COMPARISON OF LMBP AND LMBP HYBRID ALGORITHMS DURING THE PREDICTION OF RING SPUN YARN EVVENNESS

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3 authors:

Josphat Igadwa Mwasiagi
Moi University

Nkosilathi Nkomo
National University of Science and Technology, Bulawayo

Lloyd Ndlovu
National University of Science and Technology, Bulawayo

COMPARISON OF LMBP AND LMBP HYBRID ALGORITHMS DURING THE PREDICTION OF RING SPUN YARN EVVENNESS

Igadwa Mwasiagi[1], Nkosilathi Zinti Nkomo[2], Lloyd Ndlovu[3]

[1]Department of Industrial and Textile Engineering

Eldoret, Kenya

[2,3]Department of Fibre and Polymer Materials Engineering

National University of Science and Technology

Bulawayo, Zimbabwe

Email: zintinkomo@gmail.com

Abstract

Yarn evenness is one of the important yarn quality parameters, which affects the subsequent processing and usage of the yarn. This research work concentrated on the study of Kenyan ring spun yarn evenness. Cotton and yarn samples were collected from factories in Kenya. The data collected from the samples was used to design yarn evenness prediction models. The yarn evenness prediction models were trained using Levenberg-Marquardt Backpropagation algorithm (LMBP), one of the most commonly used algorithms in the prediction of yarn properties. This research work went a step further and attempted to improve the working of the evenness prediction models using hybrid algorithms, namely Differential Evolution and LMBP (LMBP-DE) and LMBP and Particle Swam Optimization (PSO), christened LMBP -PSO. A comparison of the performance of the yarn unevenness prediction algorithms as the neurons in the hidden layer were varied from 2 to 16 in steps of twos was undertaken. In terms of speed (training time) and performance (mse value) the hybrid algorithms performed better than the LMBP algorithm. LMBP also showed a higher CV of mse values which could imply that it was more prone to getting stuck in local minima than the hybrid algorithms.

Introduction

African exports more than 80% of the cotton lint it grows as raw material instead of adding value by manufacturing yarns or fabrics. Kenya has over 52 registered textile countries, but only 15 are operating. The quality of Kenyan ring spun yarns has recorded poor yarn quality (in comparison with Uster standards), yet the yarn is manufactured using good quality cotton (Mwasiagi 2013, 172). Artificial Neural Networks (ANN) yarn quality parameters prediction models can be trained using the Backpropagation (BP) training algorithm. This research work attempted to improve the prediction efficiency of BP trained algorithms by using hybrid algorithms. Two hybrid algorithms; Differential Evolution (DE) and Levenberg-Marquardt Backpropagation (LMBP) and LMBP and Particle Swam Optimization (PSO) were designed and used to predict yarn evenness. The prediction efficiency of the algorithms was compared to LMBP algorithms during the prediction of yarn evenness.

In this research work, the training of the yarn evenness prediction model was done using three training algorithms: LMBP, LMBP-DE and LMBP-PSO. The training of an ANN algorithm using LMBP includes the selection of weights and biases and then adjusting them by performing computations backwards through the network, using algorithms such as conjugate gradient, quasi-Newton and LMBP (Ham and Kostanic, 2003, 24). This research work designed an hybrid of DE and LMBP, where the DE algorithm was used to do the initial search for weights and biases. The weights and biases selected using DE were thereafter passed on to the LMBP (Mwasiagi et al 2012, 1201). The second hybrid algorithm used in this research work was designed using the particle swarm optimization (PSO), which is based on animal social behavior such as schooling of fish and flocking of birds and LMBP.

Methodology

The samples used in this research work (Cotton lint and carded ring spun yarn) were collected from textile factories in Kenya. A total of 125 samples of counts (Ne) 20, 24 and 30 were collected (Table 1) and tested under standard conditions. The cotton was characterized using the High Volume instrument (HVI).

An ANN model, with one hidden layer was designed and trained as the neurons in the hidden layer was varied from 2 to 16 in steps of 2. The inputs of the ANN model were ring diameter, spindle speed, ring frame draft, traveler mass, twist, count and HVI parameters of the cotton. The training of the algorithms was undertaken by varying the number of neurons in the hidden layer from 2 to 16 in steps of twos. At every level of neuron, for example 2 neurons in the hidden layer, the algorithms were run 50 times and the average mse value and training time recorded. The Coefficient of Variation (CV) was also calculated. This was done with an aim of studying the variation of the mse values at a given number of neurons in the hidden layer.

