International Journal of Engineering & Technology, 7 (4.38) (2018) 1436-1439

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Artificial Neural Network Forecasting

Abdul Talib Bon & Hew See Hui

Department of Production and Operation Management,
Universiti Tun Hussein Onn Malaysia, 86400 Johor, Malaysia
**Corresponding author E-mail: Email: talibon@gmail.com*

Abstract

Zero defect as a goal for the manufacturing sector especially when the factory engage in global market which the market is required a highest grade quality product. A defect will occur when it is fail to meet the intended design. Hence, defect prediction methods play an important role to forecast the number of product defect. For this study, Artificial Neural Network (ANN) used to forecast the product defect in furniture manufacturing in in order to develop a well suit ANN model for the product defect prediction and obtain an accurate prediction defect number for decision making. Colour defect as one of the product defect category. Therefore, data of colour defect was collected within eight (8) working hours for fourteen (14) days and the analysis process carried out by MATLAB R2015a application using the neural network toolbox. The neural network framework for the colour defect prediction was developed with the minimum error. The company is able to conduct prediction process with the framework and make a better decision based on the result in order to reach their goal.

Keywords: *Artificial Neural Network. Forecasting, Defect*

1. Introduction

The latest technology today has bringing uncountable convenience to the human activity. For example, navigation system helps the people go to unfamiliar places through a simple and faster way. The growth of the technology was successfully to make people easier to find out the problem and then conduct the proper solution. For the most familiar technology is namely as program and computerizes technology. This kind of technology could be laughing in many type of the software and useful in few of sector. For this project, furniture manufacturing sector will be focused because this sector involved a lot of software or machine to produce their desired product. But then, a product with a good design does not mean that essentially parallel to a good product. A defect product will be occurring when it is fail to reach the intended design and improperly manufactured (Azeem & Usmani, 2011). It will able to increase a large portion of the manufacturing cost and time consuming due to the quality of the product. Defect prediction plays an important role to represent the quality and reliability of the software. It can be predicted well based on defect classification and through the available prediction model due to the effective management of defect (Fenton et al., 2008). The expert system known as a soft computing which is combining the essential techniques with some engineering disciplines; there consists of computer science technique, Artificial Intelligence techniques and the last is Machine Learning techniques (Verma & Singh, 2015). The Artificial Neural Network prediction model as an expert system which is familiar applied by many countries. A reliability and capable defect prediction models able to explore a defect process in quickly and effective way and then provide the information to improve the product quality (Tunnell, 2015). An expert system leads to greater generality and friendly relationship with reality as well.

2. Methodology

A kind of single case study method will be applied to this study. A set of colour defect data collected from the AX Furniture within fourteen days and recorded in a way of hour by hour which is total eight (8) working hours. After the data was collected, the method of Artificial Neural Network would be applied and used software namely of MATLAB R2015a to carry out a prediction process. According to Babkin et al. (2015), it is a set of neurons will have connected in term of interconnections and composed in two or three layers in order to identify the input layer and also output layer. It is a multilayer network structure or defined as multilayer perceptron network. Figure 3.1 is shown a neural network model which is multilayer neural network with one hidden layer and one neuron output and Figure 3.1 show the process of developing an Artificial Neural Network model.

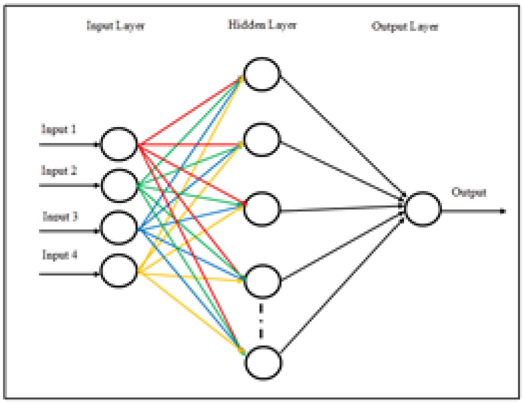

Figure 3.1. Artificial Neural Network Architecture

Artificial Neural Network applied in feed-forward back-propagation algorithm learning with multilayer perceptron structure network to carry out the forecasting process in order to minimize the error by the time the network learns the training data (Ziaei-Rad *et al.*, 2016; Gupta & Kashyap, 2015). Firstly, the input is propagated forwardly and the desired output will compare with the actual output; secondly, the weight will be changes after the creation of backward action in order to minimize the error as expected between the desired output and actual output (Tan *et al.*, 2015).

