Automatic recognition of woven fabric patterns by extraction of the characteristics of texture.

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Abstract

The extraction of the characteristics is one of the most important stages in the process of pattern recognition. This stage is defined as being the stage of coding and extraction of information necessary to the recognition before passing to the phase of classification [6].
In our work, a major importance has been given to the algorithms of training and more particularly the algorithm of retro-propagation of the gradient applied to multi-layer perceptrons. Among the applications of this algorithm, we find the field of pattern recognition and in particular the identification of the fabric patterns which initially consists in collecting raw data from the digital camera or the scanner. This initial image requires a set of pretreatments in order to eliminate parasitic information and to preserve those which are relevant for the recognition [3]. In our case, the images were captured through a scanner with a resolution of 300 dpi. After a series of treatments, two parameters were retained to automatically recognize the fabric pattern: obliqueness and orthogonality.

Key words

Image processing, pattern recognition, fabric pattern, neural network.

Introduction

The image processing consists in eliminating parasitic information and storing the relevant information for the pattern recognition. Techniques of image processing were particularly employed for the identification of the fabric pattern [2, 7]. Other researchers combined the techniques of image processing with the neural networks to solve the problem [1]. In this work, we began with a series of image processing then we passed to a stage of extraction of information on the fabric texture of the fabric. Thereafter, we opted for the use of an artificial neural network having as inputs the obliqueness and the orthogonality.

Generally, the main problems of the pattern recognition are the representation of the input data and the extraction of the characteristics of these patterns (to reduce the dimension of the problem).

Image processing

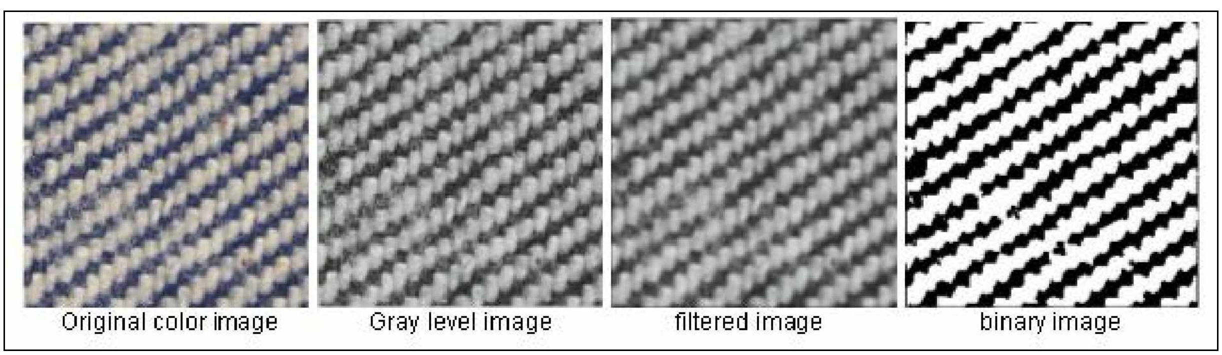

Figure 1: Stages of image processing

The first stage in the image processing, after the conversion of the original color image into a gray levels image is the filtering. This operation is fundamental since it helps to improve the perception of some details, reduce the noise and compensate certain defects of the sensor. In an image, the low frequencies correspond to slow variations of the intensity (uniform zones) whereas the high frequencies correspond to fast variations (edges, noise) [5].

After a comparative study on the effects of several filters, we noted that the use of a low-pass filter gives an image clearer than the other types of filters. Since our study is related to the extraction of the texture parameters, it is necessary to preserve all the visual details of the image. In our case, each image will be analyzed as being a set of parameters and characteristics. In order to make the images easier to treat numerically, we converted them into binary images using the process of histogram equalization. This last operation is a useful tool to improve the quality of certain images (bad contrast, too dark or too clear images, bad distribution of the intensity levels …etc.) [5]. In other words, equalizing a histogram means to make it as flat as possible.

Extraction of the characteristics

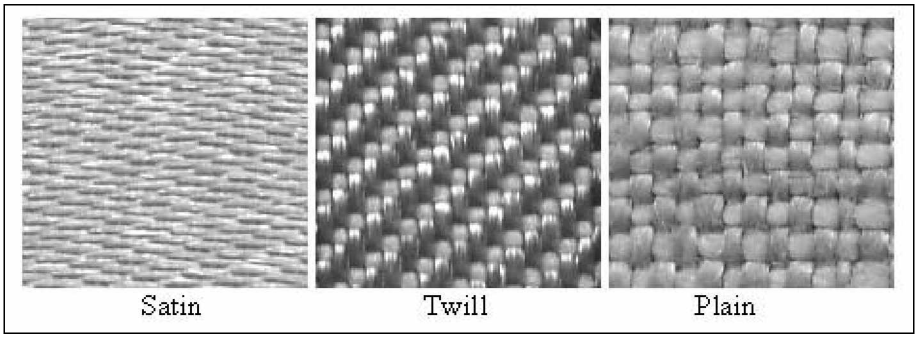

Figure 2: Woven fabric patterns.

