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Application of artificial neural network in textiles

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Abstract
The term neural network is used to describe different models intended to imitate some of the functions of human brain using its basic structure. Artificial neural network (ANN) models have been shown to provide good approximations in the presence of noisy data and a smaller number of experimental points. The assumptions, under which ANN models works, are less strict than those for regression models. Therefore, over the past decades, ANNs have been used for modeling various textile nonlinear problems. From spinning to garment manufacturing units, it has contributed in many ways improving processability, reducing cost and minimizing variability in quality aspects. The present paper discusses various applications of artificial neural network in textiles so as to realize us that there are still a lot, which is to be exploited by implementing the use of this tool.

Keywords: Artificial neural network, back propagation algorithm, fabric faults

1. Introduction
An artificial neural network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people learn by example. ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exists between the neurons. This is true of ANN as well. Neural networks with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an “expert” in the category of information it has been given to analyze.

2. Advantages of using ANN
The main advantages of using neural nets for predictive modeling can be as follows:
1. Neural networks require little human expertise; the same neural n*et al*gorithm will work for many different systems.
2. Neural networks have non-linear dependence on parameters, allowing a non-linear more realistic model.
3. Neural networks can save manpower by moving most of the work to the computer.
4. Neural nets typically work much better than traditional rule-based expert systems for modeling complex processes, because the important rules and relationships are difficult to discern, or when the number of rules become overwhelming.
5. The trained neural net can be used in sensitivity analysis. This information can be used to reveal the measured and control variables to which the process is sensitive.

3. Applications of ANN in textiles
In cut throat competition of world trade where every want to shorten Product life cycle and becoming more quality and cost conscious its become necessary to develop such a system through which one can predict finished product properties without undergoing test processing which consume lot of time and add cost of final product.
Artificial neural network provide such an opportunity to get rid of this entire head ache. Through ANN we can predict the properties of our final product by just putting the raw

material properties as input in the trained neural network. Through this we can even get the raw material properties required to get desired output, we get the idea which property is more important for to get the desired output.

Some of the fields in textiles where ANN has been successfully utilized:-

- Prediction of yarn tensile properties.
- Cotton co1or grading
- Predicting bursting strength.
- Neural fuzzy classification for fabric defects.
- Classifying textile faults.
- Classifying web defects by back propagation
- Pridicting strength of Air-Jet spun yarn
- Prediction of thermal resistance of fabrics
- Selecting cotton bales by sinning consistency index and micronaire
- Determining Spinnability
- Prediction of cotton yarn irregularity.
- 12 Relaxation behavior of yarns.
- Predicting hairiness of yarns.
- Analysis of cotton trash classification.
- Evaluation of wrinkle recovery.
- Selecting optimal interlining.

3.1 Prediction of yarn tensile properties by using artificial neural networks

The work also has been done to design an artificial-neural-net model for predicting yarn tensile properties. A single hidden layer neural network trained by using the back-propagation algorithm performs a functional mapping between material properties, process variables and the resulting yarn tensile properties. The material and process variables, namely, yarn count, blend, and front-and back-nozzle pressure on an air-jet spinning machine, are correlated with the next was trained and then used to predict the tensile properties of yarns. The errors or prediction were low despite the availability of only a relatively small data set for training, and in each case the prediction error was less than the standard deviation or experimentation. Use of the cross-validation technique ensures that the neural net obtained a generalized mapping of the inputs and outputs (Ramesh, Rajamanickam & Jayaraman, 1995) [2].

3.2 Cotton color grading with a neural network

It is well known that disagreements about cotton color grades between high volumes instruments and classers are substantial, and these machine-classer disagreements deter Full acceptance of machine grading of cotton color. So first a quantitative Analysis of the distributions of these disagreements across all the color grades, both major and sub color categories has been done. The study proves that the disagreements can be both systematic and random, and further analyzes the possible sources for them. Also the novel design of neural network has been introduced for cotton color classification. This classifier consists of multiple networks performing a two-step classification that identifies major and sub color categories separately. The classifier can be trained by any desirable data. In this research, it is trained using a set of classers' grades, and it exhibits good generalization for the new testing data. The classifier seems to reduce machine-classer disagreements to a minimal level, which is limited by the classer's reproducibility (Xu, Su, Dale & Watson, 2000) [3].

3.3 Predicting bursting strength of cotton plain knitted fabrics (Ertugrul & Ucar, 2000) [4]

Physical and mental properties of knitted fabrics are very important in many ways. Among these properties, bursting strength is extremely important. The fabric should have sufficient strength against forces acting upon during dying finishing and use. However it is very difficult to predict the bursting strength of knitted fabrics before performing bursting strength test. In some cases, it may be necessary to predict the bursting strength of a fabric before manufacturing by employing the characteristics of the yarn in order to knit the fabric.

A fabric's extensibility affects its bursting strength and increases inversely with the tightness factor. When tensile loading is applied to the fabric the yarn moves until jamming occurs. After the yarn movement is completed, the yarn elongates until it breaks. This yarn breaking strength and breaking elongation are measured input element for predicting the bursting strength in a plane knitted fabrics in the dry relaxed state. Since the fabric's weight is also affected. By its tightness factor this is the third major input. Besides being the major parameter that effects bursting strength, these three parameters are known values and available from the manufacturer before knitting operations.