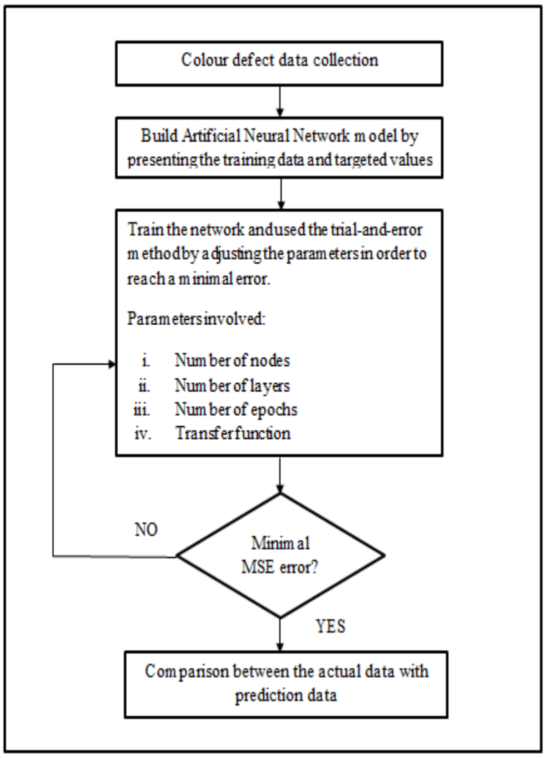

Figure 3.2. Process of developing an Artificial Neural Network model

The back-propagation algorithm of the Artificial Neural Network as follow (Tan et al., 2015):

$$\Delta W(k) = n\left(-\nabla E\big(W(k)\big) + \beta \Delta W(k-1)\right) \quad (3.1a)$$

$$\Delta b(k) = n\left(-\nabla E\big(b(k)\big) + \beta \Delta b(k-1)\right) \quad (3.1b)$$

Where,

W = Network weight

$\nabla E\big(W(k)\big)$ = Gradient of E at $W(k)$, with κ = 1, 2, 3, …, M

$\nabla E\big(b(k)\big)$ = Gradient of E at $b(k)$, with κ = 1, 2, 3, …, M

n = Learning rate

β = Momentum factor

In order to obtain the best performance of Artificial Neural Network model, measurement of Mean Square Error will be conducted. An optimum neural network model will accompany by the minimal MSE value. The equation showed as below is used to calculate the mean error value.

$$\text{MSE}=\frac{\sum(error)^2}{n} \quad (3.2)$$

Where,
Error = Actual value – Prediction value (3.3)
n = amount of data

3. Result and Discussions

According to fellow previous studies, a feed-forward neural network model which conducted in Levenberg-Marquard back-propagation (LM-BP) algorithm with a single hidden layer was a well suited method to train the network (Kabir & Sumi, 2012; Moustafa, 2011; Afrand et al., 2016). Figure 4.1 showed the architecture of neural network.

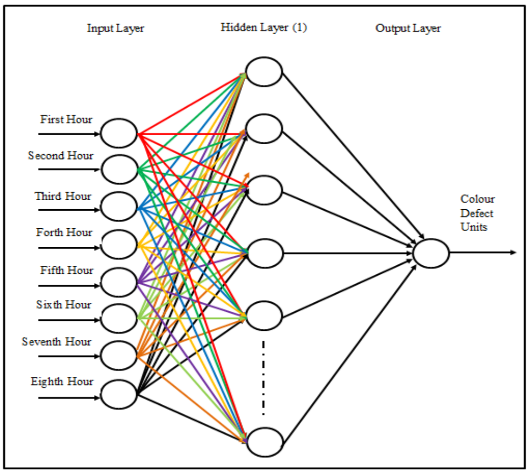

Figure 4.1. Architecture of the neural network

The neural network analysis carried out by the MATLAB R2015a application that using the neural network toolbox. There would be involved as many of 112 data entries and randomly divided up 100% of data in three sections which were 70% for the section training, 15% used in section validation and 15% for the section testing. Trial-and-error method was developed in order to determine the number of neuron with the minimize Mean Square Error (MSE). The training process would be started with one (1) neuron in hidden layer until seventeen (17) neurons with tangent sigmoid transfer function ‘tansig’ and train in as many as 1000 epochs, 5000 epochs and 10,000 epochs. Table 4.1 showed the result of each epoch set after training the network. From the Table 4.1, the optimum number of neurons in hidden layer was nine (9) where it produced a smallest MSE value at 10,000 epochs compared to the others two (2) epoch sets.

