

Research Article

Dynamic Generation and Editing System for Wrongly Written Chinese Characters Font

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The uniqueness of Chinese makes Chinese language a hotspot in language learning. In view of the problem of wrongly written character teaching in Chinese language teaching, it provides a simple, convenient, and efficient input method of wrongly written characters and realizes a dynamic generation and editing system for wrongly written Chinese character font, which solves the problems of real-time edit, coding, and input of wrongly written character in editing process using dynamic editing technology, and provides a convenient input method of wrongly written character in editing, printing, typesetting, and the research of digital Chinese language teaching. This method can also be used in dynamic editing, generation and processing of ancient variants, Oracle bone inscriptions, Bronze inscription, folk combined characters, and other fonts.

1. Introduction

With the increase of economic strength, economic and cultural exchanges between China and the world grow increasingly, and the world pays more and more attention to Chinese, with the phenomenon of “Chinese fever” frequently heating up. Chinese attracts worldwide attention with its unique charm and it is precisely the unique characteristics of Chinese that make Chinese learning more difficult. In the last analysis, this certain difficulty is determined by the complex structure of Chinese, among which Chinese characters writing is the most difficult to learn. It is easy for beginners to write wrong words, and the writing errors with different Chinese learners have different rules, thus causing a certain degree of difficulty in Chinese characters teaching. The status of the teaching difficult in Chinese characters has restricted the development of the domestic Chinese language teaching and teaching Chinese as a foreign language (TCFL). Although the writing mistakes for Chinese characters can hardly be avoided, but there are no large-scale error statistical analysis results for wrongly written characters which can provide guidance and reference for Chinese characters teaching. On the one hand, there are many difficulties in computer processing of wrongly

written characters (e.g., editing, coding, input and output, printing and typesetting of wrongly written characters, etc). On the other hand, it currently lacks coding scheme of wrongly written characters in line with international standards and simple and effective input method of wrongly written characters in the field. Thus it makes difficulties for computer processing of wrongly written characters.

Therefore, it is very necessary for researching and designing a simple and effective generating and processing scheme for wrongly written Chinese characters.

2. Application Requirement and Present Situation of Generating System for Wrongly Written Chinese Characters

2.1. Chinese Characters Represented in the Computer. To use Chinese characters in the computer system, the first problem to be solved is how to input Chinese characters into a computer. The prerequisite of processing the information of Chinese characters into the computer is to encode each Chinese character, and these codes are collectively referred to as Chinese characters code. But the characteristics of

various words and complex shape of Chinese characters make Chinese characters have a different encoding rule compared to ASCII code. Therefore, our country introduced a unified coding standard specially used for Chinese characters information exchange between computer systems: “character set for information interchange of Chinese characters encoding;” that is, Chinese characters GB code, also called “interchange code,” and all Chinese characters codes should follow the standard.

Chinese characters machine code, also known as the “Chinese characters ASCII code” or the “code” for short, refers to the code composed of 0 and 1 in binary notation for computer internal storage, processing and transmitting Chinese characters, and also it is formed by the highest GB code byte after treatment.

A set of computer keyboard symbols designed for the convenience of Chinese characters input is called “Chinese characters outer code,” also called “input code”. The external code commonly used includes phonetic code (such as spelling), font code (such as five strokes), water code (such as location code), and sound form code (such as smart ABC). The input code in the computer must be converted into machine code and then can be carried on storage and processing [1].

In order to output Chinese characters glyph using the computer, it usually needs to store the related information of Chinese characters font in the computer; thus the font has been formed. Digital information of Chinese characters glyph stored in the font is called Chinese characters font code, a font code of one Chinese word corresponding to a unique machine code. There are a variety of classification for fonts; based on the different coding standard it can be divided into GB2312-80 font, GBK font, GB18030 font, and so forth; in terms of language it can be divided into Chinese font, foreign language font, graphic symbols, and so forth; according to the format it can be divided into TrueType font, PostScript font and OpenType font, and so forth.

