese hand input on the touch devices.

- Sending text message via mobile phone or mobile chatting applications.
- Searching keywords in online applications, including search engine, musical application, video websites via the touch devices.
- Short comments on the news, friends' status, and photos.

Figure 2 shows the hand input process for Chinese character in three scenarios. This process is iterative, when user find all of the recognized characters are not their target character they would choose to rewrite the character. And user touches the functional

button on Chinese hand input system to switch to another input system such as symbol input system, number input system, and alphabetic input system. These actions assist the user to combine hand input with another input method.

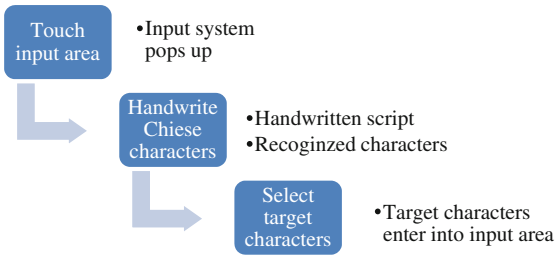

Fig. 2. Hand input process for Chinese character

The typical interface of Chinese hand input system on the touch devices includes the input area, recognized character area and functional area. The recognition algorithm and dataset are also essential to Chinese hand input. In the physical level, the texture of the touch screen and reactions time of touch action is also important to the Chinese hand input users. Table 3 shows the list of usability considerations of Chinese hand input system based on the results of focus group. The results are useful to improve the usability of current Chinese hand input system and make the system user-friendlier.

Table 3. The list of usability considerations of Chinese hand input system

Type	Considerations
Interface	• Input box: shape, size, location, background color/photo, script weight, script color, feedback • Recognized area: size and location of shown character, number of shown characters, words, sentence, character mixed with alphabetical letters, numbers, symbols, Chinese sentence • Functional area: delete, confirm, input system swift, send, ignore
System	• Recognition algorithm: reaction time, minimum strokes • Dataset: character, words, sentence • Physical realization: touch technology, screen texture, response time

Input Area. The design of input area is the most important interface design. Beside the general interface design considerations such as color, color, shape, value, direction, there are some design considerations for the Chinese handwriting. First, the size of input box is the critical factor for the effective handwriting area. The size of input box should be suitable to users' finger size no matter which finger user use to handwrite Chinese characters. And meanwhile the input box should be large enough so that users can see clearly of the handwritten scripts in the process of handwriting. The size of input box also has a connection to the size of handwritten scripts. Although handwritten script is individually different, the input box size limits the handwriting area and consequently

influences the input performance such as input time. The national and international standards have demonstrated the finger size for Chinese (CNIS 1988; 1996). But updated and detailed dimensions of finger size for Chinese are still working in progress currently. Previous studies have indicated the optimal size of input box on hand-held devices should be 30 mm × 30 mm (Chen and et al. 2013; 2014). However, it is not clear that the optimal input size for Chinese handwriting on small display size such as smart watch or large display size such as Kiosk.

The location of input box is the key issue that probably has a significant influence on the handwriting performance and users' subjective ratings. The location of input box reflects to the distance between the relaxing position to the handwriting position. The distance will reflect to the input time in handwriting. And it should be taken into consideration that the necessary information can display on the screen while handwriting. For example, user may check the name and phone number of the contact person when handwriting the text message to them. Inappropriate location design for input box may lead to blocking the sight for display. Thus design consideration on location of input box is important to balance display and input. And the dominant hand may be another factor related to the location of input box. Location design for the right-handed users may not suitable for the left-handed users.

It is probably better if the background of input box has similarity to the paper in paper and pen-based handwriting task. Chinese users learn and train their handwriting skills in the paper using pen. The familiarity of the system will increase if the design of the background of input box is close to the paper, for example, imitating the texture and color of paper for the background of input box. It is shown that "米" style or "Nine block box" is the assistive way that young Chinese learn handwriting Chinese characters (Chen and et al. 2014), as shown in Figure 4. Thus it is better to consider to add this photo to the background of the input box so that the handwriting on touch devices are consistent with users' mental model and expectations.

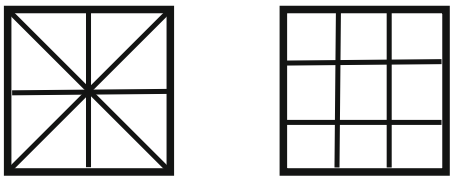

Fig. 4. Background design in paper-pen based Chinese handwriting

Script weight is another issue should be specially considered in the input area. If the script weight is too low it will not match the users' mental model as user expect the script weight should be consistent with the tip of handwriting finger. This expectation results from users' experiment in paper and pen based handwriting experience as the script weight is connected to the thickness of the tip of pen. The script weight should not be too high because it is hard to distinguish each stroke especially when in some cases Chinese characters with dozens of strokes are used in handwriting task.

Recognized Area. Like the input box, the size and location of shown characters, the script weight should be taken into considerations when designing a user-friendly Chinese handwriting system. These design factors have direct connections to the handwriting performance. Since the main task in the recognized area is to select the target character, there are some special design considerations for the recognized area, such as the style of shown characters, number of shown characters, words and sentence, characters mixed with alphabetical letters, numbers, symbols, Chinese sentences. Taking the number of shown characters for example, how many of recognized characters should be shown in the recognized area is one of the key factors. In an idea situation, the recognition system and recognition algorithm will correctly understand users' intention and there is no need to shown any recognized character to let user select the target character. However, due to the handwriting style and connecting strokes and other reasons, it seems impossible to skip the selecting step with the current recognition system. The more shown characters there are, users have more choice to select but will spend more time on visual search and finger movements. Thus the number of shown characters depends on many other factors such as handwriting scenarios, display size.

Functional Area. There is a functional area in the Chinese handwriting interface which leave the space for the button of delete, confirm, input system swift, send, ignore and etc. The key to design functional area is to find users' specific handwriting requirement and design for it. For example, when user are exploring the Internet and searching the keywords with the Chinese handwriting system. The keep a button named "search" is appropriate.

Recognition Algorithm. Recognition algorithm is critical to the input accuracy and input time and directly influence users' subjective rating on the whole Chinese handwriting system. Using an adequate and fast algorithm may reduce the reaction time and even minimize the strokes user need to handwrite. It is essential that one of the most important reasons influencing users' satisfaction on Chinese handwriting is that some Chinese characters have so many strokes to handwrite.

Dataset. Chinese semantic meaning needs consideration in the design. Chinese is composed of character, words and sentence. It will help to save the input time when the handwriting system can suggest the word or sentence based on uses' writing history or usage history.

Physical Realization. It is also important to consider the physical features of the touch devices such as touch technology, screen texture, system response time.

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