Pakistan Journal of Information and Technology 2(1): 69-71, 2003

Materials Matching Using Back-Propagation Algorithm

Bekir Karlik and Yousif Al-Bastaki
The College of Information Technology, University of Bahrain
P.O. Box: 32038, Kingdom of Bahrain

Abstract: The aim of this study is to come up with solutions that help decoration firms to deal easily with the conflicting demands of its client by finding the most appropriate matched material to a given sample. For this purpose, a Multi Layer Perceptron (MLP) structure neural network, which has back-propagation training algorithm, program was developed. This program is built on the principle of matching plain material with a textured one; based on the least existing percentage of the desired color, which is the color of the plain material.

Key Words: Material Matching, Neural Network, Decoration

Introduction

Computer programs that perform color recognition for paints, inks, plastics and textiles commonly are very important. Most companies are now equipped with spectrophotometers to measure the reflectance of physical samples. However, when colors are measured by a colorimeter, or when a new color is selected within the framework of a colorimetric ally calibrated CAD application, only coordinates of XYZ values are available and a much less efficient approach must be adopted to find the values of colorant concentration that will produce a matching color. The application areas are all those requiring that color matched material are specified, displayed and preserved using perceptual matching. Typical areas where color is an important feature of the product and where these methods are proposed are: textile printing and dyeing; ceramic, paper, paint and plastic products; quality control for food production; visualization of sales products. Automated material matching is a good alternative to reduce human workloads and labor costs as well as to improve decoration firms easily. In fact, much research has been done in automated image matching on various materials (Nastar, *et al.*, 1996; Xinli and Albrengsten, 1995 and Kwak *et al.*, 2000).

The selection of an appropriate classifier is also a very difficult problem because classification accuracy as well as many other factors should be considered in the production environment. In general, classifiers can be categorized as either rule-based classifiers or learning classifiers. Since it is often difficult to clearly define matching classes in terms of rules, the rule-based classifiers seem inappropriate for material matching. The method proposed can be used easily and effectively to desire the most appropriately matched material using back propagation algorithm for decoration and furniture industrials.

The Structure of MLP and Back Propagation Algorithm: Artificial Neural Networks (ANNs) are widely used in functional approximation and pattern classification applications due to their capability for modeling complex and highly non-linear functions. There are many different kinds of ANNs. The Hopfield Network, Multi-Layer Perceptron (MLP), Radial Basis Function Network (RBF), Adaptive Resonans Theory (ART) (Hopfield, 1982; Grossberg, 1987; Rumelhart *et al.*, 1986), etc. are some examples. Neural Networks find extensive application in industries especially for modeling processes which are inherently complex and hence difficult to understand. In general, physical systems are characterized with the help of mathematical models. Very accurate models can be built when the physics underlying the system being modeled is known. However, in many cases, the mechanism is either too complex or unknown. This calls for empirical modeling techniques to develop classification which are inferred from available data.

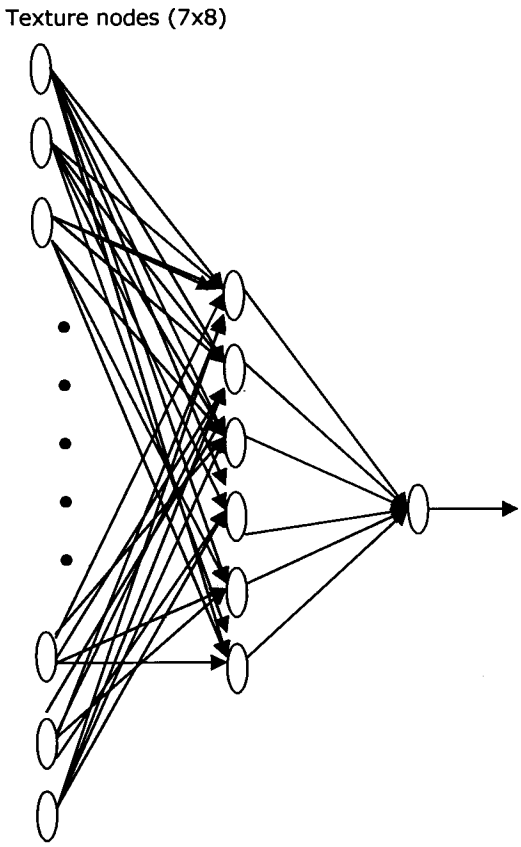


Fig. 1: Architecture of MLP

ANNs have been shown to provide good classification for nonlinear systems with high computational speeds, even with large problems due to their highly parallel structure and powerful representational capacity. The MLP exhibits very good performance (Hopfield, 1987; Ozbay and Karlik, 2002) in terms of convergence and training time for the different classification applications.

