A Study of Hangul Typography in Internet TV

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Abstract

One of the fundamental GUI design issues to be addressed is system typography. Many ergonomic studies have been conducted to develop design guidelines for typography, but most of previous studies have been focused on the typography legibility on PCs. However, the legibility guidelines for PC could not be equally applied to Internet TV because of the poor display quality for TVs. Therefore, this study was conducted to provide guidelines for designing proper user interface on Hangul typography with reading time and preferences in interlace scanning Internet TV. The independent variables were fonts, sizes, and contrasts. The fonts were Gulimche, Batangche, and Dotumche with sizes of 14, 16, 18, and 20 points. The contrasts included positive text and negative text. Based on the objective measure of reading time, the results showed that Gulimche and Dotumche with 18 point in the positive text produced the fastest reading time. The slowest typography was Batangche with 14 point in the negative text. For subjective preference, Gulimche and Dotumche with 20 point were rated the highest while Batangche with 14 point was rated the lowest.

Key words: Hangul, Typography, Legibility, Font, Size, Contrast, Internet TV

1. Introduction

As the Internet becomes a more prevalent part of our daily lives, more consumers are demanding a simple, cost effective way to access all that it has to offer. Bolstered by the almost-daily announcement of new products, technologies, and vendors, information appliances markets are making significant strides to meet consumers' needs. With a growing number of vendors attempting to address the "Post PC Era," the worldwide market for information appliances will exceed 89 million units or $17.8 billion in 2004, up from a market of 11 million units and $2.4 billion in 1999 (Nua, 2000).

Growth of Internet audiences leads the e-commerce based on PCs in worldwide, and an extension of mobile technology triggers M-commerce. Now TV-based electronic commerce (Internet TV) becomes another popular online gateway to people who do not currently have their home PCs online. Even with the characteristic of easy access to TVs, TV has limitations in users' information processing compared to PCs. As an example, TV has lower resolution and higher brightness. These limitations affect user's information processing, resulted in the legibility problems in Internet TV environments.

2. Literature Review

Internet TV is one of the information appliances, such as PDA, Screen phones, Internet gaming consoles, Internet smart handheld devices and Web terminals. Internet broadcasting is transmitted with the HTML type data via the fiber cables and phone lines. Internet TV is composed of the basic functions of TV and Internet functions to send email, to surf the Internet, and to interact with new forms of entertainment.

To accomplish various functions of Internet and TV, simultaneously, good visual design and legible display are necessary for the online document communications. Hasen (1988) and Reinking (1992) estimated that reading screen was typically 20 to 30 percent slower, slightly less accurate, and more variable in speed than reading print. This was especially true for users with little experience in reading screen. However, Gould et al. (1987) found that anti-aliased fonts of 91 dots per inch (dpi) produced about the same speed and accuracy as they were on print, and pointed out that improving the legibility of text
required more attention to letter shape, type size, contrast, and text layout.

In the studies of Hangul (Korean Character), Whang et al. (1997) experimented Hangul font and size with VDT. They suggested that the Korean Gothic be superior to the Korean Ming style in user's performance. The optimal letter size that gave user the optimal performance ranged from 39.8' to 55.5' in Ming style, while the visual angle ranged from 39.8' to 52.6' in Gothic style. These results were different from recommended standards of American National Standards Institute (ANSI) because of different structures between Hangul and English. As an example, the number of strokes (2–48 strokes) in Hangul is more than English (1–3 strokes). In addition, Hangul is coded by 2 bytes, whereas English is coded by 1 byte in VDT. Whang et al. mentioned the optimal performance was 12-point in the print.

In the case of English text, Tullis et al. (1995) compared reading speed, accuracy, and subjective preference with four different font families in Windows environment. They found that the best fonts and sizes were Arial and MS Sans Serif with 9.75 point.

For the image polarity, Gould et al. (1987) supported the notion that dark characters on a light background were read faster than light characters on a dark background. According to Fowler and Stanwick (1995), the main determinant of legibility of a particular foreground/background combination was the amount of contrast between them. White (1990) and Fowler and Stanwick identified that the difference in lightness should be at least 30% to be legible, or difference in gray values of at least 77 (gray values range from 0 to 255). To improve the readability of information, according to International Standards Organization (ISO9241-3), the contrast ratio between text and background should be at least 3:1 and be proper at 10:1.

