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THE EVALUATION OF TEXTILE DESIGN'S VISUAL FEATURE BY USING A GENETIC ALGORITHM

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ABSTRACT

The designs that have been stored in early days are often used as a reference when textile designs are created. To effectively use these resources, a well-equipped design database must be constructed and a useful searching method must be studied. As for a design searching method, searching methods that deal with human subjective information are requested. A technique for these searching methods, one method that uses visual features of textile design is proposed. Therefore, we were interested in spatial frequencies as visual feature of textile design. We investigated a correspondence between the subjective evaluation obtained from the subjectivity as "pop out feeling" and the objective evaluation obtained from spatial frequencies of textile design image by using a genetic algorithm. In the result, it shows that the subjective evaluation based on the subjectivity as "pop out feeling" is related to lower components of spatial frequencies of textile design image. In this view point, we feel that lower components of spatial frequency domains are available for one of subjective searching items of the subjective design searches.

1. INTRODUCTION

Designers that create textile designs often use an earlier design that has been stored as a reference or a base design. However, this accumulation of textile designs is immense. So, it is difficult for designers that create textile designs to discover the design closest to their intent. To effectively use these resources, a well-equipped design database must be constructed. Particularly, it is an important problem to examine a searching method of design. In traditional methods, it was considered that establishing objective data, such as the textile name and the textile design data, were necessary to search for design. However, this is unsatisfactory for subjective search requests such as "this kind of feeling" from designers[1, 2]. Therefore the search methods based on visual feature of textile designs have been desired. If it was shown that the subjective evaluation of visual features of a textile design was related to the objective evaluation, we could search the textile design based on the objective evaluation that include the subjective information of textile design. We examined the correspondence between the subjective evaluation of textile design and the spatial frequency components that are one of objective visual feature of textile design[3].

First, we obtained the subjective evaluation from measuring examples by using a paired comparison that is a method of sensonary evaluation for textile designs[4]. Next, we obtained spatial frequencies of textile design images by using the two-dimensional discrete Fourier transforms corresponding to the optical Fourier transforms[5, 6]. In general, the spatial frequency characteristics of human visual perception exhibit the characteristic of a low-pass filter[3,7]. In this view point, we obtained low-pass filtered images from the filer processing for spatial frequency domains. Furthermore, we obtained the objective evaluation from a cross-correlation between a low-pass filtered image and an origin image. When the cross-correlation between the objective evaluation and the subjective evaluation is at its maximum, we feel these evaluations to be related. In the process of examining this correspondence, low-pass filtered images must be reconstructed. However, It takes much time to reconstruct those. To save the processing time, we use a genetic algorithm[8, 9].

2. EXAMINATION OF THE SUBJECTIVE EVALUATION OF TEXTILE DESIGN

To acquire the subjective evaluation of textile design, we set up a standard of evaluation and examine based on it. For that reason, we practice a paired comparison that is one method of sensonary evaluations based on the subjectivity as "pop out feeling" and acquire the subjective evaluation of textile design. Fifteen examinees with healthy vision examined a pair of 10 examples of a checkered textile design and selected one from a viewpoint of strong feeling. We practiced this examination for all combinations of textile design examples. We made sure that each one of the examinees had distinguishable capacity by using a coefficient of consistency. Furthermore, we examined an agreement degree of judgment between examinees by using a coefficient of agreement. If the result of examination was effective, we obtained a paired comparison value by measuring examples by Bradley's method[4]. We consider a paired comparison value as the subjective evaluation.

3. EXAMINATION OF THE OBJECTIVE EVALUATION OF TEXTILE DESIGN

The objective evaluation of textile design was obtained from spatial frequency components that are one of the objective visual features.

The colors in the input image are displayed as color intensity levels of the three primary colors of red (R), green (G), and blue (B) in an additive color mixture. To obtain the same values that agree with the colors visually perceived by people, we use the L*a*b* system established by the Commission Internationale de l'Eclaiage(CIE) as the standard ULCS color coordinate system[10]. Spatial frequency components are obtained from taking the two-dimensional discrete Fourier transform to textile design images. In general, the spatial frequency characteristics of human visual perception exhibit the characteristics of a low-pass filter. So, we consider lower components of spatial frequencies are expected to be related to visual features. Therefore, we dealt with the spatial frequency domains by a low-pass filter. By taking the two-dimensional inverse discrete Fourier transforms and by converting the L*a*b* system into the RGB system, an image with any passband of spatial frequencies can be obtained. We regard cross-correlation between a low-pass filtered image and an original image as the objective evaluation.

4. THE CORRELATION BETWEEN THE SUBJECTIVE EVALUATION AND THE OBJECTIVE EVALUATION

We examined a correlation between the subjective evaluation and the objective evaluation. When this correlation is highest, the subjectivity as "pop out feeling" correlates closely with spatial frequency components.

