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Estimation of Pigment Magnitudes in Synthetic Leather by using Scanner and Artificial Neural Network

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ABSTRACT. In the present work the magnitudes of pigments in the synthetic leather, were measured by means of scanner. Initially synthetic leather samples pigmented by three different pigments of yellow, blue and red colors were prepared. Then the pigmented samples were scanned, and the values of RGB of images were calculated. The artificial neural network (ANN) method used to make relation between RGB values and pigment magnitudes. The method was successfully applied for the estimation of pigment magnitudes in the synthetic leather samples.

Keywords: Synthetic leather, Pigment, Determination, Scanner, Artificial neural network.

1. INTRODUCTION

Nowadays with the rapid development of computer-based image processing techniques, color images are widely used in visualization, communication, and reproduction [1−5]. With the steadily improved quality and decreasing prices of digital cameras and scanners, digital photography is beginning to replace conventional film-based photography. The two main types of digital color input devices are scanners and digital cameras that record the incoming radiation through a set of color filters (typically RGB). This signals generated by a scanner are device dependent, i.e., different scanners produce different RGB signals for

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the same scene [5–10]. The most important point in function of scanners is their calibration. Device calibration is the process of maintaining a device with a fixed known characteristic color response, and should be carried out prior to device characterization. A successful calibration operation can lead to a successful scanner based color measurement system [11,12]. Device characterization techniques can be classified into two categories: colorimetric and spectral. Colorimetric characterization transforms the imaging device responses, or RGB values, into device-independent CIE tristimulus values [13,14]. Typical techniques used for colorimetric characterization are least-squares-based polynomial regression, look up table with interpolation and extrapolation, and artificial neural networks [6,7,10–17].

In conventional methods for obtaining accurate measurements using scanners, a relation must be established between the scanner and color values of an independent color space such as CIEXYZ or CIELAB. The main goal of color calibration process is to attain the transformation function of "g" from device dependent elements, RGB to CIEXYZ or CIELAB elements [6–8,10] that the mathematical expression can be written in the form of (1):

$$[L^*, a^*, b^*] \text{ or } [X, Y, Z] = g(R, G, B) \tag{1}$$

A variety of methods such as regression, neural networks may be used in order to obtain the above mentioned relation.

Artificial leather is a fabric or finish intended to substitute for leather in fields such as upholstery, clothing and fabrics, and other uses where a leather-like finish is required but the actual material is cost-prohibitive or unsuitable. There is considerable diversity in the preparation of such materials. A common variety consists of a mixture of dispersed PVC polymer particles together with plasticizer. By heating, the plasticizer can penetrate in to the polymeric particles and finally leather Plastisol would be obtained. Some stabilizers such as Tio_2 may also be added to the synthetic leather to prevent probable environmental degradations. In addition different color synthetic leathers can be obtained by addition of pigments either single or combinatory to the synthetic leather.

In the present work a polynomial regression method was developed in order to make relationship between color values (obtained by scanning the leather surface) and different proportions of pigments in the leather. In this way it was tried to estimate the magnitudes of pigments in the synthetic leather.

2. MATERIALS AND METHODS

Epoxy (stabilizer) and PVC 1302 were purchased from LG Corp. Three pigments of yellow 84 ‹Red 48:2 and Blue 13:3 were from PATCHAM Company. $CaCO_3$ and Sudarshan were also prepared from Zagros powder Corp. A MATHIS instrument was used for preparing the synthetic laboratory leather.

In this work 128 synthetic leather samples were pigmented by using mixtures of the three pigments and Tio2 in ratios of 0, 1, 2 and 4. For testing the efficiency of the method 85 samples were used as training samples and 43 samples were used as test samples.

The pigmented samples were scanned with a Benq ST-5550 flat scanner. Subsequently RGB values of the captured images were derived by using Photoshop 10 cs3 software. For establishing a relation between RGB values and magnitude of pigments, artificial neural networks with different constructions (number of layers and connections) were used.

The neural network was trained using back propagation algorithm. Seven different conditions were used that among them five forms had one layer that the number of neurons in layers were different. The numbers of neurons in the five forms were 3, 4, 5, and 6 neurons in layer. In the other two forms, a neural network with two hidden layers was used that in the first form the layers had 2 and 3 neurons and in the second form both layers had similar numbers of neurons (two).
The difference between real concentration and predicted concentration of pigments (as relative error percentage) was evaluated by Eqn (2):

$$E = 100 \times \frac{\left| C_{actual} - C_{predicted} \right|}{C_{actual}} \quad (2)$$

3. RESULTS AND DISCUSSIONS

The results for estimation of pigments ratios in test samples after training the network are given in Figures 1 to 4. As can be seen in these figures, the effect of difference in number of neurons as well as hidden layers are evaluated. Figure 1 illustrates the mean error percentage in estimation of blue pigment in test samples. It was observed that the network with one hidden layer and three neurons in layer resulted the highest level of estimation error (18%) and with increasing the number of neurons in hidden layer the error level decreased. When a network with seven neurons in layer was used, the error level relatively increased to (14%). Subsequently by changing the numbers of neurons and layers, the amount of error level decreased and when a network with two neurons in each layer was applied the obtained error was (9%).

