Calligraphy Art's Application Within LED Variable Information Board

Shiqin Liu\textsuperscript{1,a}, Jinsheng Lu\textsuperscript{2,b}

\textsuperscript{1}Donghua University, Shanghai, China
\textsuperscript{2}Donghua University, Shanghai, China

\textsuperscript{a}lsq_647@foxmail.com, \textsuperscript{b}lujinsheng888@126.com

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Abstract. Purpose: combining with calligraphy theory, to improve the visibility of bitmap fonts on the LED variable information board, on the basis of these, to enhance aesthetics and cultural characters of bitmap fonts, so as to display the cultural intension of countries and cities. Methods: through literature review and field investigation, analyzing the problems of identification and aesthetics on the LED variable information board in urban public space, according to the method of Chinese characters' structure in calligraphy theory, combined with some traditional Chinese characters as pace of force field, counter, type face, bring up optimum design of bitmap fonts from the aspects of strokes and structure, in order to improve the recognition of the bitmap fonts and aesthetics. Conclusion: Through spatial structure theory, improved the identification of bitmap fonts; according to the method of Chinese characters' structure to enhance aesthetics and cultural characters of bitmap fonts. Based on calligraphy theory, to summarize the design method of the bitmap fonts about identification and aesthetics.

Introduction

With the rapid development of smart city, LED variable information board has been widely used in road traffic, public buildings and other kinds of public space, and fully integrated into People's Daily life, which playing an extremely important role in some ways such as guiding, warning, announcement, popularizing knowledge to disseminate information to people. Among them, the main text of LED variable information board—the Chinese characters, as a part of the Chinese tradition, which represents the development of history and the heritage of culture, has its unique aesthetic, not only have played an important role in communication, but also as the carrier of culture, to display the cultural intension of country and city\cite{1}.

However, the space of LED variable information board screen is too limited, especially the smaller size screen, to display Chinese characters. Compared with English and Arabic numerals, the type of strokes and the shape of fonts are more various. At present the Chinese characters displayed on the LED variable information board is not standard, some problems like the distortion of characters, the stack of stroke, seriously impact the look and feel of the text on LED variable information board, which makes the text difficult to read, and even affects the appearance. Therefore, it's difficult to reflect the required cultural characteristics, which leads to low efficiency of information transmission, and brings some bad effects to peoples' living conditions; in addition, the city image will be affected.

Combine the art of calligraphy with the type design of LED variable information board, can enrich its artistic appeal and the characters, and highlight the theme, deepen the connotation,
moreover, the calligraphy art also provides some methods for bitmap fonts design and aesthetic foundations for structure and strokes of characters\cite{2}. By absorbing the form of beauty such like rhythm, ideological and practical, black and white from calligraphy, applying those lines and patterns to bitmap fonts design, can accurately convey information to readers and improve the visibility of characters. According to the trace of development of calligraphy, it could be found that the calligraphy fonts like large seal script, small seal script, Clerical script, cursive script, regular script has epoch-making significance. Therefore, we can learn from it which has the role of guidance and reference on bitmap font’s design\cite{3}.

As a consequence, in view of the bitmap fonts existing problems of visibility and aesthetics on LED variable information board, applying the theory and method of calligraphy to the LED bitmap fonts design, can improve the visibility of bitmap fonts, enhance the beauty and display the cultural inheritance of Chinese characters, which make the transmission of information more efficient.

1 Current Status And Problems Analysis

Through the spot investigation which has been analyzed from the perspective of space structure, characters strokes, and text alignment, summarized bitmap fonts, the existing problems of visibility and aesthetic on LED variable information board can be divided into three aspects as follows:

1.1 Character Structure Problems

1. The center of gravity of each character is different;
2. The size of characters on the vision are different;
3. The text structure is not reasonable.

As shown in left-hand side of figure 1 (1), the characters on LED variable information board appear to be high and low, big and small, very chaotic, and difficult to identify.

