Relationship between colors and forms and their significance for education

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Abstract

Rapid changes in models and fashion trends, different standards and the ever-growing demands of consumers, the creation of new materials, expect manufacturers to respond quickly and offer the latest items. This reflects on the training in fabric design, where new methods of training students – future designers – are constantly sought and developed. The diverse information and computer technologies provide an opportunity to study the relationships between colors and forms in textile design. In the present work, a method and tools for forecasting consumer demand have been developed, based on features of the color and forms of folk costume elements, represented by two-dimensional contour descriptions, which is based on a certain set and relationships between them. The obtained results increase the knowledge about the connection between colors and forms and their significance for textile designers. They would help to better illustrate the materials presented and the consistency in the design of textile fabrics and will generally support the specialized training of students studying fabric design.

Keywords: Textile design, Knowledge transfer, Color and form, Data analysis, Consumer perception

1 Introduction

A problem in art and design education is that creative practice is presented as the result of research or practice-led research (Niedderer et al., 2007). This problem arises from the desire of teachers to use their creative practice, as well as to offer contributions to research. Such a problem also occurs in the analysis of the relationship between colors and forms, in the development of new textile designs and analysis of consumer demand. (Sliburyte & Skeryte, 2014). A partial solution to the problem is proposed by Georgieva (2017). The main disadvantage of her research is that it does not offer a model for forecasting consumer demand. Also, the study covers only one ethnographic area in Bulgaria.

The analysis of the definitions of form of designers, architects and theorists in the field of design shows that according to all authors form and function are interrelated (Kazlacheva, 2014; Indrie et al., 2019). When designing new patterns, the designer must take into account the color preferences of consumers. Very often the color is the first sign on which the textile consumer makes a choice, and in all other cases after the choice of a certain form, the color is the second sign determining the choice. (Elnashar & Boneva, 2016). Sharing data on the color and form of decorative elements for textiles has the potential to improve consumer demand forecasting. Such a method is proposed by Mladenov (2020). By combining data from different sources, the predictive power of the models proposed by him is increased. The use of such an approach will strengthen the desire to provide a solid basis for the further development of research in the field of art and design. (Secan et al., 2012; Stoykova, 2015; Kazlacheva, 2017). The aim of the present work is to develop a method and tools for forecasting the demand of textile elements by consumers, based on features of color and form. The main task is to enrich the knowledge in this area.

2 Material and methods

Elements of Bulgarian costumes were used. The decoration of these costumes is achieved mainly with embroidered floral, animalistic and geometric ornaments. The variety of the apron is also complemented by colorful embroidery. Data for folklore elements selected by the users were used. The data are from surveys for a total of 106 elements. As descriptors of costume ornaments, their color indices and those of their form were used.

Color indices have the look (Cermakova et al., 2019):

[1] $NEXG = \frac{2G-R-B}{G+R+B}$ [2] $GLI = \frac{2G-R-B}{2G+R+B}$ [3] $NGRDI = \frac{G-R}{G+R}$

[4] $RGBVI = \frac{G^2-RB}{G^2+RB}$ [5] $VARI = \frac{G-R}{G+R-B}$ [6] $EXG = 2G - R - B$

where R, G, B are the color components of the RGB model.

Shape indices (K_f), eccentricity (K_1), orientation (K_o), density (K_R), area ratios (K_A and K_{MR}) were used. They have the look (Elnashar & Boneva, 2016):

[7] $K_f = \frac{P^2}{A}$ [8] $K_1 = \frac{D}{d}$ [9] $K_o = \frac{P^2}{4\pi A}$

[10] $K_R = \frac{1}{K_o}$ [11] $K_A = \frac{A}{A_i}$ [12] $K_{MR} = \frac{A}{A_{MR}}$

where A is the area of the element; P - perimeter; A_i - ideal area; A_{MR} - area of a minimum rectangle.

These characteristics of the costume elements were used to construct feature vectors. The features were selected by the methods RELIEFF, SFCPP, FSNCA, FSRNCA. When processed with these methods, the data are normalized in the range [0,1]. PCA and PLSR methods were used to reduce the amount of data. Principal components (PC) and latent variables (LV) were obtained from them. Regression models by PC and LV were obtained. The second-order polynomial model, which is more often used in practice, is accepted as the main one. The models were compared by: Regression coefficient (R^2); Fisher's criterion (F); p-level; Standard error (SE); Sum of error squares (SSE); Root of the root mean square error (RMSE). The coefficients of the selected model are optimized with the means of the Curve Fitting Toolbox, in the Matlab software system (The MathWorks Inc.). 80% of the data for the costume elements were used in compiling the predictive models, and 20% in the validation of the selected model. All data were processed at a level of significance $\alpha = 0.05$.

The obtained results are demonstrated through personalized products. Digital Fabrics tools are used for this purpose (https://www.digitalfabrics.com.au/).

