Modelling Analysis of Stroke Consistency of Latin Letters and Chinese Characters

Yinghui Zhang
Beijing Institute of Graphic Communication, Beijing, China
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Abstract: This thesis uses the modelling analysis of the Latin and Chinese writing systems to find a way of improving visual harmonisation and legibility in dual script typeface design. This research includes a review of relevant literature resources, the outcomes and conclusion of the analysis process. The findings of this research identified common features in the stroke shapes of Latin letters and Chinese characters. It helps to confirm the feasibility of applying similar strokes from different writing systems, and to design a typeface that gives an optically balanced appearance to Latin letters and Chinese characters when used together.
***Keywords*:** strokes, Latin letters, Chinese characters, modelling analysis

1. Introduction

Typeface harmonisation is a relationship of coherence among characters of different shapes and proportions in a single typeface. Assessing and composing both Chinese characters and Latin letters based on the proportions of radicals or their strokes can help develop a systematic approach to examine their possible harmonisation. Therefore, I explored a possible way of providing a common principle of rationalization in a systematic approach to the process of typeface design, to build a standard for common design parameters, and minimize the conflicts arising from differences in proportions and structures of writing systems, in order to improve the possibility of harmonisation.

2. Basic shape of strokes

"The stroke is the fundamental artefact. Nothing goes further back than the shape of a single stroke" (Noordzij, 1985, p.10). Thus, the study of the stroke is a main approach to thinking about the harmonised shape of Latin letters and Chinese characters and their design. In contrast to the stroke-based approach proposed by Noordzij, William Addison Dwiggins (1940, p.2) took the view that character shapes can be seen as being made up of one or more component shapes. His theories provided a framework for focusing on the critical features of typeface design, such as the contrast of strokes, the composition of letter shapes from recurring components, the proportions and axis of the counters and joins. These elements work as different components to bring various 'flavours' into one design, but at the same time they also require harmonisation.

While Dwiggins's use of repeated elements was distinct from the stroke-based concepts advocated by Noordzij, this provided me with a modular method to study typeface design, enabling me to focus more on creating methods to share common design parameters across different scripts. In the digital age, this design method of bringing separate recurrent elements together to form letter shapes has been aided by computer technology.

The method of using elements to build up characters was developed by Rob Meek. In 2010, he created FontStruct, a type-design tool using an approach in which each character is made up of modules. These components remain constant in size and shape. Although the set of modules is finite, it can be shared across different character concepts of the same font. Visual consistency is achieved in this way. Each element can be modified in several different ways; rotated, stretched, or scaled, to suit the visual context of a particular character.

Since using multiple components has been applied in typeface design, these researches provided me with a critical tool for the design of Latin letters and Chinese characters using basic stroke elements to design different characters. Conceptualizing characters from repeat components seemed particularly relevant to the harmonisation of a dual script typeface. Within one typeface, the letterforms of each font are visually related by common stroke thicknesses and recurrent graphic features. Thus, it can be hypothesized that different characters can be derived from the same stroke group, which contains the primary stroke elements and design attributes that characterize a typeface. In this way the appearance of different characters can be harmonised. To test this hypothesis, it was necessary to identify the similarities between the basic elements of different stokes of Latin letters and Chinese characters, as a possible means to creating visual consistency between them.

3. Modelling similar stroke groups

3.1 Modelling analysis step

In this current study, the 'similar stroke group' was based on the similar geometric attributes of different strokes. In order to analyse the stroke similarity of Latin letters and Chinese characters, assisted by computer technology, I primarily used three steps to build the stroke similarity model of Latin letters and Chinese characters. These are: (1) to input the separate strokes of Latin letters and Chinese characters, (2) to categorise similar strokes and (3) to calculate how many kinds of strokes there are within one stroke group.

The first step of this model analysis involved collecting original data from 52 Latin-letter pictures, including capital and lower-case letters, and 50 common Chinese-character pictures. In order to acquire accurate test results via computer technology, I needed to choose a pair of typefaces with similarities between the component shapes in the Latin letters and Chinese characters. I chose Frutiger for the Latin letters and FZHei for the Chinese characters as the prototype. Both of these sans-serif typefaces have a limited variation of stroke width, which can facilitate the computing process when calculating results from the data. I separated each Latin letter and Chinese character into various stroke images, with the size of each image 64×64 pixels. Using the same-sized stroke images helped the computer to calculate the area that different strokes occupied. I then entered these images into the model program to categorise them and compare their similarities, according to the stroke proportion of each picture. To increase the accuracy of the result, during this process, the analysis included four Convolution layers (conv), four Max Pooling layers (max pooling), and two Fully-Connected layers (fc) as the sample mode.

By dismantling different characters' strokes and using the similarity model calculation, I then found that there are five categories of strokes that exist in the Latin and Chinese writing systems: horizontal, vertical, dot, right-falling and left-falling. In each category, there are various kinds of strokes.