Table 1: Cotton Lint and Yarn samples

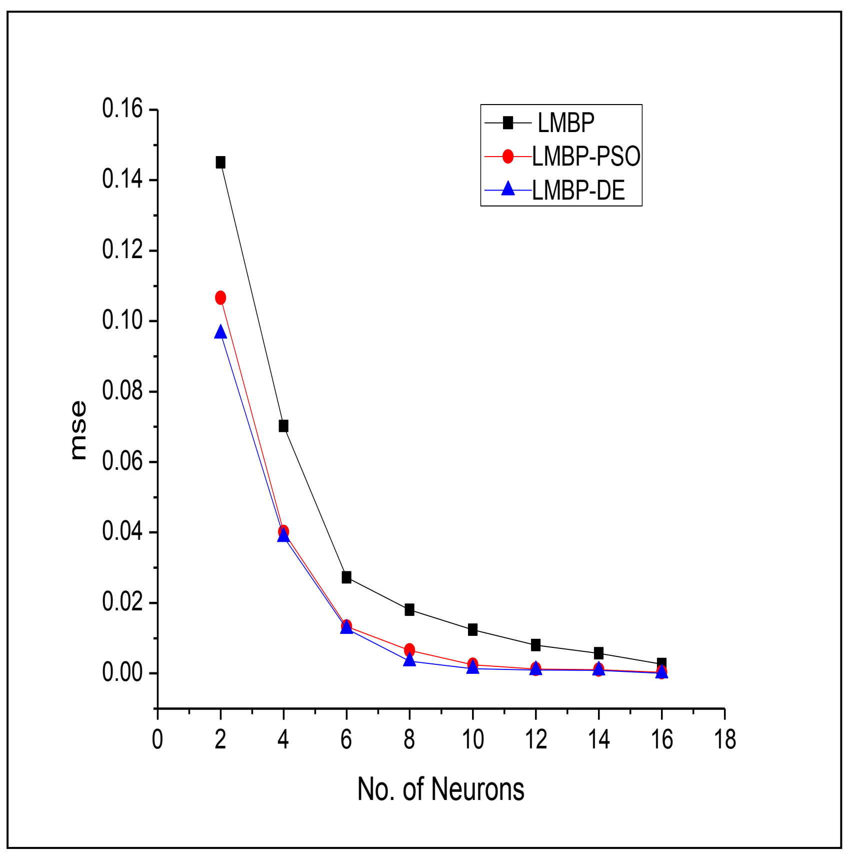
Cotton Lint	Mill Code	Yarn Ne	No. of cops	Spindle Speed (rpm)
Voi	B	30	25	11,000
Voi	B	20	25	10,000
WT	A	30	25	12,000
Kitui	A	30	25	12,000
Kitui	A	24	25	11,000
Kitui	C	24	25	8,000

Table 2: Maximum values for evenness algorithm

No. of Neurons	Maximum mse values LMBP	LMBP-PSO	LMBP-DE
2	0.39430	0.26030	0.133900
4	0.26755	0.09636	0.079730
6	0.17198	0.03213	0.086400
8	0.21600	0.03357	0.010460
10	0.17170	0.00776	0.008300
12	0.03645	0.00717	0.006880
14	0.01540	0.00700	0.006630
16	0.01819	0.00165	0.000094

Results and Discussions

The performance of the three models as measured using mse are given in figure 1 below.



From the results obtained in Figure 1, it is clear the performance of the three algorithms improved as the number of neurons in the hidden layer increased. The LMBP exhibited a lower performance when compared to the hybrid algorithms. The performance of LMBP-PSO and LMBP-DE was not significantly different from one another. Therefore it can be concluded that the hybrid algorithms performed better than the LMBP algorithm.