2.2. Existing Problem and Demand in Generation of Wrongly Written Chinese Characters. It is a very common thing for Chinese characters input, typesetting, and printing using computer currently in the field of office automation and printing. Therefore, the computer font must be used in the treatment of Chinese characters. However, if the Chinese characters which are not existing in the computer fonts are to be input and printed, it will be a long haul. There are two commonly used methods: one is making Chinese characters which are not in the computer fonts with character-creation program; the other is using images to substitute the Chinese characters temporarily. As the wrongly written characters are not in the fonts, a few wrongly written characters can be generated using the above methods. But with more and more people learning Chinese characters and the exponentially growing phenomenon of types and number of writing errors, it could not meet the need of digital Chinese language teaching by making Chinese characters with character-creation program and editing wrongly written characters images.

Many scholars began to research in words editing and recognition and have made some achievements, typically such as the “wrongly written Chinese characters processing solution based on Unicode” [2, 3] written by teacher Li and Lin at the Inner Mongolia Normal University, which expressed the wrongly written character code with an orthography as the center and the orthography plus variant selector based on IVS (ideographic variant sequences) standard from Unicode 5.1 and applied OpenType font technology for input and output.

The word processing method above stores the wrongly written characters using idle area in standard font or infrequently used Chinese characters code region on the basis of the original font, whose biggest deficiency is the occupation of valuable coding space of Chinese characters. And with the expansion of the scale of wrongly written characters, these reserved intervals will soon be exhausted. For example, customized Chinese GBK code are [AAA1-AFFE], [F8A1-FEFE], and [A140-A7A0], just three sections, sum of 1894; customized Unicode code is [E000-F8FF], total of 6400 [1], that is only for 6400 even though each Chinese character takes one wrong word. But the reality is that one Chinese character has far more than one wrong word. So the existing words input and processing method has many defects in the processing of large quantities of wrongly written characters. In addition modern Chinese characters font library is based on the font file as a unit, each font file contains a kind of Chinese characters with different encoding, and each Chinese character is described by glyph outline which makes the description of wrongly written characters more troubling because of the wide varieties of wrongly written Chinese characters decided by its generation. Outline font can ensure the output font quality but is not conducive to the edit and dynamically generation of wrong words font [4–6]. So it will become more and more troubling using glyph outline for character description.

Therefore, it needs to find an input and editing method for wrongly written Chinese characters based on font description [7–9], so as to open the edit number of wrong words, facilitate user input, better serve the publishing and printing of wrongly written Chinese characters, and provide digital typo editing and printing environment for Chinese teaching especially teaching Chinese as a foreign language in particular.

3. Dynamic Description Library for Wrongly Written Characters Font

According to the requirement above, we propose a method based on font coding of wrongly written Characters, which establishes a dynamic description library for wrongly written characters font (shorted for DDL in the following), makes a dynamic vector description of wrongly written characters font using stroke segment and stroke unit [10, 11], then finds the feature points in the glyph skeleton, carries on the quantification and storage through the feature points, and ultimately realizes font coding of wrongly written Characters. The application of DDL solves the difficulty of font dynamic

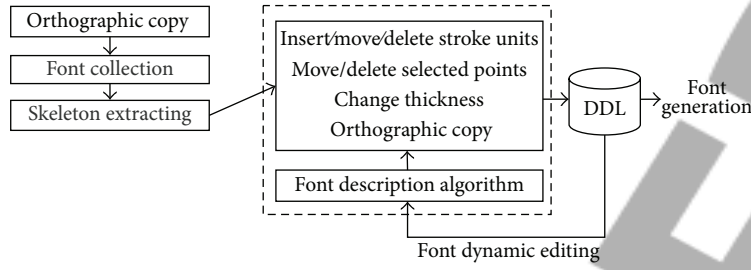


FIGURE 1: Creation process of DDL.

editing and font transformation caused by using glyph outline description of wrongly written Chinese characters and solves the problem of difficult editing and difficult writing in wrongly written Chinese characters teaching.

