

Donuts: A Chinese Input Technique Using Pressure-Sensitive Marking Menus

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ABSTRACT

Handwriting recognition is often considered as an ideal solution for pen-based Chinese input. However, handwriting Chinese suffers from a performance bottleneck due to the complex structure of Chinese characters. We designed Donuts, a technique that allows a user to enter Chinese characters by navigating through a hierarchical marking menu of phonetic symbols. In particular, to place 12 vowels into a marking menu while keeping the performance, we designed a pressure-sensitive marking menu to organize the 12 vowels into two pressure-sensitive layers. Informal user testing on Donuts has shown positive feedback.

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Keywords: pen-based interfaces, marking menu, stylus keyboard, virtual keyboard, pen pressure, Chinese input.

INTRODUCTION

There are two major approaches for pen-based text input: handwriting recognition and stylus keyboards. For Chinese input, the majority of work has been done in the domain of handwriting recognition. Handwriting Chinese suffers from the performance bottleneck due to the complex structure of Chinese characters. The average stroke count for the most frequently used 3000 Chinese characters is 9.10 [5]. On the other hand, regular stylus keyboard approaches allow users to tap on a keyboard with phonetic or stroke structure symbols, using a finger or stylus. Although they need only 2-5 key strikes to input a character, tapping on a stylus keyboard requires intensive wrist lifting and arm movement [6].

Several pen-based text input techniques have been designed for English (e.g., *Cirrin* [2], *Quikwriting* [3], *SHARK* [6]) based on stylus keyboards. They allow users to input English characters with continuous pen movement. However, as they were mainly designed for English, they all use single-level layout and marking technique for selection. Chinese phonetic symbols carry a hierarchical nature, making it possible to use a multi-level layout to reduce pen travel distance and ease the cognitive effort for item searching.

Based on the attributes of Chinese, we designed Donuts, a technique that allows a user to enter Chinese characters by navigating through a hierarchical marking menu of phonetic

symbols. In particular, we designed a pressure-sensitive marking menu to organize the 12 vowels into two pressure-sensitive layers. Donuts reduces the input stroke count to a maximum of 3, without increasing ambiguity comparing to regular stylus keyboard approaches.

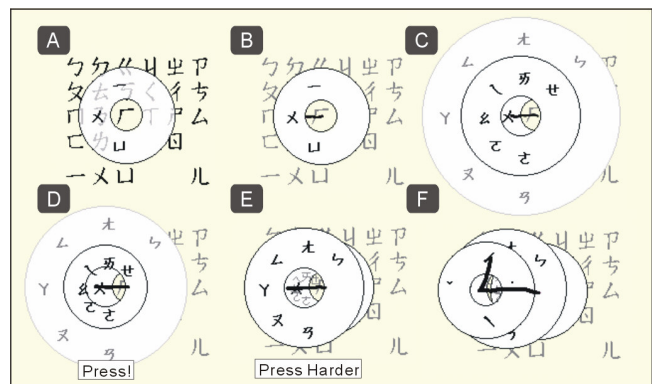


Figure 1: An example of entering a Chinese character using Donuts.

ATTRIBUTES OF CHINESE INPUT

Several input methods are available for typing Chinese characters from combinations of symbols based on either stroke structures or pronunciation. Donuts uses a phonetic-based input method called Bopomofo (Zhuyin), which is the most common input method used for Traditional Chinese characters. All Chinese characters are pronounced with one syllable, with five different tones for each syllable (for Mandarin Chinese). Therefore, it takes one consonant, one medial (sub-consonant), one vowel, and one tone selection to input one Chinese character using the phonetic method.

DESIGN OF DONUTS

Donuts consists of one consonant stylus keyboard and a three-level hierarchical marking menu (see Figure 1). All phonetic symbols are placed in alphabetical order.

It is the sequential nature of Chinese phonetic symbols that makes a hierarchical selection suitable for Chinese character input. We always select an item from the consonant set, then the medial set, followed by the vowel set and finally, the tone set. The phonetic symbols are nicely divided into four exclusive sets for sequential selection.