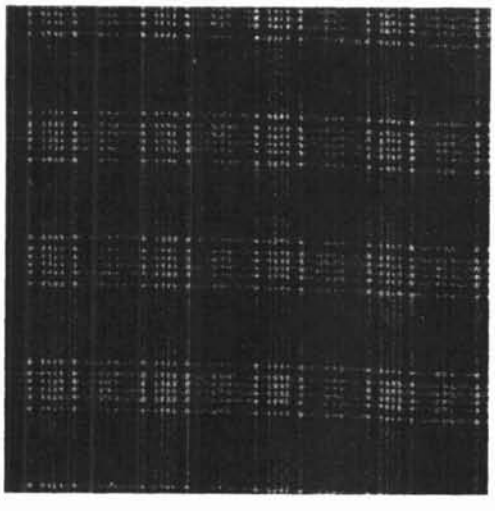
5. APPLYING A GENETIC ALGORITHM

We introduced a method of examining a correlation between the subjective evaluation and the objective evaluation. In this way, however, low-pass filtered images must be reconstructed to obtain the objective evaluation. The number of those images increases as the range of low-pass filtered radii are extended. It takes immense time to obtain low-pass filtered image from each textile design image. Therefore, we apply a genetic algorithm to save time. First, we obtain the spatial frequency domains from each textile design images. In genetic algorithm, we create an early population that is made up of individuals whose phenotype represents a low-pass filtered radius. We obtain low-pass filtered images by taking a low-pass filter processing with a radius that was represented as a phenotype of an individual. We calculate a cross-correlation between low-pass filtered images and original images for each one of textile designs. We regard this cross-correlation function as the objective evaluation of textile design images[11]. Furthermore, we calculate a cross-correlation between the objective evaluation and the subjective evaluation. We regard this cross-correlation funciton as the fitness of each individual. When operation of a genetic algorithm is over, a mean fitness of population passes a goal that we decided in advance. Otherwise the population is given operations of selection, crossover, and mutation; a new population was made up in result. We give an operation with this new population since a filer processing. In spatial frequency domains, the spatial

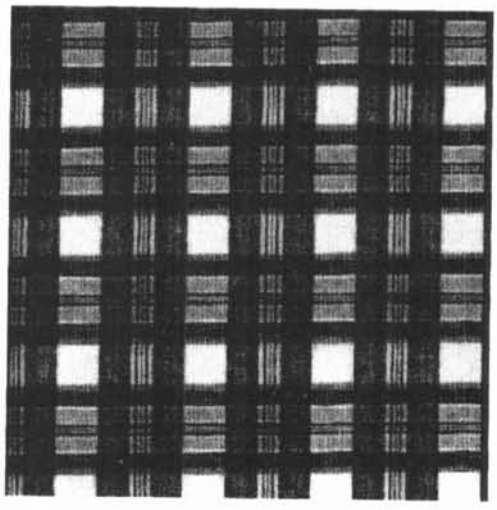
frequency components that exist inside a low-pass filtered radius that was represented as a the phenotype of individual of the last population are related to the subjectivity as "pop out feeling." We give the above-mentioned operation every component of L*a*b* system. Thus, we reduce the number of necessary low-pass filtered images by using a genetic algorithm and shorten the necessary time.

6. EXPERIMENTAL RESULTS AND CONCLUSIONS

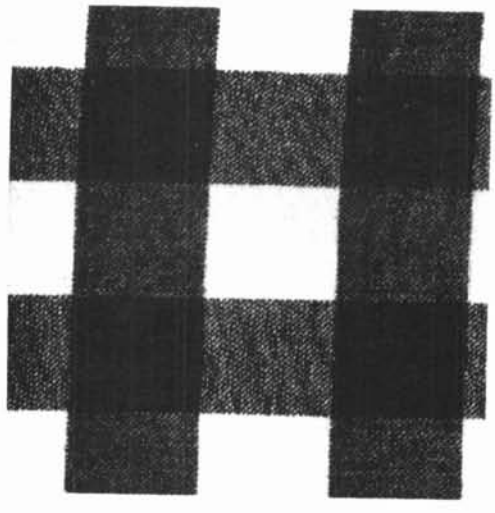
Figure 1 shows a hard copy of a pair of textile surface used as an example of textile design. According to the result of sensonary evaluation that uses examples of textile design, it showed that all examinees have the ability to distinguish and a standard of judgment between examinees was correspondence. Table 1 shows a measured value that was calculated by using a Bradley's method based on a previous result. We dealt with a paired comparison value as the subjective evaluation of visual feature of textile design.



Sample E



Sample F



Sample J

Fig. 1 Color Images of Textile Design

Figure 2 shows the result of examination of correlation between the subjective evaluation and the objective evaluation. The curve in Figure 2 represents values of cross-correlation function and the line segments on the curve represent a distribution of individuals.

Table.1 A paired comparison value

Textile design	A paired comparison value
A	0.001606
B	0.004176
C	0.017118
D	0.032463
E	0.042664
F	0.083541
G	0.158889
H	0.146958
I	0.189562
J	0.323023

In Figure 2, individuals distribute in a range that low-pass filtered radius is small, we find out the correlation between the subjective evaluation and the objective evaluation in this range. Namely, we obtained the result that lower components of spatial frequency of a* component in L*a*b* system correlated closely with the subjectivity as "pop out feeling."

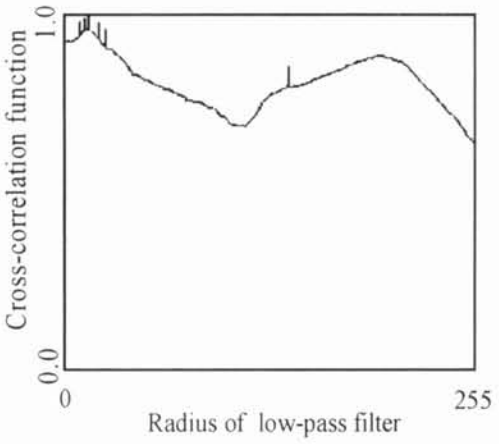


Fig.2 The result of GA

In the result, we can substitute the design of an image that was reconstructed by using a low-pass filer processing in spatial frequency domains for the design observed when men make a comparative judgment. Specifically, we consider lower components of spatial frequencies that are the objective visual features are available for one of the subjective searching subjects of the subjective design searches. In this report, we obtained the subjectivity evaluation of visual feature of textile design from the subjectivity as "pop out feeling." The subjectivity cannot, however, represent all the subjectivity as "this kind of feeling." Therefore, to examine a case using the subjective evaluation obtained from another subjectivity and to add the objective evaluation method that describes the subjectivity well are future topics.

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