3.1. Description of Wrongly Written Characters Font. According to the writing method of modern Chinese characters, we introduce the concepts of directed stroke segment and directed stroke unit to describe glyph skeleton of wrongly written Characters in DDL. The directed stroke segment is a directed line, which can recognize stroke starting, stroke wielding, and stroke collection in the process of font generation of wrongly written Characters. The coordinates of start point and ending point of each segment are represented as “shi” point and “zhu” point. Let (X_i, Y_i) be “shi” point and let (X_j, Y_j) be “zhu” point, so the one-dimensional vector of the directed segment S_{ij} is

$$S_{ij} = (X_i, Y_i, X_j, Y_j). \quad (1)$$

The stroke unit is a complete stroke structure composed of one or more directed segments, supposing one stroke unit consists of n segments, so this stroke unit can be described as a vector of E_n , $E_n = (S_{i_1j_1}, S_{i_2j_2}, \dots, S_{i_nj_n})$. For any $k \in \{1, 2, \dots, n\}$ and $S_{i_kj_k}$ which is shorted for S_k , the stroke unit above can be recorded as below for short:

$$E_n = (S_1, S_2, \dots, S_n). \quad (2)$$

In addition, the “shi” point of the first segment S_1 is called the starting point of E_n , and the “zhu” point of the last segment S_n is called the ending point of E_n .

3.2. Definition of Stroke Unit. In the font description library, “boundary point” is used to segment each stroke unit. Each stroke unit has the starting point and the ending point. In order to make the starting point and the ending point of different strokes not confused, defined symbols are added before the starting point of each stroke unit so as to define stroke unit, and the defined symbols are called boundary point. Suppose the boundary point is $D = (D_1, D_2)$; then the description vector of E_n is

$$E_n = (D_1, D_2, S_1, S_2, \dots, S_n). \quad (3)$$

3.3. Coding Description of Wrongly Written Characters. A wrongly written Chinese character is a collection of its

stroke units. For the convenience of computer recognition, this collection is represented as the arrangement of stroke units, according to Chinese characters written order. Suppose one Chinese character consists of “ m ” stroke units: $E_{n_1}, E_{n_2}, \dots, E_{n_m}$; thus the description vector of this wrongly written character is

$$ZX = (E_{n_1}, E_{n_2}, \dots, E_{n_m}). \quad (4)$$

The description vector of all wrongly written characters is processed into codes in the description library which are stored in a text file, and in order to define different wrongly written character codes defined symbols “ $H = (H_1, H_2)$ ” and “ $T = (T_1, T_2)$ ” are added before the first stroke unit and after the last stroke unit; thus the description vector of this wrongly written character is

$$ZX = (H_1, H_2, E_{n_1}, E_{n_2}, \dots, E_{n_m}, T_1, T_2). \quad (5)$$

3.4. Dynamic Description Algorithm. The main function of dynamic description algorithm is to regulate and store stroke units information after drawing and adjustment. The steps of the algorithm are as follows.

Step 1. Open font description library and initialize variables, including the initialization operation of boundary point D , starting point H , ending point T , the number of stroke units ele_num , and font description library $ZXDATA(i)$.

Step 2. Select the type of operation. If the operation is “Ins,” then insert the stroke unit; if the operation is “Mov,” then move the stroke unit; if the operation is “Del,” then delete the stroke unit; if the operation is “MovDot,” then move the selected point (“shi” point or “zhu” point); if the operation is “Change,” then change the thickness of the stroke unit; if the operation is “Copy,” then do transparent copy; if the operation is “NoOper,” then turn to Step 3.

Step 3. Save the operation and close the font description library.

Inserting stroke units can be achieved through inserting each stroke segment of the stroke unit one by one, and moving the whole stroke unit can be achieved through modifying each point of the stroke unit (except boundary points). In conclusion, the creation process of DDL is shown in Figure 1.