Since the relationship between yarn properties and fabric strength is very nonlinear and involves many input parameters, it is very difficult to use conventional techniques such as regression to predict fabric strength before manufacturing. On the other hand, artificial neural networks and fuzzy logic, generally called intelligent techniques, are capable of mapping very non linear and complex relations. Unlike regression, intelligent techniques do not require knowledge or estimation of any mathematical model ion advance. Several studies using neural networks as an alternate approach to predicting problems in textiles are available in the literature which reveal that neural network can also be an effective tool for predicting the bursting strength of knitted fabrics (Cheng & Adams, 1995; Sette, Boullart & Kiekens, 1995) [5, 6]

3.4 Neural-fuzzy classification for fabric defects

Monitoring products in different phases of textile manufacturing is very important because of a growing demand for high quality products. Fabrics defects in weaving often occur degrading the quality of final products, so classifying fabric defects in order to locate their causes if crucial to quality control. Fabric defects are inspected by human operators, a Tedious time consuming process that tiers ones eyes when a great deal of inspection is to be done more over mistaken decisions are often made due to poor mental and physical conditions. Image processing techniques provide and objective and reliable way to recognize and classify fabric defects without weariness. With recent progress in image processing techniques and computers, image classification of fabric defect has become quick and inexpensive. Their for an image analysis system with learning and reasoning algorithm is more and more feasible as an alternative to human inspection of fabric defects (Huang & Chen, 2001) [7]

3.5 Classifying Textile Faults

In 1989 Wood Hodgson used a computer to process carpet images and to classify the various kind of defects on the carpets by autocorrelation. The method could not be used in the production line because it took a relatively long time to accomplish the job. In 1993 Ribolzi *et al*. used an opto-electronic technique to detect defects in real time. First they founer transformed the textile image and then examined its local peak values, which corresponds to the Zero-th order and first order diffraction maxima of the two-dimensional power spectrum. By comparing these maxima, obtained from both normal and defective textiles, they could detect defects. Although the method could detect textile defects in real time, it was able to detect only a few kinds of faults, probably because Ribolzi an his colleagues discarded the information in the area between the Zero-th and first order peaks. Later on in 1998 Chen *et al*. has done some work to solve this problem that is new system could detect in real as well as able to find a number of defects. He consider two-dimensional Fourier transforms derived from the 2D Fourier transformed rather than the 2D Fourier transformed itself. Furthermore, in addition to the diffraction maxima analysis, we also consider the region between the Zero-th and first order maxima. He thought that the feature characteristic of each kind of defects are also present in this region because different spectra from different defects give rise to different fine structure in this region under close inspection. Probably because of this consideration, the method is able to detect more kinds of defects than Ribolzi's method (Chen *et al*., 1998) [8]

3.6 Classifying web defects with a back-propagation

The main aim of this research is to construct an appropriate back-propagation neural network topology to automatically recognize neps and tracks in a web by color image processing. After studying the ideal back ground color under moderate conditions of brightness and contrast to overcome the translucent problem of fibers in a web, specimens are reproduced in a color bmp image file format. Assuming that neps and trash can be distinguished without difficulty from the color image, the image taking device in the system can be easily altered as long as the optical conditions for other color image resources (i.e., CCD) are considered to ensure image quality. With a back-propagation neural network, the RGB (Red, Green and Blue) values corresponding with the image pixels are used to perform the recognition and three categories (i.e., normal web. nep. and trash) can be recognized. The numbers and areas of both neps and trash can also be determined. According to experimental analysis the recognition rate can reach 99.63% under circumstances in which the neural network topology is 3-3-3. Both contrast and brightness are set at 60% with an azure background color. The results show that both neps and trash can be recognized well and the method is suitable not only for cotton and man-made fibers of different lengths, but also for different web thicknesses as to a limit of 32.9 g/m2. Since neps and trash in a web can be recognized yarn quality not only can be assessed but also improved using a reference for adjusting manufacturing parameters (Chattopadhyay & Guha, 2004; Shiau, Tsai & Lin, 2000) [1, 9]

3.7 Prediction of strength of Air-jet spun yarns

ANNs have been successfully used by Ramesh *et al*. (1995) [2] to predict the strength of microdenier polyester/cotton blended air-jet spun yarns. The inputs for this ANN model are first and second nozzle pressures, yarn count, and blend ratios; the outputs are yarn breaking load and elongation. The ANN was "trained" by presenting it successively with thirty-five sets of input-output data pairs. The weights of the interconnections were adjusted using the back propagation algorithm [9] as each training data set was successively presented to the model.

The trained neural net was then used to predict the tensile properties of four different sets of input pairs it had not seen during the training. The main disadvantage of the ANN is that it cannot be reliably used to predict yarn strength outside the range of the data set over which it was trained. However, the scope of the neural net can be broadened by retaining it with new data. Another disadvantage of neural nets is that they provide no insights into the physics of air-jet spinning. A neural net does not provide any understanding of why an input set of material and process parameters results in the predicted level of yarn strength (Rangaswamy, Hassen & Jayaraman, 1997) [10, 11]

4. Conclusion

Given this brief description of application of neural network in textile and how they work, we can realize that neural network have broad applicability in various facets of research areas, business and industries. So we can conclude that ANN is an intelligent mean of predicting the output of a certain problem when variables as a inputs are provided. Looking at the applications of ANN in textiles, there is no doubt that in near futures, this will be going to benefits for all sections relevant to textiles from spinning, weaving, processing to garment manufacturing units.

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