In summary of the past studies, text should be Sans Serif font of at least 8 to 10 points in a high contrast color combination using dark characters on a light background in PC environments.

Nielsen (1997) and Krebs (2000) proposed the basic guidelines for Web (Internet) TV. Even though their guidelines included user interface in Web TV, those were focused on Web TV for English Windows equipment. On the other hand, Yim and Myung (2001) experimented Hangul typography in progressive scanning type TV connected STB (Set-Top-Box). They recommended that the most preferred Hangul be Gulimche with 18-point in the negative text.

As reviewed so far, previous studies on the legibility of Hangul have been focused on PCs. The legibility guidelines for PC cannot be equally applied to Internet TV. Therefore, this study was conducted to investigate the legibility of Hangul in Internet TV environment with STB. The scanning type of TV was interlace scanning type because most of TVs are interlace scanning type. Another objective was to recommend the efficient guidelines for Internet TV-based user interface in Hangul environment.

3. Method

3-1. Subjects

Twenty-five volunteers from Samsung Electronics participated in this study. The subjects were 13 males and 12 females, ranging in age from 19 to 40 (average was 26.6). The corrected eyesight for subjects was more than 25/25 vision.

3-2. Apparatus

The 29-inch TV connected with STB was used. The scanning type of TV was Interlace scanning. The distance, picture control conditions, and illumination of the test room and on the screen surface were 2.5 meters, normal positions, and 60 lux based on IEC107-1 recommended methods of measurement on receivers for television broadcast transmissions.

3-3. Experimental Design

The experimental design for this study was three-factors within-subject design with completely randomized and repeated design. The dependent variables were reading time and subjective preference. The independent variables were font, size, and contrast. The levels of independent variables were three fonts (Gulimche, Batangche, and Dotumche), four sizes (14-point, 16-point, 18-point, and 20-point), and two contrasts. The contrasts were positive text (black text on white background) and negative text (white text on black background) with the contrast ratio of 4:1 (80% gray and 20% gray). Spacing between lines was 1:1.5 and the resolution of screen space was fixed at 580*440 pixels.
3-4. Procedure

Subjects were asked to read 48 different paragraphs (3 fonts × 4 sizes × 2 contrasts × 2 replications) of approximately 280 characters selected from editorials in a Korean newspaper. Subjects were also asked to read a randomly chosen paragraph as quickly and accurately as possible. The reading time was measured for each paragraph. Subjects were then asked to rate their preference on a seven-point Likert scale from 1 (very hard) to 7 (very easy).

4. Results

4-1. Performance (Reading Time)

The ANOVA for reading time was shown in Table 1. Since all the interactions were not significant, main effect tests were meaningful. All main effects were significantly different; font, sizes, and contrasts (p<0.0001).

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**Table 1** ANOVA for Reading Time

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MSE</th>
<th>F</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Font</td>
<td>2</td>
<td>10792.6</td>
<td>5396.3</td>
<td>12.5</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Size</td>
<td>3</td>
<td>22925.7</td>
<td>7641.9</td>
<td>22.1</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Contrast</td>
<td>1</td>
<td>4366.3</td>
<td>4366.3</td>
<td>33.2</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Font×Size</td>
<td>6</td>
<td>1368.1</td>
<td>228</td>
<td>2.05</td>
<td>0.063</td>
</tr>
<tr>
<td>Font×Contrast</td>
<td>2</td>
<td>163.2</td>
<td>81.6</td>
<td>0.7</td>
<td>0.486</td>
</tr>
<tr>
<td>Size×Contrast</td>
<td>3</td>
<td>1160.1</td>
<td>386.7</td>
<td>2.46</td>
<td>0.069</td>
</tr>
<tr>
<td>Font×Size×Contrast</td>
<td>6</td>
<td>696.2</td>
<td>116</td>
<td>0.96</td>
<td>0.455</td>
</tr>
</tbody>
</table>