Table 4.1. Result of each epoch set

Number of Neurons	MSE value		
	1000 Epochs	5000 Epochs	10000 Epochs
1	1.5164	0.014561	0.54848
2	1.0424	0.21855	0.67086
3	0.70511	0.27881	1.5593
4	4.6795	1.0864	0.54623
5	2.0582	2.8239	2.4688
6	16.3816	0.2176	2.0012
7	2.2588	17.3917	4.4267
8	0.07351	0.0020005	0.00010802
9	14.7182	4.0399	**0.0000010801**
10	2.8317	0.50775	0.00010343
11	1.3892	0.018879	0.0056403
12	1.3454	0.011129	0.38934
13	7.5442	2.9781	0.80833
14	9.607	0.082556	1.2056
15	0.022352	2.3915	0.0095978
16	1.7126	0.6457	0.1855
17	2.1321	16.1439	0.0016503

The optimal neural network model was found out at nine (9) neurons in hidden layer at 10,000 epochs with a minimize MSE value, 0.0000010801. Figure 4.2 showed the neural network architecture where presented by the neural network toolbox and Figure 4.3 showed an opened window of the network when it was reached the minimum gradient.

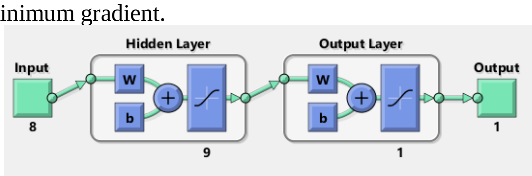

Figure 4.2. Neural Network Architecture

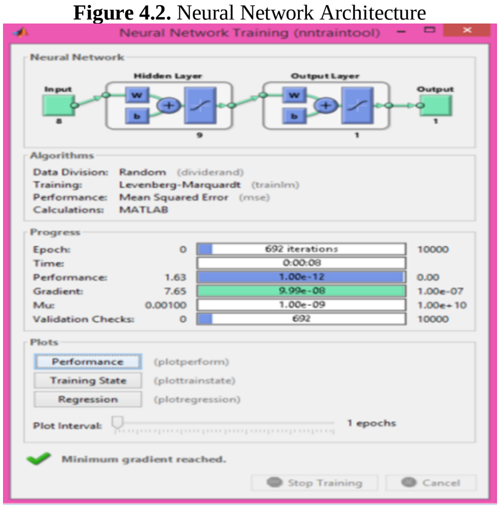

Figure 4.3. The opened window of network

The performance plot shown in Figure 4.4 was presented to the minimum MSE which dropped at an epoch of 0 and the value was 0.0000010801 or 1.0801^{e-6} for the validation dataset. The training process stopped when MSE of validation dataset stared to increase.

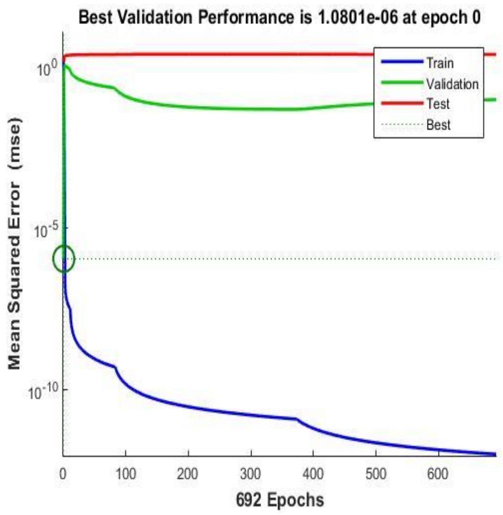

Figure 4.4. The best validation performance plot

For this study, an over fitting situation may occurred when the test curve higher than the validation curve (Khamis & Wahab, 2016; Ahmadloo & Azizi, 2016). However, according to Karia et al. (2013), there had no evidence to show that it was an over fitting situation due to the following condition of the performance plot. First, the test plot was similar with the validation plot and also the test plot was not raise significantly than the validation plot. Second, there was indicate an evidence showed that the performance of validation errors improves with the training errors due to the MSE were small enough. MSE is represented how close a set of point in regression line and also the difference between predicted value and measure value. From the result, the MSE value is very close to zero (0). Thus, it can be generated a best fit regression line where the regression line showed in Figure 4.5.