The results for estimation error of red pigment ratios are shown in Figure 2. As can be seen the highest amount of error level was obtained by using network with three neurons in a hidden layer. The obtained results of red pigment showed that the lowest level of error (7%) was obtained when the two hidden layers had two and tree neurons.

The Figure 3 shows the results for estimation of yellow pigment ratios. The obtained results showed that the highest level of error was obtained by applying network with seven neurons in a hidden layer. On the other hand the lowest error level (11%) was achieved by network with two hidden layers of respectively two and three neurons in each layer.

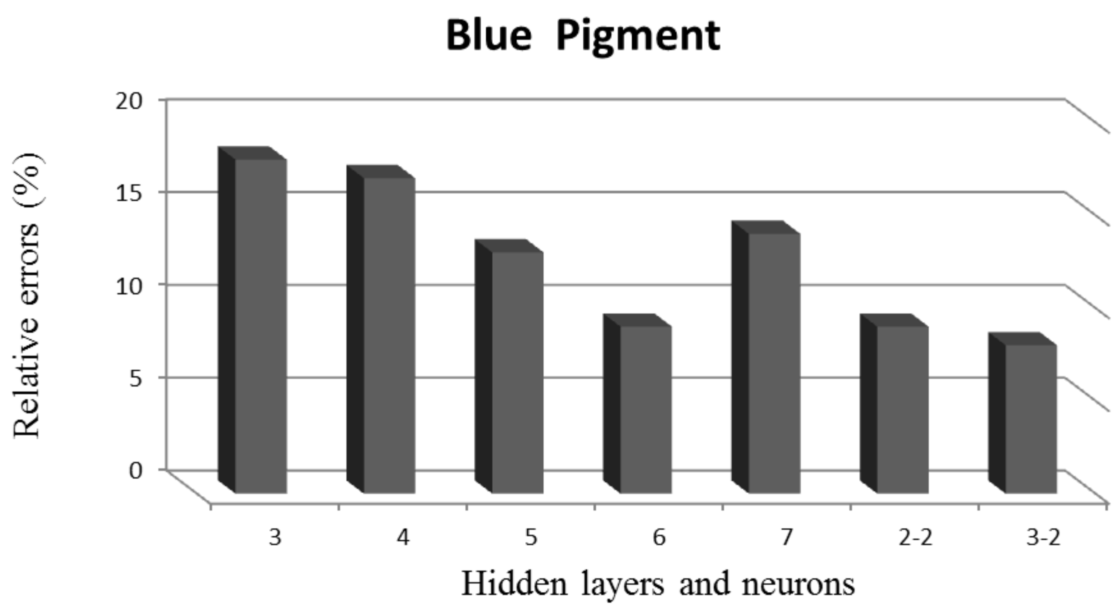

Figure 1. Relative Error Percentage in Determination of Blue Pigment.

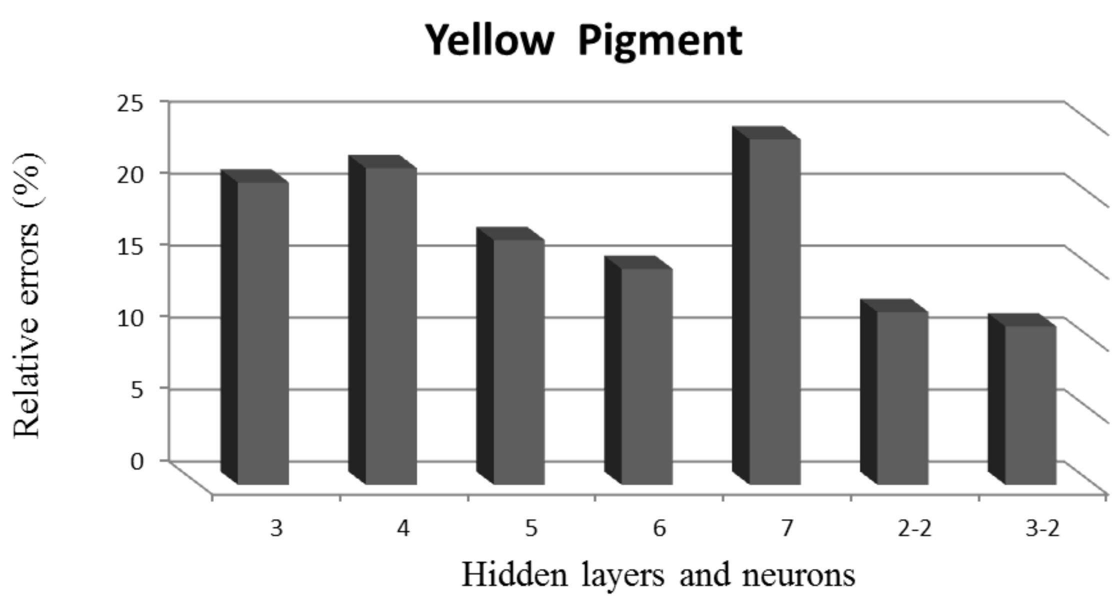

Figure 2. Relative Error Percentage in Determination of Yellow Pigment.

