

Using a Geometric-Based Sketch Recognition Approach to Sketch Chinese Radicals

Paul Tael, Tracy Hammond

Sketch Recognition Laboratory, Department of Computer Science, Texas A&M University
 Mail Stop 3112, College Station, TX 77839
 ptaele@cs.tamu.edu, hammond@cs.tamu.edu; (979) 862-4284

Abstract

Unlike English, where unfamiliar words can be queried for its meaning by typing out its letters, the analogous operation in Chinese is far from trivial due to the nature of its written language. One approach for querying Chinese characters involve referencing their dictionary component called radicals. This is advantageous since users would not need to know their pronunciation nor their stroke-order, a requirement in other querying approaches. Currently though, sketching a character’s radical for querying is an unsupported capability in existing systems. Using the geometric-based LADDER sketching language combined with the Sezgin low-level recognizer, we were able to construct an application which can first recognize handwritten sketches of Chinese radical, and then output candidate Chinese characters which contain that radical. Thus, we were able to demonstrate that a geometric-based sketch recognition approach can be used to easily build applications for recognizing symbols related to Chinese characters while having reasonable recognition rates. Unlike current image-based recognition systems, our system also maintains stroke order information of characters. Since stroke order is important in written Chinese, our system can be easily expanded for use in Chinese language education by providing visual feedback to students on correct stroke order.

Introduction

As pen-based devices grow in popularity, the field of sketch recognition aims to harness the capabilities of such input by combining the naturalness of pen writing and the power of computing. One direction involves a geometric approach, where strokes drawn during pen-based output can be converted into geometric objects for later interpretation [1][3]. The geometric approach can be especially useful for domains in which symbols can be described geometrically, such as Chinese symbols. One such subset of these symbols are called radicals, an identifying component within characters analogous to letters in English words. Although current systems are capable of recognizing radicals, none use stroke-based techniques to recognize them for querying Chinese characters. Instead, current querying methods are restricted to either selecting candidate characters based on an entire character sketch, manually locating the desired radical from a list, or inputting them with knowledge of its phonetic representation. In our paper, we address the above issue directly by using the geometric-based sketching language LADDER [1] combined with the Sezgin low-level recognizer [3]. Combining these two tools, we developed a reasonably accurate and easily implementable application for recognizing a subset of written Chinese for querying purposes.

Approach

Although there is no one dominant approach to reference unknown Chinese characters, computer applications in the form

of Input Method Editors (IMEs) provide mechanisms that strive to ease this querying. One way to enter Chinese characters into a computer is by inputting its associated radical, which is a component within a character. Figure 1 illustrates a few common Chinese characters for two radicals.

Radical	Characters	Radical	Characters
口	喝, 嗎, 台	言	話, 語, 談

Figure 1. Two radicals and example corresponding characters.

If a user does not know the pronunciation or stroke order of a particularly unfamiliar Chinese character, searching for that character by its radical is a viable alternative to sketching the entire character. Currently though, radical querying is limited to manually sifting through lists of radicals by its stroke order using a dictionary or an IME. We discuss how we used the LADDER sketching language to create an application capable of satisfactorily recognizing handwritten Chinese radicals.

Related Work

Research on handwritten recognition of Chinese characters in general is actively being pursued by several groups using various image-based techniques. In addition to work by those groups, contributions by several other groups narrow their focus on handwritten recognition to Chinese radicals. Proposed alternative approaches to the geometric-based sketch recognition method used in our paper to specifically handle Chinese radical recognition include image processing and genetic algorithms by Shi et al [4][5] and neural networks by Kuo et al [2]. Although these approaches generate exceptionally high results of 95% and above for radical recognition, several draw-backs exist that severely hinder people from making use of these approaches: the need for thousands of sample data to train on, the inability to modify systems due to their proprietary nature or insufficient online availability, the requirement of knowing advanced machine learning techniques, and so on. Also, since these image-based techniques are not capable of retaining useful stroke order information for use in domains which may benefit from it, such as Chinese language learning.

We demonstrate that a geometric-based sketch recognition approach can be used to easily build an application which can provide the functionality of sketching Chinese radicals to query its corresponding characters. Furthermore, we show that it can be done while working with only a few tools, requiring no training on the system, and having reasonable recognition rates. Additionally, while our system recognizes characters drawn in any stroke order, stroke-order information is still available and useful in a character-drawing instruction program.