1.2 Stroke Problems

1. The strokes are not standard;
2. The feet of characters have extra bright spot;
3. Stroke are incoherent and incomplete;
4. Stroke stack;
5. The strokes are inconsistent or missing;
6. Bitmap fonts are not standard.

As shown in the middle graphs of figure 1 (2), the characters "Wu" and "Fu" have stroke conglutination, which couldn't be figured out. Bottom left as shown in figure, the stroke of the character "Chuang" is missing, and this character is too narrow with the numeric character in front, besides, the feet of this character has extra bright spot which makes it hard to recognize. The character in the middle of the picture is the regular script, whose size is small that leads to more jagged edges. On the right side
there're two pictures, the above one has a unnoticeable contrast. The character in the figure below is bold regular script, which has rough edges that seriously affect the visibility.

1.3 Arrangement Problems

1. Row spacing and kerning is not reasonable;

2. English word confused with numbers.

As shown in the right side of figure 1 (3), bitmap fonts on the left side spaced obviously too narrow, leading to a passage crowded, which is unable to identify effectively.

![Figure 1. bitmap fonts problems.](image)

According to the investigation and analysis, it can be found that the bitmap fonts of LED variable information board should first solve the problem of identification, then on the basis of high efficiency of recognition, taking full advantages of the characteristics of Chinese characters, so as to enhance the cultural values and aesthetic experience of the bitmap fonts.

2 Bitmap Fonts To Choose

LED bitmap fonts design usually sets a certain kind of font as a reference to optimize. Research has shown that the existing bitmap font on LED variable information board includes boldface type, song typeface, and regular script etc. Among them, boldface type as the most visible font, is widely used in road traffic and other public spaces. Next, analyzing different kinds of boldface, and trying to find out to find the most suitable font for reference on bitmap screen. By comparing the features among several excellent boldface font, select the most appropriate blackbody as the basic font for LED screen [4].

At present, some kinds of boldface widely used in screen because of the efficient identification, which include: Source Han Sans, Microsoft YaHei Font, STXihei, Founder Lanting black etc.

In order to compare different types of boldface intuitively, use CAD software to measure the counter, the type face and the center of gravity among several kinds of fonts in a digital way. As shown in figure 2, the orange part represents an area diffused from center outward, the blue part is type face, and in the middle of the character there's a white dots which was computed as a center of gravity.

![Figure 2. different types of boldface index quantification.](image)

Taken together, each font style of boldface has advantages, Source Han Sans, Microsoft YaHei Font and Founder lanting black have a loose counter, among them, Founder lanting black has a high
center of gravity, while Source Han Sans' is low, and the space surrounded by the strokes of the character is relatively narrow. By contrast, as reference for bitmap fonts design, Microsoft YaHei Font is more appropriate than other font types. Therefore, Microsoft YaHei Font can be taken as a reference.

3. The Design Of Bitmap Fonts’ Strokes

In ancient China, a lot of Calligraphy theories and methods are summarized by calligraphers through practice; some of those methods are still applicable to real life.

The method of characters' structure is an extremely influential calligraphy theory. Qing calligrapher Huang Ziyuan summed up the structure rule of Chinese characters' structure, putting forward The Form and Structure of the Ninety-two Law [5], which can be said to be the ancient calligraphers' wisdom crystallization, whose comprehensive study had a huge impact on modern characters design. Some of the theory is still helpful for bitmap fonts design, especially in terms of aesthetics. Although Microsoft jas black font can be used as a template of bitmap fonts design, some details of strokes and structures displayed on the lattice screen is not comprehensive, while the method of characters' structure will make up for this regret. Here are some application examples of structure methods for bitmap fonts design.

1. The hook method: This kinds of characters put cross hook as their main strokes, and the surrounded part of that has multiple strokes, if so, cross hook stroke should be straight and quite long with angular square. For example: Pu, Tao, Shu, Ge, etc. As shown in figure 3 (1).

2. Repeated strokes should be irregular: If there are multiple horizontal or vertical strokes of this character, the length of the horizontal strokes should be different, so that it won't appear to be inflexible. Such as San, Ran, Lan etc. As shown in figure 3 (2).

