The Legibility of Chinese Characters in the Perspective Environment.

Chiwu Huang

National Taipei University

of Technology

How to present a large quantity of information in a limited computer display space is always an important issue. One of the solutions is to present information three dimensionally. Depth cues are the reason that people can perceive things three dimensionally on computer displays. They include: light and shade, relative size, interposition, texture gradient, aerial perspective, motion parallax and perspective. However, these cues might disturb the reading of Chinese characters on the computer screen.

This research aims to explore the legibility of Chinese characters in the computer perspective environment. The user tests were used in the research. Firstly, a perspective three-dimensional space was simulated on the computer screen. A few sets of Chinese characters were selected and placed on the perspective space. 40 participants were asked to read out the Chinese characters on the perspective environment. The time was measured and errors were recorded for analysis. The findings include:

1 The larger the perspective angle the easier to recognize the Chinese characters.

2 The typeface of the Chinese characters will influence the legibility. It was found that the typeface of Medium Ming is better than Medium Black in the experiment.

3 Whether the characters have meaning or not would affect the result. The characters with meaning are easier to recognize than the characters without meaning.

4 The characters on the left side wall seems to be easier to recognize than the characters on the right side wall in the perspective environment.

The Legibility of Chinese Characters in Perspective Environment

Chiwu Huang
PhD, Associate Professor
Graduate Institute of Innovation Design and Department of Industrial Design
National Taipei University of Technology

Abstract

How to present a large amount of information in a limited computer display space is always an important issue. One of the solutions is to present information three dimensionally. Perspective is one of the reasons that people can perceive things three dimensionally on a computer display. However, in a perspective background the legibility of Chinese characters might be affected. Therefore, this research aims to explore the legibility of Chinese characters in the computer perspective environment.

The legibility test was used for the research. First, a perspective space was simulated on a computer screen. A few sets of Chinese characters were selected and placed on the space. 40 participants were asked to read the Chinese characters. Time was measured and errors were recorded for analysis. The findings include: 1) The font of the Chinese characters might influence the legibility. 2) The larger the view angles the easier to read the Chinese characters. 3) The characters on the left side wall seems to be easier to read than the characters on the right side wall. 4) Characters with or without meaning might affect the legibility.

Keywords: Chinese characters, legibility, perspective

1. Introduction

How to present a large amount of information on a computer display is always an important issue. One of solutions is to present information three dimensionally. For instance, Xerox Palo Alto Research Center (PARC) has developed many information visualization techniques, e.g., Cone Tree, Hyperbolic Tree Browser and Disk Tree etc (Chi, 2000).

Another development in Virtual reality (VR) can simulate a real world based on computer technology. VR refers to the computer-generated simulation of a world, or a subset of it, in which the user is immersed. (Dix et al., 1998) With VR and three-

dimensional (3D) technology, data or information can be visualized into diagrams, pictures or models for easier to perceive by the observers. For example, a wind tunnel experiment can be simulated by VR in which the invisible air particles can be visualized into air bubbles so that an operator can see it. In this way the cost of building a real wind tunnel and models can be saved. Another example is the weather forecasting picture on television in which the atmosphere can be simulated from the satellite meteorological data.

VR can be classified as two categories: Immersive VR and Nonimmersive VR. The usual definition of VR involves full immersion (Robertson et al., 1993). That is, users wear head-mounted stereo displays to provide full visual immersion and special gloves that allow six-degree-of-freedom input for directly manipulating the environment. Alternatively, Nonimmersive VR also places the user in a 3D environment that can be directly manipulated, but it does so with a conventional graphics workstation using a monitor, a keyboard, and a mouse. The Scene is displayed with the same 3D depth cues used in immersive VR. Depth cues include: Light and shade, Relative size, Interposition, Texture gradient, Aerial perspective, Motion parallax, Perspective and Depth Cuing (StereoGraphics Corporation, 1997).

Video game industries have successfully applied VR technology to let players immerse themselves into the imagined world. A Personal Digital Assistant (PDA) Guidebook also uses such technology and allowed user to tour around a historical house and gives the users information by taping on the PDA (Aoki and Woodruff, 2000). Among those depth cues, Perspective is the most obvious one. It can be defined as: “The relationship between foreground and background objects. If it is exaggerated, or if there are perspective cues such as lines receding to a vanishing point, the image’s depth will be enhanced.” (StereoGraphics Corporation, 1997)

However, would it still be legible when a text appears in perspective environment? Would the perspective background affect it? What are the factors?

Some literatures have discussed the legibility of Chinese characters. For example, Cai (2000) claimed that numbers of strokes and font design are key factors affecting the legibility of Chinese characters. However, most of them are limited in two-dimensional environment. The legibility of the characters in 3D environment remains to be explored. It leads to the aim of this research: 1) To explore the legibility of Chinese characters in the perspective environment. 2) To identify the factors affect the legibility of Chinese character.