* significant at α=0.05

To find the significant levels of fonts, sizes, and contrasts, SNK multiple comparison tests were conducted. The results were shown in Fig. 1:

- The fastest times came from Gulimche (110.9±39.9**) and Dotumche (112.5±38.5). Even though Dotumche was slower than Gulimche, the time between Gulimche and Dotumche had no significant difference. The Batangche (117.9±40.3) produced significantly longer reading time than the other group.
- Three significantly different groups were found for size. The fastest size was 18-point (107.6±38.5) and was significantly different from other sizes (20pt, 16pt, and 14pt). In the second group, no significant differences were shown between 20-point (113.1±38.9) and 16-point (114.6±38). The last group, 14-point (119.9±41.1), was significantly slowest.
- In the contrast, positive text (111.9±38.5) was significantly faster than negative text (115.7±40.1).

![Fig. 1] Reading Time per character

4-2. Subject Preference

To prove the hypothesis of normality for 7-scale Likert scale data, Kolmogorov-Smirnov Normality Test was conducted. The results showed that the preference data satisfied normality assumption (p>0.15). Therefore, the parametric data analysis could be used.

The ANOVA for the subjective preference was shown in Table 2. There were no interaction effects. The subjective preference showed statistically significant differences in the fonts and sizes (p<0.0001).

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**Table 2** ANOVA for Subjective Preference

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MSE</th>
<th>F</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Font</td>
<td>2</td>
<td>42.35</td>
<td>21.18</td>
<td>14.15</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Size</td>
<td>3</td>
<td>239.57</td>
<td>79.86</td>
<td>21.72</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Contrast</td>
<td>1</td>
<td>1.14</td>
<td>1.14</td>
<td>0.27</td>
<td>0.6058</td>
</tr>
<tr>
<td>Font×Size</td>
<td>6</td>
<td>0.33</td>
<td>0.05</td>
<td>0.08</td>
<td>0.9978</td>
</tr>
<tr>
<td>Font×Contrast</td>
<td>2</td>
<td>1.82</td>
<td>0.91</td>
<td>1.01</td>
<td>0.3723</td>
</tr>
<tr>
<td>Size×Contrast</td>
<td>3</td>
<td>2.71</td>
<td>0.9</td>
<td>1.16</td>
<td>0.3301</td>
</tr>
<tr>
<td>Font×Size×Contrast</td>
<td>6</td>
<td>4.38</td>
<td>0.73</td>
<td>1.22</td>
<td>0.3005</td>
</tr>
</tbody>
</table>

* significant at α=0.05

The SNK multiple comparison tests were performed and are shown in Figure 2. The results are as follows:

- Gulimche (4.64±1.3) and Dotumche (4.55±1.35), which were not significantly different from each other, were significantly preferred than Batangche (4.21±1.32).
- 20-point (4.87±1.19) was the most preferred size, while...
the second preferred sizes were 18-point (4.66±1.22) and 16-point (4.62±1.29). Between 18-point and 16-point had no significantly difference. The least preferred size was 14-point (3.71±1.32).

- The contrast between positive text (4.5±1.36) and negative text (4.44±1.31) had no significant differences.

In summary for the study, Gulimche and Dotumche with 18-point in the positive text produced the fastest reading time. For subjective preference, Gulimche and Dotumche with 20-point were rated the highest while Batangche with 14-point was rated the lowest. Based on objective and subjective criteria on Hangul legibility in Internet TV environment, Gulimche and Dotumche with 18-point could be said to be optimal. Batangche with 14-point should be avoided in text.

5. Conclusions

This study was aimed to determine the legibility threshold of Hangul typography manipulated by fonts, sizes, and contrasts in Web TV. Obviously, there were distinct preferences and performances with which users could read various fonts, sizes, and contrasts. In conclusion, the following guidelines are beneficial for Hangul Internet TV user interface:

- Use Gulimche with 20-point in the positive text for subjective preferences.
- Use Gulimche with 18-point to improve reading performance.
- Avoid using Batangche with 14-point in the negative text.

6. References

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