Implementation

Since we envisioned easily implementing a system to do radical recognition for querying characters using geometric-based sketch recognition, we made use of a sketch recognition language that relied on a geometric-based recognizer. We chose to use the LADDER sketching language [1] and the Sezgin low-level recognizer [3] to perform our desired task. With a sketching language like LADDER, our approach avoids having to explicitly rely on numerous training examples, since the radicals are constrained geometrically in the language and processed with available recognizers such as Sezgin.

An example of our structured symbol construction technique can be found for radical 木 in Figure 2, composed of four line primitives. We enumerate these lines in the order of how they are typically drawn. From Figure 2, we demonstrate our formatting style for shape descriptions by dividing the constraints into three parts. The orientation and relation position sections represent the initialization of the lines in LADDER relative to each other. The actual construction of the shape descriptions takes place in the symbol construction section.

Radical: 木		
Orientation:		Relative Position:
<i>horizontal</i>	<i>line1</i>	<i>leftOf line1.p1 line1.p2</i>
<i>vertical</i>	<i>line2</i>	<i>above line2.p1 line2.p2</i>
<i>posSlope</i>	<i>line3</i>	<i>above line3.p1 line3.p2</i>
<i>negSlope</i>	<i>line4</i>	<i>above line4.p1 line4.p2</i>
Symbol Construction:		
<i>intersects</i>	<i>line1</i>	<i>line2</i>
<i>below</i>	<i>line1.center</i>	<i>line2.p1</i>
<i>above</i>	<i>line1.center</i>	<i>line2.center</i>
<i>leftOf</i>	<i>line2.center</i>	<i>line1.p2</i>
<i>rightOf</i>	<i>line2.center</i>	<i>line1.p1</i>
<i>sameY</i>	<i>line3.p1</i>	<i>line1.center</i>
<i>sameY</i>	<i>line4.p1</i>	<i>line1.center</i>
<i>sameX</i>	<i>line3.p1</i>	<i>line2.center</i>
<i>sameX</i>	<i>line4.p1</i>	<i>line2.center</i>
<i>below</i>	<i>line3.p2</i>	<i>line2.center</i>
<i>below</i>	<i>line4.p2</i>	<i>line2.center</i>
<i>not below</i>	<i>line3.p2</i>	<i>line2.p2</i>
<i>not below</i>	<i>line4.p2</i>	<i>line2.p2</i>

Figure 2. Shape description for radical 木.

Results

We conducted a user study with ten university students of varying written language skills and input methods to gauge the recognition rates of our application for radical querying. The user study had them sketch a subset of radicals two times each. Recognition rates for each radical used in the study can be found in Figure 3. When we calculated the recognition rates of all the users combined, our application achieved satisfactory recognition rates above 70%.

Discussion and Future Work

As we noted earlier in this paper, competing methods which provide radical recognition functionality achieved excellent recognition rates of 95% and higher, in contrast to our application achieving recognition rates above 70%. On the other hand these methods train on immense datasets, whereas we constructed and tested our application in a short time period of a couple weeks while working on a much smaller set of data. Given additional time to further refine our symbol construction

technique, we would have achieved even higher radical recognition rates by further analyzing which geometric properties gathered from our system can be exploited as possible features for aiding recognition.

Radical	%	Radical	%	Radical	%
人	80	女	70	目	70
儿	30	子	60	木	100
冂	80	小	70	气	70
刀	40	玄	80	父	80
又	90	弋	60	生	90
口	90	彳	70	竹	40
夕	100	心	60	言	80
大	60	田	60		

Figure 3. Recognition rates for radicals.

We wish to carry our approach for another application geared towards students of languages which use Chinese characters, providing feedback for free-form drawing of characters as to whether they were drawn in the correct stroke order or not. Our method is especially advantageous considering that existing systems like IMEs for Chinese characters disregard stroke order.

Conclusion

Using the LADDER sketching language and the Sezgin low-level recognizer, we were able to develop an application capable of reasonable recognition rates of Chinese radicals capable of querying Chinese characters. In the process, we were able to develop this application with few resources, a small time frame, no training, and without requiring additional knowledge in machine learning techniques for implementation. Additionally, our system recognizes Chinese radicals drawn in any stroke order, while simultaneously capturing stroke order which can be used in a Chinese radical instructional program.

Demonstration video of our program can be found below:

<http://srl.csdl.tamu.edu/radical.shtml>

Acknowledgements

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References

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