It can be seen from Figure 1 that the wrongly written characters are dynamically edited from the standard characters

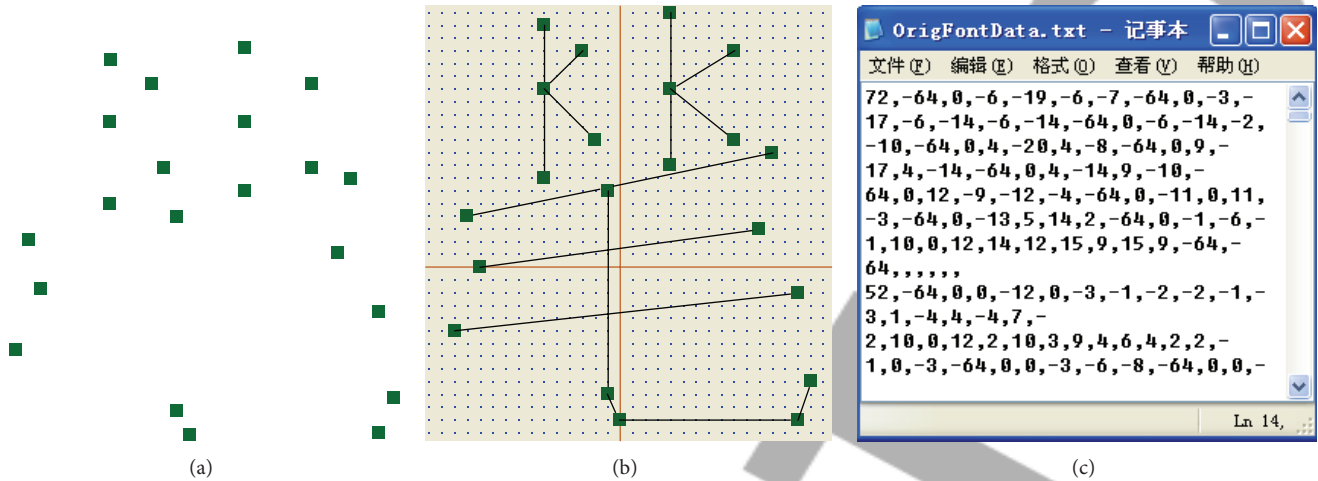


FIGURE 2: Diagram of connection of feature points of the wrongly written character font of “pen.”

(i.e., orthography), so we establish the connection between the two fonts through the list; the list node structure is as shown in (6), in which identifier domain “Tag” values 0 or 1 (“0” means standard characters, and “1” means wrongly written characters), chain domain “Link” stores a pointer to the next node in the same list, and coding domain “Code” stores the codes of that Chinese characters. Structure of list node is as follows:

$$[\text{Tag} \quad \text{Code} \quad \text{Link}] \quad (6)$$

When editing the wrong word, first enter the correct word in word document and then depict the skeleton of the orthographic (i.e., stroke units) using “transparent copy” in software. The system will record information of the feature points and store the orthographic codes in the head node of the list, then edit the wrong word using operations (such as moving the stroke unit) provided by the software based on orthographic font, and last save the operations; thus the wrong word codes will be stored in the node and inserted into the corresponding list and so on. While editing a new word, it can be stored in another list. Moreover all head nodes of the lists will be established “orthographic index” in order to facilitate retrieval. When exiting the system, the system will automatically update all the font codes and generate the recent text file to ensure the smooth implementation of the initialization when opening the description library next time.

3.5. Extraction and Encoding of the Feature Points. According to the above description of dynamic description library, the extraction of feature points relates to the extraction of stroke segments and stroke units of wrong written characters font. The extraction algorithm of stroke units in the font can be achieved through searching boundary points, and the extraction algorithm of stroke segments can be achieved through analyzing “shi” points and “zhu” points of stroke units. So the extraction algorithm of feature points is implemented as follows.