3. Parallel stokes should not oblique, otherwise it will look ill-featured. Such as Yun, Qu, Qie, Dan etc. As Figure 3 (3) shows that character "Qu", the left one looks better than the right side, because three horizontal strokes are parallel, which makes it visible and beautiful.

4. Inclined stroke should not be flat, or it will weaken the imposing manner of the character such as Qi, Ye, Ci etc. Figure 3 (4) shows the character "Ye", the cross hook stroke of the right one is flat, which on the one hand, gives a feeling that the center of gravity shift to the right, on the other hand, compared with the left one, it looks apparently weak.

5. Oblique hook stroke of characters, most avoid weak and bended. Such as Wu, Cheng, Huo etc. As shown in figure 3 (5), the character "Xian" on the right side, based on the Microsoft YaHei Font. Though this character has already been designed in a very coordinated way, it lacks momentum from the perspective of calligraphy. By adjusting the oblique hook stroke, the left one appears to be more forceful, sharp than the right one.
The Form and Structure of the Ninety-two Law will normalize the existing bitmap font's strokes by adjusting the details of strokes on LED variable information board, which render the structure more harmonious, reading smoother, appearance more pretty and cultural. As the space is limited in this paper, only a few methods narrated here, the rest is not to detail.

4 Bitmap Fonts' Space Structure And Layout Design

The most critical thing in Bitmap fonts design is mastery of the structure. From the traditional calligraphy there're many detailed summaries about Chinese characters' structure, which is based on the spatial distribution, spatial field, center of gravity, counter, typeface and so on, to analyze the character's structure, by adjusting the spatial arrangement of dot matrix characters, in order to improve the visibility and readability of the whole text on LED screen.

4.1 Space Theory

Chinese characters structure space refers to the blank space, divided into inner space and outer space by stroke, which includes two principles, one is the principle of uniform, and the other is the principle of density [6].

When designing the bitmap fonts, using these principles can judge the dot matrix arrangement of strokes and the location and form of Chinese character component, which can ensure whether the arrangement of bitmap font is reasonable and easily recognizable.

1. The principle of uniform

In the requirements of uniform principle, the basic strokes should be observed: the strokes which are in the same sequence, should keep unification for the spacing, and the length of stroke should be proportional to the spacing size. Because of the limitations of LED screen, many characters can't get the optimal display results; only render the strokes consistent as far as possible. As the orange line in figure 4 showed, for example, in order to maintain uniform spaces, the strokes should be parallel so that the characters won’t appear to be chaotic.

2. The principle of density

The requirement of the Chinese character component is: the blank space between and within the Chinese character components should remain consistent.

For example, character "Yan" in figure 5, the character component "Se" on the right side has more strokes than the character component "Feng" on the left side, so "Feng" should be written smaller in order to make the space division consistent. Keep the space of strokes consistent can make different strokes, components and characters are all in the same sequence of organic, thus ensuring visual harmony of bitmap fonts.
4.2 Space Force Field

Within the limited space, any one of elements such as point, line and plane could cause a feeling of force or weight. And this force will change with the change of element, which is called the space field [7].

Chinese characters is no exception, although presented a state of balance, the tension still exists in different spatial dimensions. As we all know, Chinese characters have gone through several thousand years of evolution and remain until now, calligraphy beginners use "Mi grid" in common practice, which help to master the distribution of character's force from different direction, used to measure whether the characters keep balance. As shown in figure 6.

In the "Mi grid", the strongest force direction is from "Mi" type line, which can produce force interaction. So any elements in any position of the force field, receives any visual effects which is a result of the synthetic action from the force field [8].

This principle also can be applied in the design of bitmap fonts, putting the character into the "Mi grid", as shown in figure 7, which can obviously feel that the hook stroke of the character "Zi" receives the force from horizontal direction, while the right side does not match with the left side, so the force of this character is downward sloping. Therefore, balance the force of each part will remain coordinated for whole character [9].