Obliqueness (OB)

The remarkable common feature between all twill woven fabrics is the line skew (obliqueness). Thus, we decided to make this parameter outstanding to distinguish the twill armour from the other types.

To transform this property of visual appearance to a measurable parameter of the image, we adopted the following equations:

$$\mathrm{OBi} = \frac{\text{Number of neighboring pixels inclined in the same direction and having the same color}}{\textit{Total number of pixels in the image}} \quad (1)$$

We admit that in each woven fabric, we have two directions of slope. Thus, we define the obliqueness as follows:

$$\mathrm{OB} = \mathrm{Max}\,(\mathrm{OB1}, \mathrm{OB2}) \quad (2)$$

Orthogonality (OR)

Orthogonality is defined as being the property of an image to present horizontal and vertical bands (i.e. in the direction of warp and in the direction of weft). Indeed, for the case of twill, this property is nearly untraceable. In the continuation of our study, we attributed a great importance to this parameter in order to distinguish the plain weave from the other fabric patterns.

For each image, we defined:
Black_Pix: the number of adjacent black pixels in a given direction.
White_Pix: the number of adjacent white pixels in a given direction.
L: number of pixels in a direction (vertical or horizontal).

$$OR = \frac{\max\,(\mathrm{Black\_Pix},\ \mathrm{White\_Pix})}{\mathrm{L}}$$

Application of the neural network

To construct a neural network correctly, several parameters have to be optimized. These parameters include the number of hidden layers, the number of neurons in the hidden layer, the learning rate and the number of cycles during the training [3,4].

Choice of the type of network and the algorithm of training

The network that we implemented is a multi-layer perceptron that uses the training algorithm known under the name of retro propagation of the gradient.

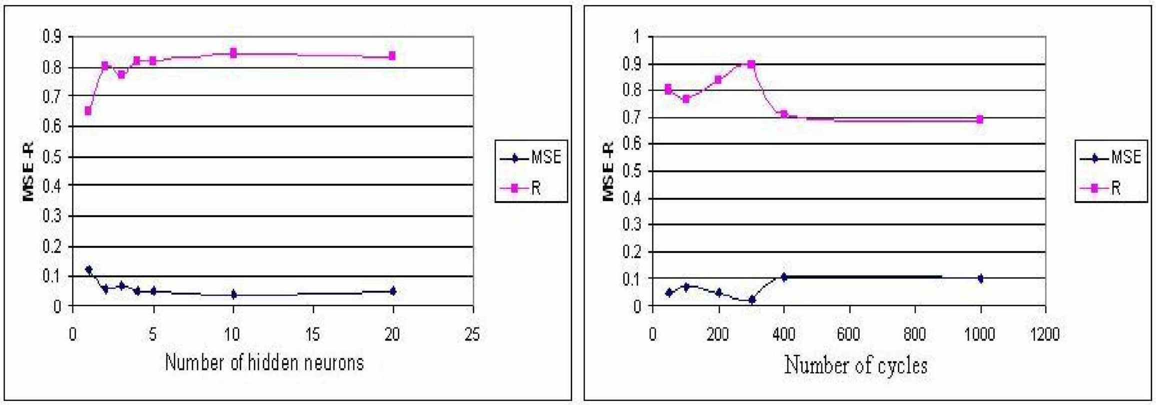

Figure 3: Effect of the variation of the number of hidden neurons and the number of cycles

Number of hidden neurons

The number of neurons in the hidden layer was selected according to the error and the correlation coefficient R between the actual values of the sample test and those estimated by the network. The number giving the minimum error and the highest value of R is retained. Figure 3 shows that the optimal value is obtained with 10 hidden neurons.

Iteration count

The number of training cycles is also determined according to the mean square error MSE and the correlation coefficient. According to figure 3, the best result is obtained for a number of cycles equal to 300.

Finally our neural network is characterized by:

- Number of iterations = 300,
- 2 inputs, one output,
- One hidden layer,
- The hidden layer contains 10 neurons,
- Selected transfer functions: logsig, purelin,
- Expected performance: 0.00.

Results

Table1: Results of the identification of basic weave patterns

Name of woven patterns	The number of woven patterns tested	The number of woven patterns classified correctly
Plain	9	9
Twill	19	19
Satin	15	14

Our training system of identification of the basic weave patterns reached an optimal rate of 100% for the plain, 100% for the twill and 93% for the satin weaves.

Conclusions

In this study, we used image processing techniques to extract the information necessary to the pattern recognition: obliqueness and orthogonality. The identified characteristics were used for the classification of the fabric patterns. After the phase of data selection, we started the training phase which consists in building a representation of the classes through a set of examples.

The two parameters which characterize the fabric patterns were used as inputs to the artificial neural network. With this system we reached a rate of recognition of the woven patterns equal to 100 % for the plain and the twill and a percentage equal to 93 % for satin weaves. This result leads us to think for another measurable characteristic to distinguish the satin for the other types of patterns such as the angle of inclination.

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