Step 1. Open font description library and initialize variables as follows.

Open ZXscript.

Int by_num ← 0, bd_num ← 0.

Point $D \leftarrow (m, 0), H \leftarrow (m, 0), T \leftarrow (m, m)$.

ZXDATA(i) ← {m, 0, m, m}.

Step 2. Compare the types of feature points. If the type is “boundary point,” turn to Step 2.1; if it is “shi” point, turn to Step 2.2; if it is “shu” point, turn to Step 2.3; else turn to Step 2.4.

Step 2.1. Add 1 to the number of stroke units, that is, by_num = by_num + 1.

Step 2.2. Add 1 to the number of stroke segments, that is, bd_num = bd_num + 1.

Step 2.3. Save the coordinate of feature points.

Step 2.4. The extraction of the first feature point is over. Turn to Step 2 to continue to extract the next word.

Step 3. Save and close font description library.

If the description vector in font description library is $ZX = (H_1, H_2, E_{n_1}, E_{n_2}, \dots, E_{n_m}, T_1, T_2)$, the wrongly written characters font codes of feature points through extraction algorithm of feature points are $E_n = (\text{by_num}, \text{bd_num}, S_1, S_2, \dots, S_n)$.

For example, the feature points of the wrongly written character “pen” through extraction algorithm of feature points are shown in Figure 2 (as shown in Figure 2(a)); word recognition program gets the font of “pen” by connection according to these feature points codes (as shown in Figure 2(b)). So any wrongly written characters font can be dynamically presented in this system.

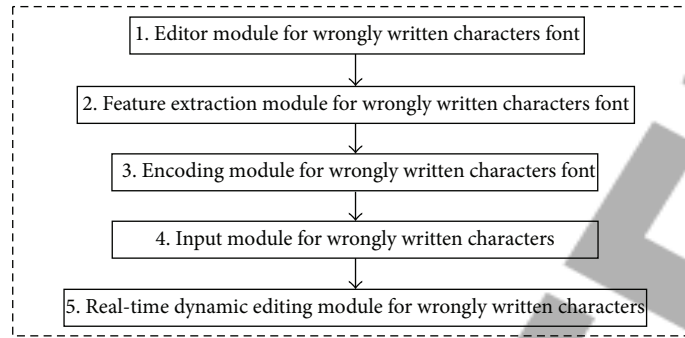


FIGURE 3: Module diagram of input system of wrongly written characters and its realization.

The extraction of the characteristics of wrongly written characters font has provided the possibility for the coding of wrongly written characters font. For example, the font corresponding to the wrongly written character “pen” consists of 10 stroke units, 13 segments, and 21 feature points, and the codes of the feature points are “72, -64, 0, -6, -19, -6, -7, -64, 0, -3, -17, -6, -14, -6, -14, -64, 0, -6, -14, -2, -10, -64, 0, 4, -20, 4, -8, -64, 0, 9, -17, 4, -14, -64, 0, 4, -14, 9, -10, -64, 0, 12, -9, -12, -4, -64, 0, -11, 0, 11, -3, -64, 0, -13, 5, 14, 2, -64, 0, -1, -6, -1, 10, 0, 12, 14, 12, 15, 9, 15, 9, -64, -64,,,,,” (as shown in Figure 2(c)).

4. Dynamic Generation and Editing System for Wrongly Written Characters

Combining the above algorithm, this paper creates an input system of wrongly written characters for real-time dynamic editing by making a font library for wrongly written characters. The system includes the following: editor module for wrongly written characters font, feature extraction module for wrongly written characters font, encoding module for wrongly written characters font, input module for wrongly written characters, and real-time dynamic editing module for wrongly written characters (as shown in Figure 3).