2. Hypothesis

It was hypothesized that the legibility of Chinese characters might be affected by the following variables: 1) view angles, 2) fonts, 3) positions and 4) with or without meaning.

3. Method

An experiment was designed to test the hypothesis. Legibility test was used for the research. The method and process are described below.

3.1 Test stimuli

A perspective view of an empty interior room was depicted with 3D MAX software. The proportion of its height, width and depth were 3:4:5. There were Chinese characters placed on its right wall or left wall for viewing test. It was shown on a 17" LCD computer display in 158mm height and 210mm width. The height of viewer's eyesight was set on 1/2 of the height. The view angle was defined as the angle between the eyesight line and the wall line on the top view of the room. The view angles were originally set between 25 and 75 degrees with every 5 degrees increased. However, it was found in a previous pilot test that most respondents could recognize the characters between 25 and 35 degrees. In order to identify the proper view angles for the viewers, therefore, the researcher decided to add 4 degrees to 35 degrees and minus 4 degrees from 25 degrees. It made the view angles between 21 and 39 degrees with every 2 degrees increased.

3.2 Test samples

"Medium Ming" and "Medium Bold" Chinese Character fonts were selected as test samples. The test samples were selected from the frequent used Chinese characters set. They were divided into two sets, meaningful and meaningless character strings. Each string contained five characters, arranged horizontally from left to right in standard space. The characters string was pasted on the sidewall of the simulated room as shown in Figure 1. The respondents viewed the test samples from smaller view angles to larger view angles sequentially with ACDsee software.

3.3 Equipments

A Pentium 4 personal computer with a 17 inches LCD screen was used to review the test samples. A stopwatch was used to measure the time.

3.4 Respondents

Since the limit of the time and budget, a non-probability sampling was used in the experiment. The respondents were selected mainly from the researcher's university. The convenience and willingness to participate the experiment rendered the recruiting process. 40 respondents were recruited to participate the experiment and received a small gift after the test.

3.5 Experiment steps

The respondents sit comfortably in front of the computer display (Figure 2). The sample pictures were shown to the respondents. The respondents read out aloud the characters on the screen while being measured with the stopwatch. The researcher is beside the respondents to judge whether it is correct or not and records the time. The meaningful and meaningless Chinese character strings appealed randomly. Each string was displayed from smaller angles to larger angles until the respondents read out the string correctly. The smallest angle was recorded for future analysis.

4. Results and discussions

Table 1. The reading time and view angle of the meaningful character string (n=40)

Font	Position	Average time (sec.)	Average angle (°)	Mode (frequency)
Medium Bold	Left	1.35	26.45	27 (16)
	Right	2.42	28.25	27 (19)
Medium Ming	Left	1.28	25.65	25 (14)
	Right	1.47	27.45	27 (21)

Table 2. The reading time and view angle of the meaningless character string (n=40)

Font	Position	Average time (sec.)	Average angle (°)	Mode (frequency)
Medium Bold	Left	3.04	28.00	27 (22)
	Right	2.74	29.80	29 (21)
Medium Ming	Left	2.54	27.65	27 (21)
	Right	2.37	29.05	29 (17)

The results regarding to meaningful character string and meaningless character string are listed in Table 1 and Table 2 respectively. They are discussed as following:

4.1 The effect of meaning

A character string with or without meanings was identified as a factor affecting the legibility of the Chinese character string. It can be observed in Table 1 and Table 2

the average time used for reading the meaningful string is shorter than the meaningless string while the average view angle for the meaningful string is smaller than the meaningless string. This suggests that meaningful strings are easier to read than the meaningless ones.

4.2 The effect of font

Font was identified as another factor affecting the legibility of the Chinese characters string. Medium Ming seems to be easier to read than the Medium Bold. From both Table 1 and Table 2, we can find that respondents used less time reading Medium Ming than Medium Bold. Also, respondents tend to read out Medium Ming in smaller angles than Medium Bold.

4.3 The effect of view angle

It was observed that most respondents read out the characters in angles between 25 and 29 degrees. Although the font was compressed and deformed into almost one fifth of its width, most respondents still could recognize them with little difficulties. It seems the wider the angle is the easier it is to read.

4.4 The effect of position

It seems the position of the string will affect the legibility as well. In Table 1 the average time for both fonts on the left wall is shorter than on the right wall. Also a smaller angle was observed on the left wall. Similarly, the meaningful string on the left wall seems to be easier to read than on the right wall. This might be attributed to the reading habit of Chinese readers. They tend to read from left to right when the Chinese characters are arranged horizontally. In the perspective environment the first character is bigger that is also helpful.