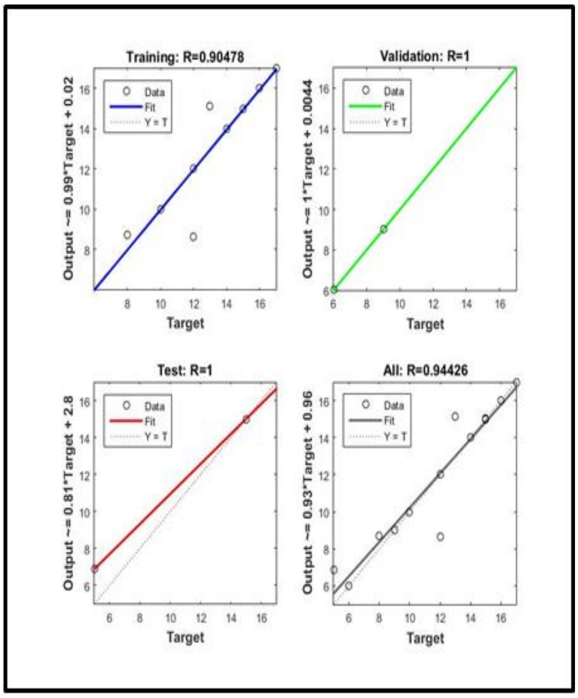

Figure 4.5. The regression plot

The neural network model is created after training the network and it is able to capture the well suited network properties for the model. Table 4.2 showed a summary of neural network model that was used to forecast the colour defect units.

Table 4.2. Summary of neural network model

Neural Network Model Properties

Neural Network Type	Multi layer feed-forward back-propagation neural network
Learning Algorithm	Levenberg-Marquardt (LM)
Hidden Layer	1
Hidden Neurons	9
Input Neurons	Production Time 1. First hour 2. Second hour 3. Third hour 4. Forth hour 5. Fifth hour 6. Sixth hour 7. Seventh hour 8. Eighth hour
Output Neuron(s)	Colour defect units
Data Division	70% for training, 15% for validation, 15% for testing (as default in NN toolbox)
Epoch(s)	10,000
Transfer Function	Tangent sigmoid (tansig)
Evaluate Neural Network Performance	Mean Square Error (MSE)
Training Termination	Stop training when reaches minimum gradient value / maximum 10,000 epochs

Figure 4.7 showed a plot graph that was plotted from the actual data and the prediction data that were obtained through the neural network model with desired properties as stated in Table 4.2. The red line represented to the prediction data meanwhile the blue line represented to the actual data. From observing Figure 4.7, it is a good fitting diagram where the prediction plot was well matched with the actual plot and two curves were much similar. Thus, it indicated that the performance of neural network model was good enough to forecast the colour defect units.

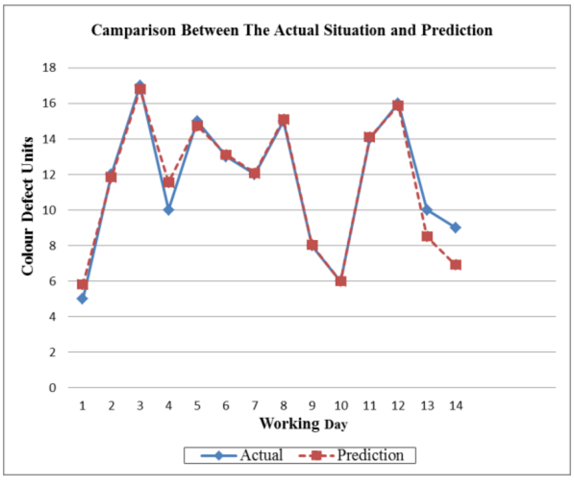

Figure 4.7. A comparison graph between the actual situation and prediction

4. Conclusion

The result of the comparison process was showed that there was well matched between the actual situation and predicted value. The company could use this model and applied to their actual work for their management purpose. A high accuracy result gained from the forecasting method was important for the management purpose because the result was capable to effect the company performance (Kerkkänen, 2010; GhasemiGol et al., 2015).

Acknowledgment

This research is supported and sponsored by Registrar Office, Universiti Tun Hussein Onn Malaysia, Ministry of Education Malaysia

References

[1] Afrand, M., Toghraie, D., & Sina, N. (2016). Experimental study on thermal conductivity of water-based Fe3O4 nanofluid: Development of a new correlation and modeled by artificial neural network. International Communications in Heat and Mass Transfer. http://doi.org/10.1016/j.icheatmasstransfer.2016.04.023

[2] Ahmadloo, E., & Azizi, S. (2016). Prediction of thermal conductivity of various nanofluids using artificial neural network. International Communications in Heat and Mass Transfer, 74, 69–75. http://doi.org/10.1016/j.icheatmasstransfer.2016.03.008

[3] Ariana, M. A., Vaferi, B., & Karimi, G. (2015). Prediction of thermal conductivity of alumina water-based nanofluids by artificial neural networks. Powder Technology, 278, 1–10. http://doi.org/10.1016/j.powtec.2015.03.005

[4] Azeem, N., & Usmani, S. (2011). Defect Prediction Leads to High Quality Product, 2011(November), 639–645. http://doi.org/10.4236/jsea.2011.411075