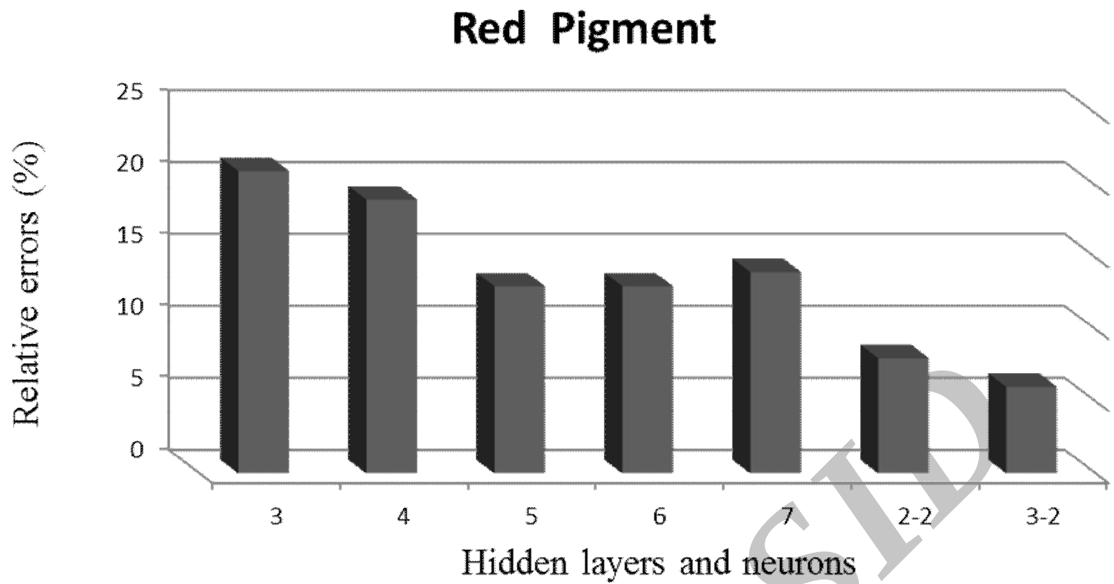

Figure 3. Relative Error Percentage in Determination of Red Pigment.

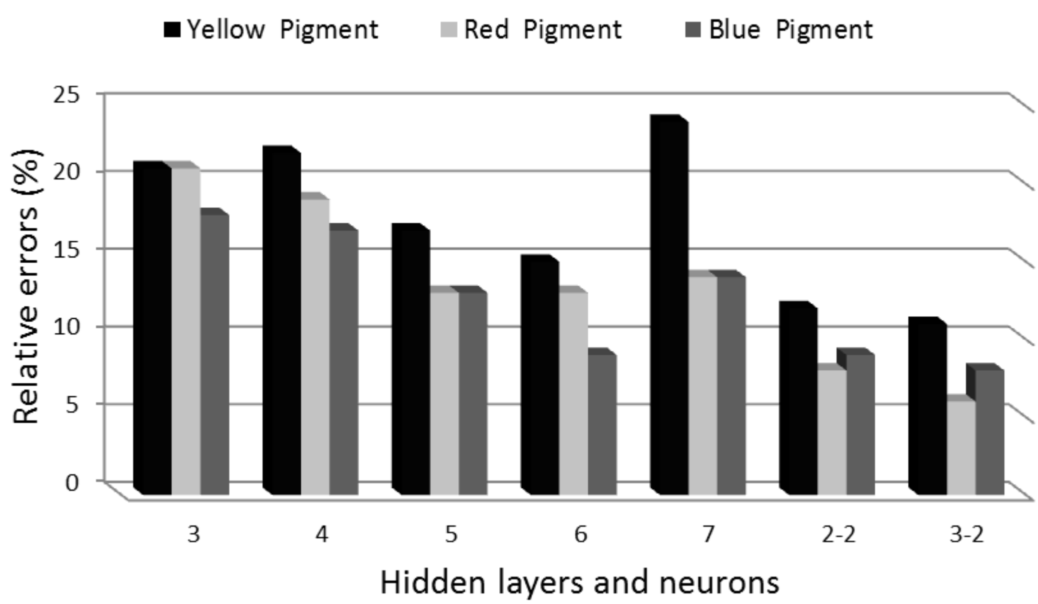

Figure 4. Comparison of Obtained Errors in Determination of the Pigments Magnitudes.

The results for comparison between determination errors of the three pigments when the networks constructions were similar are given in Figure 4. It was observed that generally the red pigment determination had the highest amounts of error levels. In the application of networks with one layer, the blue pigment showed better accuracies that red pigment, however when networks with two layers were used, the errors of blue pigment estimation increased more than red pigment.

4. CONCLUSIONS

The present method in this study can be introduced as technique for the determination of ratio or percentage of pigments in combinatory pigment mixtures in synthetic leather or other textiles. As flat scanners are relatively low price instruments, the developed method can be suitable for both industrial and home users.

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