- (1) Editor module for wrongly written characters font: edit the wrongly written character that the user needs in real time and dynamically make visual modification and combination on stroke structures based on the orthography, such as insert, move, and delete stroke units, insert, move, and delete selected points, transparent copy, and the change thickness. Then the system will transfer the edited structure information of wrongly written characters font to feature extraction module for wrongly written characters font.
- (2) Feature extraction module for wrongly written characters font: analyze the structure data of wrongly written characters font received, extract the feature points of the wrongly written character using extraction algorithm of feature points, and transfer the feature point data to the encoding module for wrongly written characters font.
- (3) Encoding module for wrongly written characters font: encode and store the feature point data extracted from

feature extraction module for wrongly written characters font through encoding algorithm for wrongly written characters font.

- (4) Input module for wrongly written characters: input the corresponding key code through the key board (the system temporarily can only use 26 letter keys and 10 digital keys for wrongly written characters input); the program will display the wrong word in the editor on the basis of the codes of wrongly written characters font according to the key code.
- (5) Real-time dynamic editing module for wrongly written characters: receive the wrongly written characters information that needs to be adjusted and edited and call editor module for wrongly written characters font to edit in real time and dynamically the wrong word in the document.

5. Example Demonstration for Dynamically Generation of Wrongly Written Characters

The following is the demonstration through this system based on a wrongly written characters font of “pen”.

- (1) Select orthography “pen” as the copy object in the edit module for wrongly written characters font, change the structure of bamboo prefix to make it a wrongly written character “pen” through stroke unit editing, and save the word “pen” (as shown in Figure 4).
- (2) Every stroke unit of the wrongly written character “pen” extracted through the extraction algorithm of feature points from feature extraction module (the values of the sequence support dynamic modification) is expressed as a sequence composed of several two-dimensional coordinates (X_i, Y_i) , several sequences, and an index code corresponding to orthography “pen;” compose the feature codes of the wrongly written character “pen” (as shown in Figure 5).
- (3) Input the corresponding digital key or letter key of this wrongly written character (i.e., key codes) in edit environment “□.”; and the wrongly written character will appear (as shown in Figure 6).

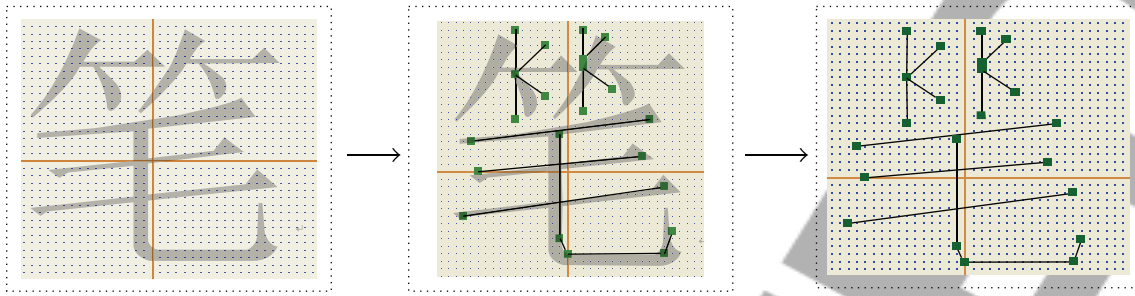


FIGURE 4: Editing process of the wrongly written character “pen” from the orthography “pen.”

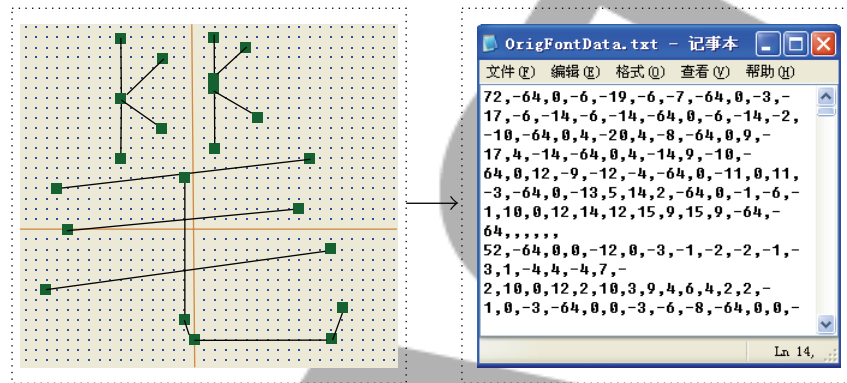


FIGURE 5: Coding and feature extraction of the wrongly written character “pen.”