4.3 Principle Of Gravity

Everything in nature is influenced by gravity, Chinese character is no exception, and every character has its own center of gravity, whose location determines the structure of Chinese characters, further affects the recognition. General rules that the center of gravity moves to the position of more intensive stroke. Adjusting the central gravity of bitmap fonts can use the following methods:

1. A single character's central gravity: According to the spatial structure of different characters, adjusting the stroke of character, to ensure overall balance, control the central gravity offset within a certain value. (Chinese character includes up-down, left-right, the middle and lower and other structures, different font structures have different position of central gravity of the character);
2. The central gravity of characters arrangement: Depending on the different shape of characters, adjusting individual character to maintain all characters in a straight line, to make the arrangement more consistent and form a good visual effect. Different characters have different center of gravity.

As shown in figure 8, "Shang", "Zhong" and "Xia" the central gravity of three characters would not be in a straight line, which looks high and low, hard to read. In fact, the center of gravity is related to the shape of character. The shape of character "Shang" is triangle, so its center of gravity is lower than the center; the shape of character "Xia"’s glyph is nabla, whose central gravity is higher than the center. After adjusting some strokes, as the picture below shows, the center of gravity of three characters looks more consistent than before.

4.4 The Counter

In general, each stroke of characters extends an inward area. The smaller the area is, the tight the counter is, that is to say, the strokes gather inward; otherwise, the counter will be more outspread and empty. Generally speaking, the tight the counter is, the delicate the character is, which is not appropriate as headline or other big characters, such as calligraphy style of Liu. Loose and outspread characters look strong, which is more suitable for big characters, such as boldface. The counter is one of the important factors to increase the visibility of bitmap fonts.

Therefore, in order to improve the visibility of LED variable information board effectively, appropriate counter enlarged during the design process can generate a visual effect of full to the characters, in addition, it’s easier to read. Generally speaking, the adjustment of counter can use the following methods:

1. Make the strokes of Chinese characters thin to achieve the purpose of expanding counter;
2. By adjusting the stroke and the location of the individual dots, increase space between strokes to expanding the counter;

As shown in figure 9, there're four characters with similar stroke numbers, but in the above image, visual size is not consistent, because of the different tightness of the counter. By adjusting the strokes in the below image, the four characters' visual size get similar.

4.5 The Type Face

Type face is the space area which formed by strokes. During the font design, designers magnify the size of type face and increase the area of the character to make better visibility of the font. The
ratio of character's type face size to box size is known as the "type face rate", so the typeface is a quantifiable concept. In the design of LED bitmap fonts, we can specify the type face rate to achieve the consistent result.

There is no clear regulation for type face rate in the design of bitmap fonts, which due to the limit of space and the number of dots, due to the differences of the font shape, the expression of each character is different. Therefore, we should keep the blank areas (i.e. the area between the type face and type box) which is outside of the stroke consistent.

5 Summary

This paper focus on solving existing problems of bitmap fonts on LED variable information board, especially the visibility and cultural aesthetics problems, by using calligraphy theory and font design theory as its instruction, from strokes, structure and other aspects to optimize the bitmap fonts' design, and summarize the method of bitmap font design. Based on improving the visibility of bitmap font, in order to promote and inherit the characteristics of the Chinese character itself, to enhance the reading experience and aesthetic feeling on LED screen, and make the urban public space more and more cultural.

The heritage and development of Calligraphy art will be applied to LED bitmap font, which embodies the concept of "people-oriented" in city information guide system. With the high development of information today, traditional culture will be combined with modern information technology, which generates a lot of inspiration and creativity. Bitmap font on LED variable information board in this paper is combined with Chinese traditional calligraphy, which is a preliminary thinking of blending traditional culture and the electronic information technology. In fact, the calligraphy art has a rich cultural connotation which is available for study, in addition, Chinese culture is not confined to the calligraphy art, in the future, and font research of LED variable information board will be explored and developed towards more humanized and cultural way.

References