3.2 Establishing stroke types

After the stroke classification, I hoped to find how many kinds of stroke existed in each stroke category. They could then be used for the design of Latin letters and Chinese characters. Since the Chinese writing system has a huge character set, when beginning a Chinese-character typeface-design project, designers usually start with 12 characters: '意', '转', '国', '今', '风', '随', '鹰', '我', '永', '警', '然' and '酬'. These 12 characters include almost all of the stroke proportions and variations in the full Chinese-character set – particularly the Chinese character '永'. According to a concept in Chinese calligraphy, called the 'Eight Principles of Yong', '永' is a character that contains eight types of the common strokes. These strokes can be used to construct 213 radicals.

Thus, in the second step, I used these 12 common Chinese-character pictures and separated them into various stroke images (64×64 pixels), entered them into the model program and transformed the stroke into a two-dimensional matrix through the Jaccard distance as a method for measuring similarity. Using the strokes of the 12 basic Chinese characters, which correspond to strokes in the five categories, I then found that there are only four kinds of stroke categories that coexist among Latin letters and Chinese characters: horizontal, vertical, left-falling and right-falling. This is because dot strokes are used in both Latin letters and Chinese characters, but in the Latin writing system the dot is a circle, while in the Chinese writing system no circle stroke is used. For example, in the Latin writing system, the dot stroke of the capital letter 'Q' is similar to the right-falling stroke in Chinese characters. Through the calculation of the stroke model, within these four stroke categories there are 15 kinds of horizontal strokes, 11 kinds of vertical strokes, four kinds of left-falling strokes and four kinds of right-falling strokes.

Among these kinds of stroke, the greatest similarities between the Latin letters and Chinese characters were in the vertical and horizontal strokes. Thus, the horizontal stroke and the vertical stroke can be used for most parts of Latin letter and Chinese character design.

4. Conclusion

Similar stroke groups help to maintain the primary design features through repeated common elements, used as the feature repertoire for the design of Latin letters and Chinese characters, to build a harmonised visual relationship among character shapes within a single typeface. The purpose of harmonisation in my research is not to make Latin letters and Chinese characters look similar, but to use the similar stroke groups to identify what kind of features exist in both the Latin and Chinese writing systems and to share the design parameter across the script. The basic forms of letters are fixed, but the strokes are treated as modular building blocks connected by different characters, sharing the common shape attributes that make them visually related and, through the consistence of stroke detail, build visual harmonisation between the Latin and the Chinese writing systems.

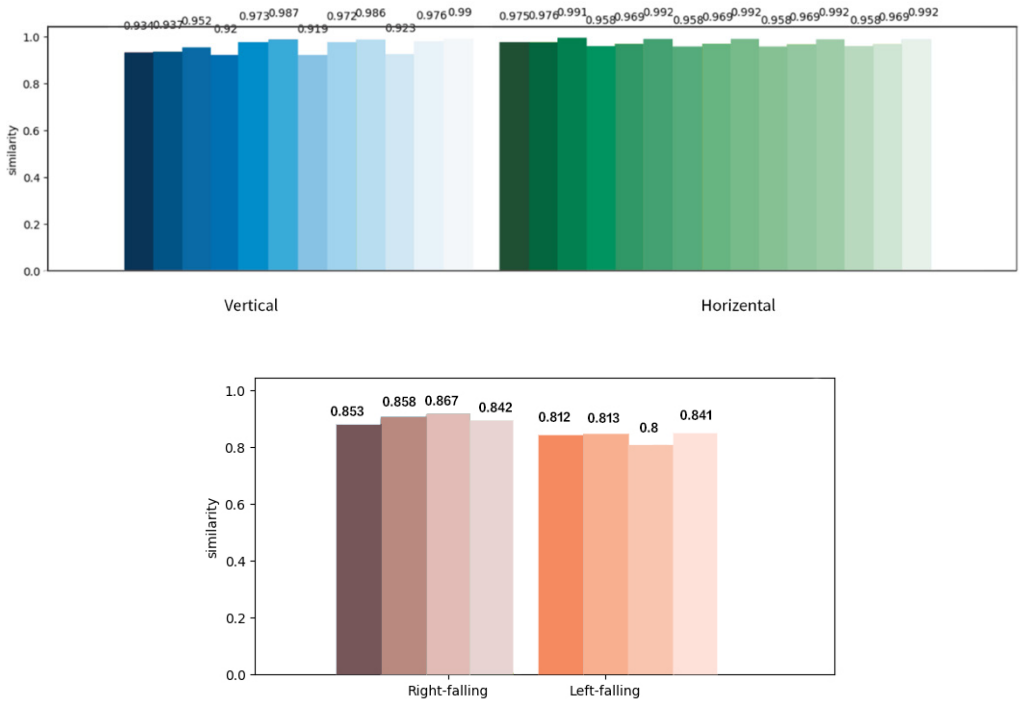

Figure 1. Similarity percentages of common strokes

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