AN ARTIFICIAL NEURAL NETWORK APPROACH FOR PREDICTING THE PERFORMANCE OF COTTON/ELASTANE BLEND CORE YARN

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ABSTRACT

The core yarn is a type of yarn that has a filament fiber in the center with a different fiber (especially cotton) wrapped around it. They have a raising importance in the textile industry. That is why error free production and design of models that can correctly estimate the product quality parameters from fiber quality and spinning parameters are needed more and more. In the literature review, a lot of artificial neural network based estimating models for the yarn production, fabric, finishing etc. can be found. However, these prediction approach did not apply on the core yarns. The artificial neural networks can be seen to show much success in the textile. Therefore, in this study the Artificial Neural Networks (ANN) was proposed to estimate the quality control parameters of core yarns. The dataset used to feed the ANNs includes 37 types of fibre quality characteristics and spinning parameters as inputs and 11 types of core yarn performance values as outputs. There are 227 samples for each of them without any missing data. The quality characteristics of the fibre are collected from both high volume instruments (HVI) and advanced fibre information system (AFIS) machines. All the available learning algorithms for ANNs was used to get a more detailed comparison and to make sure we have a valid data different number of nodes were used for the hidden layer on the artificial neural networks. ANNs have 37 nodes of an input layer and 11 nodes of an output layer. In the architecture of ANNs, sigmoid function is used as activation function. Mean Square Error (MSE) and Mean Absolute Percentage Error (MAPE) with R squared values were used as performance indicators. The neural networks were shown to have the best MSE and MAPE values. The developed model has shown to have over 90% success rate for most of the cotton/elastane core yarn quality characteristics.

Key Words: ESTIMATION, SPINNING PARAMETERS, AFIS, HVI, USTER, CORE YARN, ARTIFICIAL NEURAL NETWORKS, COTTON, ELASTANE

1. INTRODUCTION

The core spun yarn is a type of yarn that has a filament fiber in the center with a different fiber wrapped around it. They are yarns with added value where the quality has more importance than the conventional yarns. They are produced mostly on the ring and the friction spinning machines. The core spun yarns take advantage of the qualities of both components. The filament provides strength and lower twist level while the sheath allows for a fibre yarn appearance and physical attributes [1].

The elastane core yarn consists of a lycra core surrounded with cotton elastane/cotton blend core yarns add the flexible, stretching, rubber like characteristic to the durability of cotton.

The objective of this study is predicting the quality characteristics of core yarns that can be determined by USTER and Tensorapid devices, from the fiber and some important spinning parameters using artificial neural network models. This is the first study where the predicting models are focused on the quality characteristics of elastane core yarns.

2. MATERIAL AND METHOD

227 samples of 37 different fibre spinning and quality parameters were gathered with 11 product quality parameters. HVI or high volume instrument is an automated bundle testing fiber quality control machine. It is mainly used to classify cotton and the mixture of fibers in the spinning mill. AFIS or advanced fiber information system was produced to substantiate the need for additional information on fibers and for the potential role it will play in programming [2].

This study was focused on evaluating the performance of artificial neural networks In order to get the most concurring data possible, different number of nodes was used for the hidden layer on artificial neural network models.

Levenberg-Marquardt method is the standard technique for solving non-linear least square problems. Least squares problems arise in the context of fitting a parameterized function to a set of measured data points by minimizing the sum of the squares of the errors between the data points and the function. Levenberg-Marquardt (LM) algorithm is preferred due to providing fast convergence and stability in training of artificial neural networks (ANN) [3].

For ANN models back propagation algorithm was used with Levenberg Marquardt. Their performance was observed according to Test MSE and Test R squared values.

