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Calculation of Color Visual Beauty in the Foreground of Text Coverage on the Interface of Rehabilitation Robot

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ABSTRACT

The interface color of medical rehabilitation robot directly affects the operation experience of rehabilitation doctors. Text overlay image of visual interface type is one of the common interface layout methods. This paper aims to explore and experiment the influence of color contrast on picture clarity and balance in the man-machine interface with text covering part of the foreground. This paper has two hypotheses. In order to test the hypothesis, relevant pictures will be prepared before the experiment; Using the method of subjective questionnaire and objective MATLAB quantitative calculation data, the experimental data related to the hypothesis are obtained and analyzed, the conclusion is obtained and further discussed. The experimental conclusions are as follows: first, as the color contrast between the text and the foreground in the picture increases, the definition increases. When the color contrast reaches the maximum, the definition may be slightly reduced due to too strong color stimulation; Second, as the color contrast between the text in the picture and the foreground increases, the color weight of the area covered by the text in the foreground increases, and the balance of the picture will change.

Keywords: Rehabilitation robot, Interface, Text overlay on foreground, Vsual beauty

INTRODUCTION

Medical rehabilitation robot can replace doctors to carry out certain intensity repetitive training and improve rehabilitation efficiency. The rehabilitation division operates the robot through the machine interface for exchanging information. Interface design involves multi-disciplinary and multi domain concepts such as ergonomics, cognition, chromatology and design aesthetic principles. It often emphasizes the design concept of "user-centered". Humanized software interface can make computer devices win the satisfaction of users (Zhao, 2017). The interface with only function as the decisive factor may lead to poor man-machine communication channels, resulting in user operation errors and affecting the user experience. At present, there are a lot of research methods that can be applied in various fields related to interface, especially in industries, aerospace, medicine and other fields that need large equipment and top technology. Beauty is very important in human-computer interface design. Aesthetics plays an important role in the design of the overall visual interface (Lai, 2010). These features can be expressed

qualitatively or quantitatively. The beauty intention of the interface is one of the ways to qualitatively express the characteristics of the interface. The intention of interface beauty is divided into four categories: balanced beauty, concise beauty, proportional beauty and echo beauty.

RELATED WORK

The commonly used beauty intention is the balanced beauty of the interface. In order to maintain balance, the intensity elements of each color block must be synthesized in two-dimensional space, and the balance of psychological feeling around the visual center must be realized by studying the relative relationship between the number, position density and others (Liu and Yu, 2010). The evaluation experiment of bauerly and Liu (2006) shows that symmetry is closely related to the beauty of abstract image block pages. Therefore, the composition of man-machine interface can be abstracted into image blocks. There are many calculation models for text and background foreground pictures, among which the text is separated from the foreground and is only a simple layout and arrangement of man-machine interface (Lai 2010). However, this does not meet the growing aesthetic needs of users in the interface layout of existing rehabilitation robots. The color contrast of man-machine interface will affect the clarity of rehabilitation doctors' observation interface. Clarity is a basic requirement of the interface, especially when it is used to distinguish text and image types. The visual effect and clarity of high color contrast pictures attract doctors to observe the contents of the pictures, forming an unbalanced effect of the pictures visually mapped to the heart.

Therefore, this paper aims to explore and experiment the influence of color contrast on picture clarity and balance in the man-machine interface with the foreground of the text coverage part of the rehabilitation robot. Hypothesis 1: as the color contrast between the text and the foreground in the interface increases, the definition increases. When the color contrast reaches the maximum, the definition may be slightly reduced due to too strong color stimulation; Hypothesis 2: as the color contrast between the text in the picture and the foreground increases, the color weight of the area covered by the text in the foreground increases, and the balance of the picture will change.

METHOD

The irregular color blocks of red, orange, blue and green are randomly selected as the foreground. The color is relatively simple and similar, and the picture has no texture, which meets the requirements of interface picture in the direction of medical rehabilitation. Select a light color of the same color system as the background color. At the same time, the background color should be compared with the foreground, and the subjects can easily distinguish the foreground and background in a short time. The proportion of the foreground in the picture should be greater than one quarter and less than or equal to one half, so as to ensure that enough areas can coincide with the foreground in the next step, so as to avoid the unclear change of the balance of the picture due to the excessive foreground. The text used in each picture

is the same, the quantity is moderate, and the top, bottom, left and right are aligned in the middle. Each text coverage has five color changes in the same way.