There are 21 possible consonants as initials and they are presented on the stylus keyboard. The size of the consonant

stylus keyboard is substantially smaller than a regular Bopomofo stylus keyboard, which requires 41 items.

Notice that some characters' pronunciations do not include a consonant and/or medial. Therefore null selection is needed. Null selection items are placed on the right side of the menu, which is an area that's often blocked by a right-handed user's hand.

The hierarchical marking menu in our design is slightly different from the traditional ones. The menu we use looks like a radial menu with a hollow center. The hollow center is used to "point and select" a consonant from the consonant stylus keyboard (Figure 1a). The edge of the hollow center is also a visual aid that indicates the marking threshold which confirms a selection.

The first level of the menu contains the 3 possible medials; the second level contains the 12 possible vowels; and the third level contains the 5 possible tones. It has been shown that a regular marking menu is not practical for over 8 items due to a high error rate [1]. To accommodate 12 vowels while keeping the performance for selection, we designed a pressure-sensitive marking menu to place the 12 vowels into two concentric circles, each of which contains 6 vowels and indexed by a pressure spectrum. This design was inspired by a pressure widget of "Bullseye" designed by Ramos et al. [4]. We combine the input of two dimensions, i.e., pressure and spatial movement, for the efficient selection among 12 items.

Our pressure-sensitive marking menu uses dual thresholds to provide intuitive and stable visual feedback. It starts in the "relaxing" state, where the inner items are focused (Figure 1c). When the pressure exceeds the lower threshold, the menu gives continuous transitional visual feedback (Figure 1d) based on changing pressure values. As the pressure passes the upper threshold, it enters the "condensing" state with the six inner items "snapping" into the center. In the condensing state, the outer items are focused. The snapping effect gives a salient signal to inform a state change (Figure 1e). The user can only get back to the "relaxing" state by dropping the pressure below the lower threshold. The menu will "jump" back to its initial look (Figure 1c) without any transitional feedback.

DISCUSSION AND FUTURE WORK

Not all possible combinations of phonetic symbols actually occur which might enable us further optimize the design of Donuts. However, a dynamically changing spatial arrangement can make learning much more difficult which might overrule the benefit by reducing the number of items in the marking menu. A static layout will enable users to memorize relative positions as well as force for selection. This will eventually enable them navigate through the hierarchical menus without visual effort and thus enable gesture-based expert behavior [1, 6]. We keep working on Donuts so that expert users can use gestures to input Chinese without bringing up marking menus.

On average, it takes 3 segments of zigzag to input one Chinese character using Donuts. Each segment will be of con-

stant length because of the nature of radial menus. Such locality is a great advantage of Donuts over other stylus keyboarding techniques.

Besides moving the stylus, a user has to be able to differentiate the two different levels of pressure. Additional cognitive effort is needed to look up the initial consonant from a table of 21 consonants and also in between each stage when a new menu pops up. Since the layout of the input method is static, the amount of time it takes for such cognitive tasks should decrease over time as the user become familiar with the layout of menus.

Phonetic overloads are normal among Chinese characters. Lots of research and design has been done on disambiguation which is beyond the scope of this short paper. Instead, we will focus on entering the initial phonetic symbols in this paper.

We have let 8 people tried out Donuts. Informal user testing on Donuts has shown positive feedback. We intend to conduct formal evaluations on the performance of this technique by comparing it to other methods based on stylus keyboards and those based on handwriting recognition. In particular, we would like to evaluate the performance on concurrent controlling of pressure and movement. This will help us revise our current design. The results can also inform the design of general pressure-sensitive marking menus.

IMPLEMENTATION

We implemented Donuts in C# on a Toshiba Portege Tablet PC, which supports hovering and 256 levels of pressure. The lower pressure threshold we used was 170 and the upper threshold was 200. In addition, we used the Real-TimeStylus interface from Microsoft Tablet PC SDK v1.7.

CONCLUSION

We designed Donuts, a new approach for pen-based Chinese text input using a pressure-sensitive hierarchical marking menu. It reduces the input stroke count for Chinese to a maximum of 3 using phonetic input methods, and the length of each stroke is kept constant by utilizing a radial layout. Informal user testing on Donuts has shown positive feedback.

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