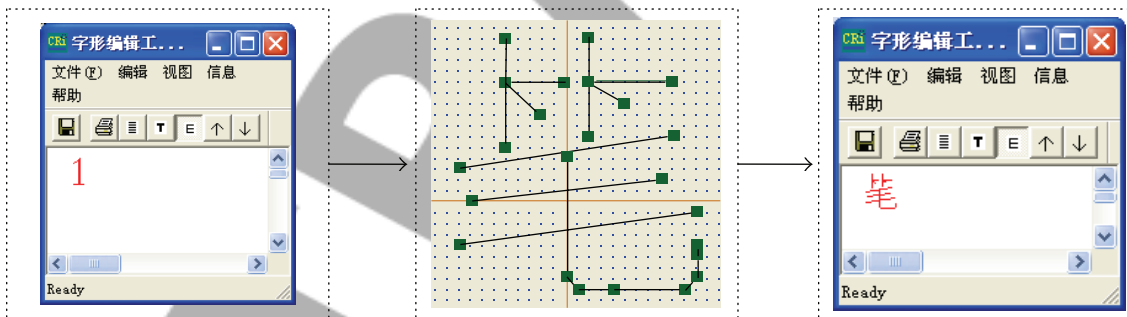


FIGURE 6: Coding process of the wrongly written character “pen” using digital key “1.”

- (4) When doing dynamic edit to the wrongly written character, first input this wrongly written character through the key board, then right-click this character to enter edit mode, and modify the character according to the need, and the modified character will be added and stored into the character font list (as shown in Figure 7).

6. Conclusion

In view of the problem and the status of wrongly written Chinese characters input in printing and digital Chinese

language teaching, this paper studies and designs a real-time and dynamic editing system based on wrongly written characters font for wrongly written characters input and processing; besides it makes full use of the characteristics of changeable structure and complex font of modern Chinese characters to combine the edit and modify font library of wrongly written characters and Chinese characters copy and ensures dynamic production of various forms of wrongly written characters font without changing the original font structure. This system provides an acquisition source of wrongly written characters for printing, typesetting, and digital Chinese language teaching, so it provides a simple, convenient, and efficient input method for wrongly written characters.

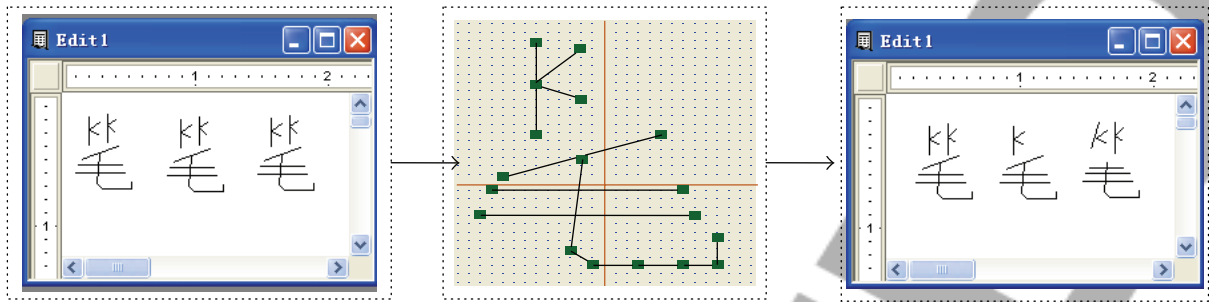


FIGURE 7: Process of dynamic editing of wrongly written character “pen.”

Conflict of Interests

The authors declare that there is no conflict of interests related to this paper.

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