3. RESULTS AND DISCUSSION

The ANN models have 12 different input variables from AFIS (SCI, Mic, Mat, etc.), 20 different input variables from HVI (NepCnt, SCN, SFC, UQL, etc.) and 5 different variables from corespun Tensorapid device (Lycra Dtex, Ratio, etc.). These models predict 11 different output variables (Um, CVm, Thin, Thick, Neps 140, Neps 200, H, B Force, ELG, RKM, RKMCV) ANN models are trained with Levenberg-Marquardt. The ANN models use a single hidden layer with a range of nodes, starting from 10 nodes, ending in 28 nodes. This makes a total of 10 different experiments for ANN models. Different numbers of nodes were used to find the best result possible for both ANN. H value is for yarn hairiness. RKM value is the breaking point of yarn where the yarn will break under its own weight. RKM is short for Reisskilometer The design of ANN models are shown in Figure 1. The best result out of ANN models was from Levenberg-Marquardt algorithm with a single hidden layer with 12 nodes with Test R squared value of 0,9196. As an example H value and RKM value results are shown in the graphs in Figure 2 (a) and (b). These results show that the predictions of ANN models are highly accurate.

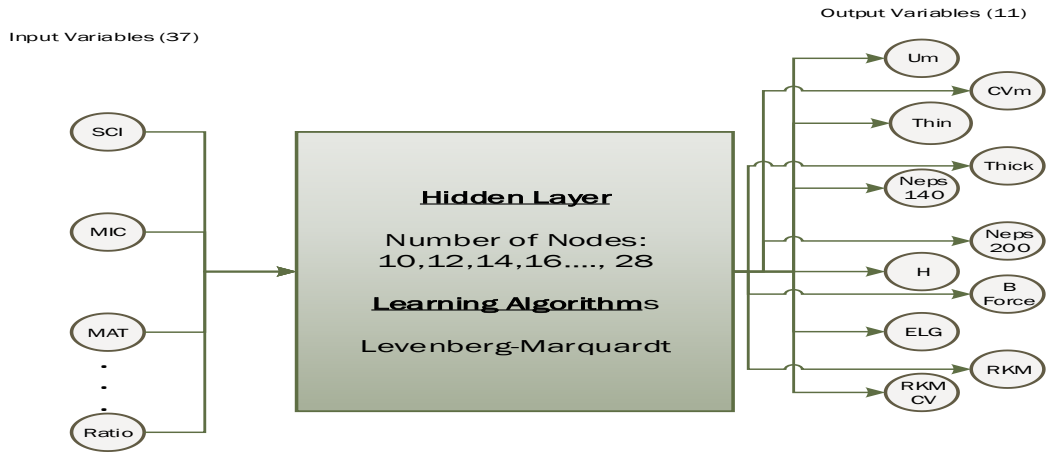

Figure 1. Design of ANN models

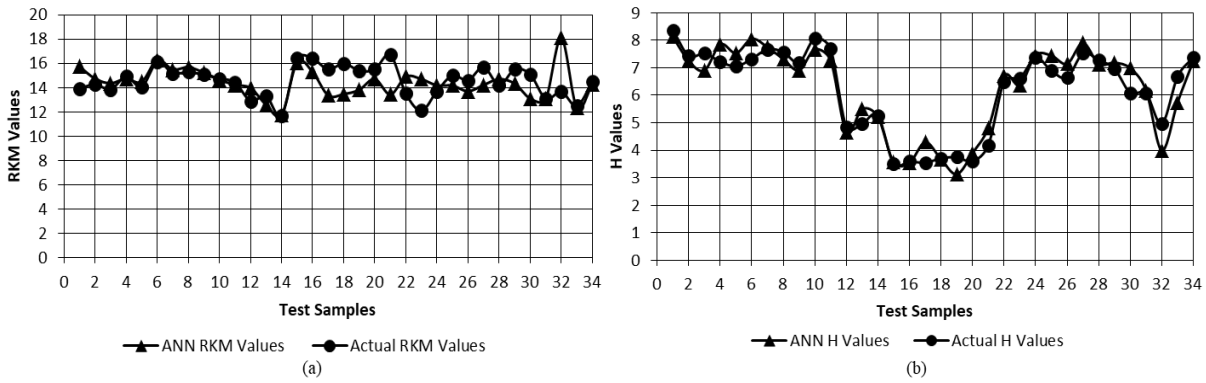

Figure 2. Results of ANN models on (a) RKM values and (b) H values

4. CONCLUSION

The ANN models have shown over 90% accuracy for most of the cotton/elastane core yarn quality characteristics according to their R squared values. This shows that ANN models are accurate in predicting cotton /elastane core yarn quality characteristics from fibre HVI and AFIS characteristics.

5. REFERENCES

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