3 Results and discussion

Feature vectors containing color and form descriptions of costume elements are selected. After reducing the amount of data of these vectors, a comparative analysis of regression models was performed. A model has been selected that describes with sufficient accuracy the relationship between the reduced color and form data of the elements and the choice of the consumers. The adequacy of the obtained model has been proven. An example of the application of the elements more often chosen by the consumers is presented.

Table 1 shows the selected feature vectors by the different methods used.

Table 1. Selected feature vectors

Feature vector	Feature / Method	NEXG	NGRDI	RGBVI	GLI	VARI	EXG	Kf	KI	Ko	KR	KA	KMR
FV1	RELIEFF		+		+			+		+	+	+	+
FV2	SFCPP			+	+		+		+		+	+	
FV3	FSNCA		+			+		+	+	+		+	+
FV4	FSRNCA	+	+		+	+						+	+

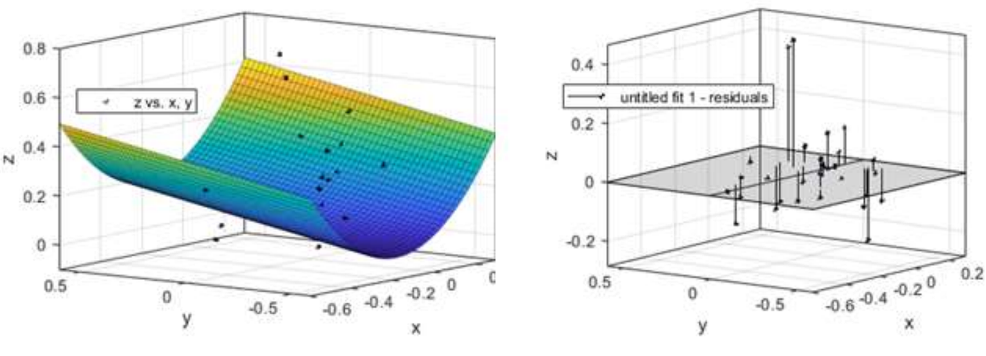
A comparative analysis of regression models obtained by principal components and latent variables is made. Their insignificant coefficients have been removed.

As a result of this analysis, a model based on FV1, selected by the RELIEFF method, by latent variables was selected. Optimization of its coefficients has been made. It was found that its regression coefficient R^2 = 0,76; SSE = 0,19; RMSE = 0,08; F (3,26) = 7,3> F_{cr} = 3,03; p <0,001; SE = 0,13.

The resulting model has the form:

[13] $$C = 0{,}15 + 0{,}67.LV_1 + 0{,}17.LV_2 + 1{,}8.LV_1{}^2$$

Figure 1 shows the resulting model and its residuals. The first latent variable is plotted on the X axis, the second is plotted on the Y axis, and the probability of selecting the elements from the consumers is plotted on the Z axis. As can be seen from the location of the residuals around the normal surface, they are close to it and it can be considered that the prerequisites of the regression analysis are fulfilled. When validating the model, low error values were obtained, SSE = 0,21 and RMSE = 0,09 were determined.



a) General view b) Residuals

Figure 1. Regression model C=f(LV1,LV2), obtained from FV1

An example of application of the more frequently chosen by the consumers elements of costumes is presented. Custom elements of interior design have been created.

Figure 2 shows examples of the application of folk motifs on curtains. A Drop iteration was used to create them. The curtains are in green and yellow range, as well as with a woven blue shade on a white background. They are placed on a dark gray wall and a window with a white frame so that they stand out smoothly in the interior of the room.

The results presented in this paper confirm and supplement those in the available literature. A model is proposed for forecasting the demand of users for elements depending on their color and shape. This complements the results of Georgieva (2017), where this connection is partially proven and the author relies more on verbal descriptions than on numerical evidence.

The joint use of data on the color and form of elements of costumes leads to an improvement of the predictive ability of the created regression models, which confirms the results of Mladenov (2020).

An example of application of user-selected elements in interior design is proposed. This complements the results reported by Kazlacheva (2017) by applying online software tools to create repeats of elements on textiles.

4 Conclusion

A method and tools for forecasting consumer demand have been developed, based on features of the color and shape of costume elements, represented by two-dimensional contour descriptions, which is based on a certain set and relationships between them.

Analytical models have been created, based on feature vectors, including characteristics of the color and form of folklore elements, reduced with principal components and latent variables. These models can be used to predict the user's choice of such elements. Models based on latent variables have been found to perform better than those using principal components.

A model is proposed by which 76% of the change in consumer desire is described by the first two latent variables obtained from a vector containing color and form descriptions of costume elements.

The obtained results increase the knowledge about the connection between colors and forms and their significance for textile designers. They would help to better illustrate the materials presented and the consistency in the design of textile fabrics and will generally support the specialized training of students studying fabric design.

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