MLP generally uses sigmoid function in the input space to determine the hidden layer activations (Fig. 1). As it can be seen this Figure, a 3-layered perceptron structure was used in this study.

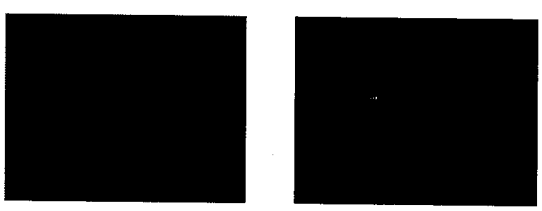
Materials and Methods

There are two distinct techniques for pattern recognition used in current machines: feature analysis and matrix-matching.

Feature Analysis: The input material is similar to that operated on by matrix-matching but each pattern is examined for certain features, such as vertical and horizontal lines, the presence of curves and loops and the location and relationship between these features. The classification is compared with stored information about known characters in a variety of materials.

Matrix-Matching: The information from the stage can be considered as being similar to a picture of a character formed by filling in squares on a graph/matrix. Each character, in each recognized font, is represented by different filled-in patterns. Perfect match is rare, so pattern recognition techniques are used to associate characters from the filled-in matrix. Artificial neural networks allow pattern recognition.

This proposed program is built on the principle of matching plain material with a textured one; based on the least existing percentage of the desired color, which is the color of the plain material. Fig. 2 shows sample patterns to explain our method in recognizing the matching material to the plain one.



(a) (b)

Fig. 2: Sample Patterns: (a) the Plain Material (b) the Texture Material

Here, pattern (a) is accepted as the plain material, the other one is the texture material. Both image patterns are converted (normalized) into binary numbers that is fed into the program as an (7*8) grids as follow:

- Pattern (a) all the grids will have value of "1".
- Pattern (b) will have value of "1" if it matches the color of pattern (a); otherwise it will be "0".

Data file is divided as training data and testing data;

1. **Training Data:** that file has the input of the textured material; which is represented in binary (0's and 1's).
2. **Testing Data:** that file has the desired material color; which represented in 1's only.

The two input files each contains a 7*8 matrix; which represents the proposed materials that we have to match. The presentation of the colors will be in binary numbers *"1's and 0's"*. The plain material will be presented by the binary value "1" and the textured material will be presented by the binary values "0 and 1" where the value 1 is the presentation of the match color of the plain material and the value "0" is the presentation of any other color in the textured material. We can try to match different textured materials with the proposed wanted color, which contain all 1's. The winning texture material will be the one with percentage of desired color less than 50%.

y = {1(winning material), x>50%,
0 (not win), x<= 50%}

This percentage could be changed according to the decoration firm taste in decorating the houses. We found out that there was only one output indicates the suitability at the texture material depending on proposed here.

In this study, the back propagation algorithm was used in order to solve the selected problem. Back Propagation (BP) algorithm is one of Neural Networks applications that is best suited to our problem because:

- It can simulate the human brain's way of thinking.
- It has strong ability for classification and recognition.

Because of this situation a BP algorithm program had been implemented by C language. It can be seen in Fig. 1, a three-layered perceptron architecture was used, which contains 2 inputs; 56 nodes represent each. The hidden layer also consists of 56 nodes. The output has only one node. Logically, winning material produces and output of 1, otherwise the output is 0.

Conclusion

In this paper, we introduced a material matching program for furniture decoration. This program is built on the principle of matching plain material with a textured one; based on the least existing percentage of the desired color, which is the color of the plain material. Here there is only one output that will indicate whether this texture material wins or not, This depends on the percentage that we proposed. Fig. 3 shows total back-propagation training algorithm error. After 50.000 iterations we observed very good results.

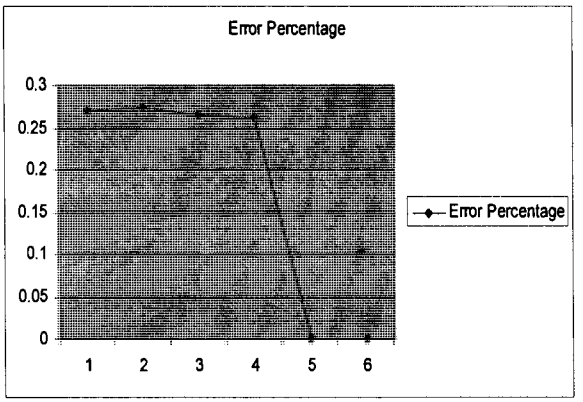


Fig. 3: Total Error Depending on Number of Iteration (x10.000)

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