While the maximum mse values for LMBP were consistently higher than those of the hybrid algorithms, the minimum values were erratic. This implies that the LMBP exhibited a higher degree of having both very high and very low mse values, which is a clear indication of the algorithm having a higher tendency to get stuck in local minima. Algorithms with lower CV are likely to give better prediction efficiency as shown in Fig 2.

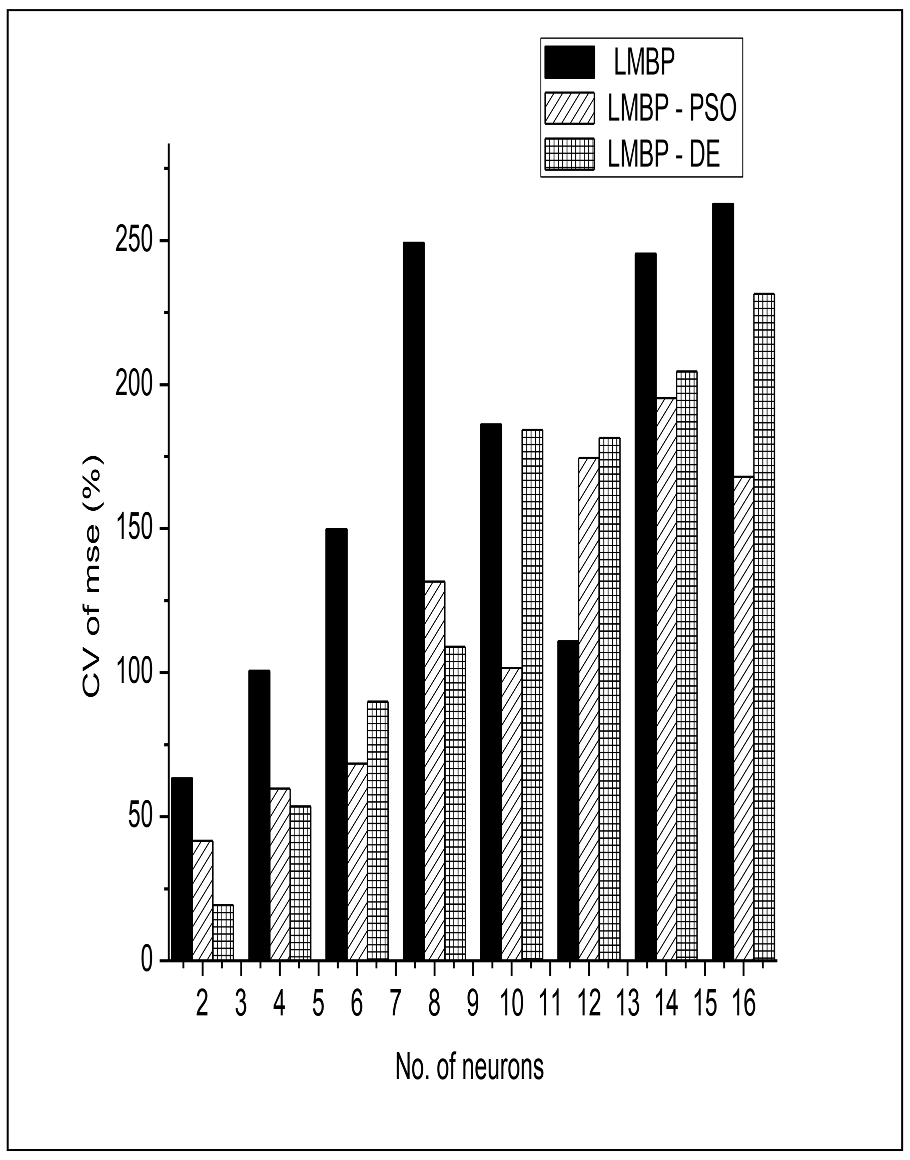


Figure 2 —The CV of mse for yarn evenness prediction algorithms

Conclusion and Recommendations

A study of the performance of LMBP, LMBP-PSO and LMBP-DE algorithms during the prediction of yarn evenness was undertaken and number of neurons varied from 2 to 16. In terms of speed (training time) and performance (mse value) the hybrid algorithms performed better than the LMBP algorithm. LMBP also showed a higher CV of mse values which could imply that it was more prone to getting stuck in local, minima than the hybrid algorithms.

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