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Color difference classification based on optimization support vector machine of improved grey wolf algorithm

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ABSTRACT

In order to establish the color difference classification model of printing and dyeing products, a grey wolf algorithm optimization support vector machine based on differential evolution (DE) model is proposed in this paper. First of all, the performance of the support vector machine (SVM)model is mainly affected by the penalty parameter C and the RBF kernel width γ, and the method uses the good global search capability of grey wolf optimization (GWO) algorithm iteratively optimization to compute the best parameter combination of support vector machines. At the same time, because the initial population of grey wolf algorithm has a greater influence on the solution speed and quality of the algorithm, the DE algorithm is used to generate a more suitable initial population for grey wolf algorithm, which makes the grey wolf population have better solution ability. Finally, through the optimization to the penalty factor and the kernel width parameter, the printing and dyeing products classification model of SVM with strong generalization ability is constructed. The experimental results show that the proposed method achieves high classification accuracy, and have good stability and generalization ability, when it is compared with the color difference classification method of printing and dyeing product based on SVM and GWO-SVM algorithm.

1. Introduction

In the printing and dyeing industry, the color difference of the textile after printing and dyeing will seriously affect the quality requirements of the finished products. Whether the dyed textile fabrics that can meet the color difference of the samples expected by customers will have a huge impact on the customer's satisfaction. Therefore, to prevent the influence of fabric color on the quality of the printed product, we must construct a model that can accurately and hierarchically classify the color difference of the printed products, then, using different grades of color difference to make intelligent post-processing work for printing and dyeing products, which will greatly enhance the efficiency of printing and dyeing in the textile industry.

Color difference detection of printing and dyeing products is one of the important research contents in textile dyeing and finishing. In the process of detection, a very important content is the control of external conditions, such as lighting, scene and other factors. At present, there are many companies, universities and research institutions that are engaged in this field of research at home and abroad. Noor [1] studied the impact of illumination differences on the color evaluation of the dyed goods, in order to get the influence of various factors on the quality evaluation to the textile, the printing and dyeing products were placed in seven different scenes, afterwards, it is evaluated by using the illumination types of each scene, the color difference value of the textile and the other

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aspects factors. To solve the data storage problem in embedded systems, Yang [2] developed a computer vision color difference detection system, which is a kind of hardware design based on digital signal processing and based on field programmable gate array and complex programmable logic device, respectively. However, the main part of the system is mainly hardware, and there is no systematic research on the color difference detection classification algorithm and illumination estimation algorithm of the printing and dyeing products. Zheng [3] studied the relationship between the grey grades of dyed fabrics color change and the corresponding color difference by image processing and calculating, and compared with the high-precision computer color matching system. Due to the dyeing process of textile is easily influenced by the change of illumination condition, it will lead to the serious error of color difference estimation. In [4], it used the Grey-Edge framework to replace the traditional high dimensional binaryzation chromaticity value method, which produces an effective low dimensional color feature as the input image data, and thus, the illumination correction method based on Grey-Edge and kernel extreme learning machine about printing and dyeing products was constructed. According to literature [5], aiming at the training accuracy and the stability of ELM are easily affected by randomly giving network input weight and hidden layer bias, an integrated particle swarm optimization extreme learning machine (PSO-ELM) prediction model of printing and dyeing products based on Bagging is proposed. In [4,5], they conducted a research to the preliminary study about the illumination prediction model of color difference in the printing and dyeing products classification, which is beneficial to correctly classify the color difference of the printing and dyeing products. For the modern textile printing and dyeing industry, it is very important to construct a color difference detection classification model with good classification effect, strong generalization performance and high stability.

SVM has been widely used as a classification model with good classification, strong generalization and high stability, such as textile testing [6], skewed data sets classification [7], high-dimensional data classification and dimensionality reduction [8], bruising degree classification of apples [9], defect inspection of flip chips [10], laser ultrasonic quantitative recognition [11], peer-to-peer networks [12], image denoising scheme [13], deal with large scale problems [14]. Zhang et al. [6] proposed a color difference detection model based on genetic algorithm optimization SVM. Although some results have been obtained, the genetic algorithm (GA) has slow optimization speed and its disadvantage of easily falling into local optimum has not been solved. In [7], SVM classification method based on PSO applied to skewed data sets was proposed. Firstly, the proposed method obtained the support vector from the skewed dataset, which was used to generate new instances and PSO algorithm to evolve artificial instances and eliminate noise instances. In [8], a sparse and minimax ridge SVM is proposed to classify and reduce the dimension. In [9], to quickly and accurately determine the damage degree of apples, using schematic of hyperspectral imaging technology, the combination successive projections algorithm is proposed, which is a kind of apple damage degree classification method based on support vector machine optimized by grid search parameters. In [14], inspired by the theory of compressed sensing, an algorithm based on dictionary compression and least squares support vector machine (LS-SVM) was proposed to deal with large scale problems. In order to obtain robust classification results, many authors optimize SVM according to the optimization theory.

On the basis of the above literature, this paper presents a color difference detection of printing and dyeing products algorithm that is based on SVM of the DE optimization grey wolf algorithm. The main contributions are as follows:

(1) In order to improve the generalization ability of the SVM model, the GWO algorithm is used to optimize the key parameters of the SVM.
(2) The initial population of the original GWO algorithm is generated randomly, which may result in the lack of diversity of wolves in the search space. Therefore, the DE algorithm is adopted to generate a more suitable initial population for grey wolf algorithm classification, thereby improving the convergence speed and better solution ability of the algorithm.
(3) The proposed DE-GWO-SVM model can get better classification accuracy, and the recognition accuracy is better than support vector machine model based on the original GWO, SVM model based on grid search and ELM or the other methods. And the proposed method achieved precisely classify to the color difference classification problems of printing and dyeing products.

2. SVM

The problem of data classification in SVM can be described as [15]: the system generates a hyperplane and continuously adjusts the plane until the point belonging to the two types in data set is located on the two side of the hyperplane, and the distance about the point of sample set to the classification plane is as large as possible. In the sample space, the classification of hyperplanes can be described by the following classified linear equations:

$$\boldsymbol{\omega}^T x + \mathrm{b} = 0 \tag{1}$$

where, $\omega = (\omega_1; \omega_2; \cdots; \omega_d)$ is a normal vector, which determines the direction of the hyperplane; b is a displacement term, which determines the distance between the hyperplane and the origin. Suppose the hyperplane can correctly classify the training samples. That is, for $(x_i, y_i) \in D$, if $y_i = +1$, is there $\omega^T x_i + b > 0$; If, $y_i = -1$ then there is $\omega^T x_i + b < 0$. Order

$$\begin{cases} \boldsymbol{\omega}^T x_i + b \geq 1, \ y_i = +1; \\ \boldsymbol{\omega}^T x_i + b \leq -1, \ y_i = -1 \end{cases} \tag{2}$$