The subjective information of subjects was collected by questionnaire. Subjective factors, human visual sensitivity, objective factors, background color and laboratory environment color will interfere with the experiment. Therefore, this paper uses MATLAB procedure to calculate the color contrast and clarity of the image area covered by text. The balance degree of man-machine interface examines the mass balance on both sides of the symmetry axis of the interface, and calculates the difference between the overall weight of elements on both sides of the horizontal and vertical symmetry axis (Zhou, 2013). The calculation formula is:

$$Db \cdot a = 1 - (|\frac{wL - wR}{\max(|wL| \cdot |wR|)}| + |\frac{wT - wB}{\max(|wT| \cdot |wB|)}|)/2$$

$$wj = \sum_{i}^{nj} aijdij = L, R, T, B$$

Where L, R, T and B represent the left, right, upper and lower of the interface space respectively; aij represents the area of object i in part j; dij represents the distance between the object center line and the interface center line; At the same time, nj represents the number of objects contained in a certain part. Convert such a calculation formula into MATLAB procedure to avoid manual calculation and improve efficiency.

This paper imports the foreground map into Matlab through imread procedure, picks up the RGB values of different colors used in the foreground through imager procedure, imgeg procedure and imgeb procedure, averages them, and obtains an average value. The following procedure describes the process of image R-value average:

```
imager = I(:, :, 1);
subplot(221) ;
title('r');
subplot(224);
a = mean(imager);
aa = mean(a);
```

In order to calculate the definition of the overlapping area, first import the foreground image into Matlab and grayscale it, pick up the maximum and minimum grayscale value in the foreground grayscale image and average it to obtain a mean value. The MATLAB procedure used in this step is:

```
M = rgb2gray(P);
baiS = double (M);
a = mean (bais);
aa = ean(a);
```

When calculating the overall color balance of the picture, the color composite image is imported into Matlab for grayscale processing through imread

Table 1. RGB mean difference.

Foreground Color System	Red Text	Orange Text	Green Text	Blue Text	White Text
Red	198, 154, 142	198, 142, 142	210, 142, 142	210, 154, 130	198, 142, 130
Blue	134, 174, 220	146, 162, 220	134, 162, 220	146, 174, 208	134, 162, 208
Green	160, 161, 162	148, 149, 162	160, 149, 162	148, 161, 150	148, 149, 150
Orange	215, 165, 73	207, 154, 80	215, 153, 80	219, 166, 68	207, 154, 68

Table 2. Gray value difference.

Foreground Color System	Red Text	Orange Text	Green Text	Blue Text	White Text
Red	163	159	166	169	158
Blue	167	160	164	155	1598
Green	158	151	150	161	150
Orange	171	161	165	169	162

program, and the gray mean value is extracted and compared. The matlab program listed below is the gray image histogram program of visual image:

```
image = rgb2gray(image);
[row, col] = size(image);
grayNum = zeros(1, 256);
for i = 1:row
for j = 1:col
grayNum(image(i, j)+1) = grayNum(image(i, j)+1)+1.
```

CONCLUSION

The results of the questionnaire show that the hypothesis is true, but this result is not enough. The evaluation of color by human eyes will be affected by many factors. Import the pictures used in the experiment into the first program in the previous chapter. The objective data analysis is shown in the Table 1.

It can be seen from the data that the greater the difference between the average RGB value of foreground and text color, the stronger the contrast. Import the above pictures into the second and third steps of the previous chapter, and compare the difference between gray values to judge the clarity of the pictures. The data analysis is shown in the Table 2.

After comparing the sharpness, the composite image is directly imported into the third process of the previous chapter, which is divided into left, right, upper and lower parts to judge the color balance of each composite image. The data analysis is shown in the Table 3.

The results of the experimental data show that the subjective feelings of most users are similar to the objective data, indicating that the hypothesis proposed in this paper is tenable. As the color contrast between the text and the foreground in the picture increases, so does the clarity. When the color contrast reaches the maximum value, the clarity may be slightly reduced due

Table 3. Gray value difference.

Foreground Color System	Gray Value of the Left Part	Gray Value of the Right Part
Red	193	167
Blue	198	143
Green	192	124
Orange	189	144

to too strong color stimulation. At the same time, the color weight of the area where the text covers the foreground increases, and the balance of the picture will also change.

By studying the man-machine interface of rehabilitation robot, color matching suggestions can be given. Color matching shall ensure the clarity of interface text and pictures that want to convey information, otherwise it will reduce the efficiency of information transmission. Appropriate color contrast, especially low saturation color, has been widely welcomed by users. Conclusion the system is not only suitable for the man-machine interface of rehabilitation robot, but also suitable for other medical devices in similar use environment

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This paper also has more in-depth research. First, the preferred colors of rehabilitation robots with different functions can be considered. Second, the influence of the screen size of the human-computer interface carrier on the results can be considered, such as projection TV.

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