Contrarily, respondents took longer time to read the meaningless character on the left wall than on the right wall (see Table 2). It might be because people tend to try harder to read what they already recognized. However, the view angle on the left is smaller than on the right.

5. Conclusion

Perspective is one of the depth cues for people to perceive 3D environment. Present information three dimensionally is one way to present a large amount of information on a computer display. This study explored the legibility of Chinese characters in perspective environment. By summarizing the experiment results and discussions, four factors affecting the legibility of Chinese characters can be identified

as: 1) fonts 2) view angles 3) positions 4) meaningful or not. They are described below:

1) Like in two-dimensional environment (Cai, 2000), fonts could affect the legibility of Chinese character in perspective environment. In this research, Medium Ming seems to be easier to read than Medium Bold. Medium Ming has quicker responses and smaller the view angles than Medium Bold.
2) In perspective environment, the view angle to Chinese characters is another factors affect its legibility. The larger the view angle the easier it is to read.
3) The position of the Chinese characters might also affect the legibility. The character on the left wall seems to be easier to read than on the right wall. It might be because traditionally the orientation of the horizontal arrangement of Chinese characters is from left to right. Especially when the character string has meaning. The enlargement of the first character in the perspective environment might help reader to read out the whole string of the characters. On the contrary, when the string has no meaning, the reader might spend longer time to figure out what they are.
4) Chinese characters with or without meaning might also affect their legibility. Meaningful characters seem to be easier and quicker to read than the meaningless ones.

Acknowledgement

This research was sponsored by the National Science Council of Taiwan (NSC 91-2213-E-027-032).

References

Aoki, P.M. and A. Woodruff, 2000, Improving Electronic Guidebook Interfaces Using a Task-Oriented Design Approach, Proc. DIS 2000, Aug. 2000, pp. 319-525.

Cai, D., 2000, Evaluation of a Chinese characters by mean of characters' descriptive values, in Chinese, PhD thesis, National Taiwan University of Science and Technology, pp. 60-76.

Chi, Ed H., 2000, A Taxonomy of Visualization Techniques Using the Data State Reference Model, InfoVis 2000, Salt Lake City, pp. 69-75.

Dix, A., Finlay, J. Abowd, G and Beale, R., 1998, Human-Computer Interaction, 2nd Edition, Prentice Hall Europe, pp. 578-583.

Robertson, G. G., Card, S. K. and Mackinlay, J. D., 1993, Nonimmersive Virtual Reality, Computer Vol.26 No.2, pp. 81-83.

StereoGraphics Corporation, 1997, StereoGraphics Developers' Handbook:

Background on Creating Images for CrystalEyes and SimulEyes, StereoGraphics Corporation, pp.1-5.

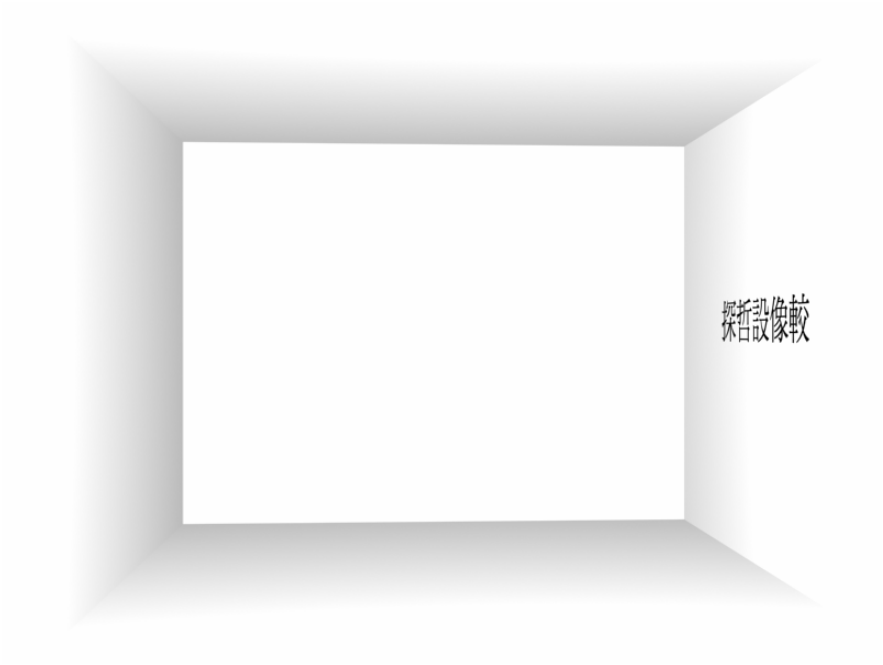

Figure 1　An example of stimuli

Figure 2　The experiment setting