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THE RELATION BETWEEN WEIGHT AND MEAN DIAMETER OF BAMBOO SHOOT

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ABSTRACT

Bamboo shoot is a one of important agricultural products of Thailand which obtain good income over 500 million bahts for a year. The production of fresh bamboo shoots after harvesting is divided in 3 steps, cleaning sizing and packing. All steps absolutely use human in the production and take a lot of time especially in sizing process by weighing. This paper deals with determination of the relation between weight and mean diameter of bamboo shoot for measuring the weight of bamboo shoot without weighing. The artifitial neural network(ANN) was a tool for this work. One thousand(1,000) bamboo shoots of Rough Giant Bamboo in Prachinburi province were used as samples. The one hidden layer and twelve neurons in the hidden layers were selected. The trained ANN provided the R^2 value of curve between the values which predicted by optimal ANN and the actual values was acceptable (0.7508).

INTRODUCTION

Bamboo shoot is a one of important agricultural products of Thailand especially in Prachinburi province. The Prachinburi cultivators obtain good income from bamboo shoots over 500 million bahts for a year. The production of fresh bamboo shoots after harvesting was divided in 3 steps, cleaning sizing and packing. All steps absolutely used human in the production. After cleaning, the bamboo shoots were sized and divided in 3 size, small size(1 kg) medium size(1.32 kg) and big size(over 2.27 kg). In this step take a lot of time, so we considered a method or tool for solving this problem. In fact, we found the bamboo shoot is similar to solid cone and the diameter of bamboo shoot depends on its weight. Therefore in this paper we considered the relation between weight and mean diameter of bamboo shoot. We hope this information can use in designing of the bamboo shoot sizing machine without weighing.

Fig. 1 Fresh bamboo shoots

Fig. 2 Bamboo shoot packs

Fig. 3 Cleaning process

Fig. 4 Sizing and packing process

Fig. 5 Ready to sale bamboo shoot packs

ARTIFICIAL NEURAL NETWORK

An artificial neural network (ANN), often just called a neural network, is a mathematical model inspired by biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases a neural network is an adaptive system that changes its structure during a learning phase. Neural networks are used to model complex relationships between inputs and outputs or to find patterns in data.[1,2]

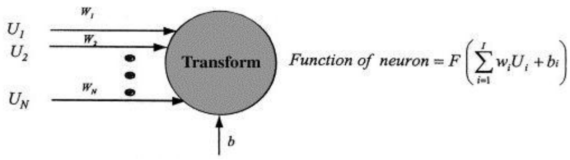

Fig. 6 Model of single neural [2]

$$Y = F\left(\sum_{i=1}^{N} w_i U_i + b\right) \tag{1}$$

When, Y = output, w = training weight, U = input, b = bias

METHODOLOGY

One thousand(1,000) bamboo shoots of Rough Giant Bamboo in Prachinburi province were used as samples. We measured the diameter of bamboo shoot tip by using vernier caliper at 4 different directions as shown in Fig. 7 and then used these values to calculated the mean diameter.

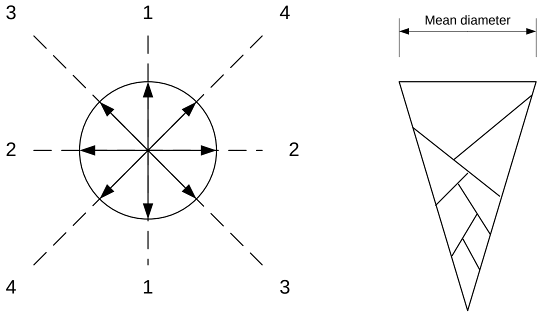

Fig. 7 Measurement direction

An artificial neural network (ANN) was used to model the relation between weight and mean diameter of bamboo shoot. The back – propagation algorithm was utilized in model training. In this case the input layer had one neural corresponding to input parameter (mean diameter) while the output layer had one neuron representing the weight of bamboo shoot.

The performances of the various ANN configurations were compared using mean square error (MSE) of weight of bamboo shoot. The error measures used to compare the performance of various ANN configuration was:

$$MSE = \frac{1}{n} \sum_{i=1}^{n} \left(K_D - K_P\right)^2 \tag{2}$$

where n is the number of data points, and K_D and K_P are the measured values and predicted values of weight of bamboo shoot, respectively.

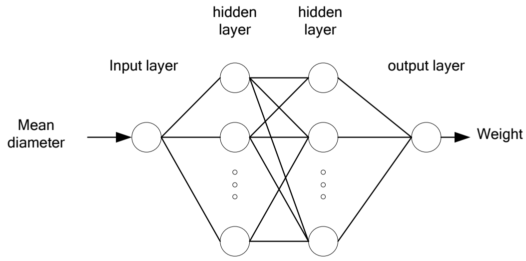

Fig. 8 Structure of feed forward multilayer ANN for Calculating weight of bamboo shoot

RESULT AND DISCUSSION

In this paper the transfer function of each hidden layer was tan-sigmoid transfer function and transfer function of output layer was linear transfer function .In the learning/testing process, there are several variables that have an effect on the ANN training. These variables are number of hidden layers, number of hidden neurons, number of iterations, learning rate and the momentum coefficient.

To find the best set of these variables and parameters, all of those must be varied and the best combination chosen. Table 1 shows the optimum value of the final selected ANN used to predict of weight of bamboo shootThe optimal number of hidden layers and number of

neurons in the hidden layers were selected by using a trial and error method and keeping the iteration, learning rate and momentum coefficient constant (chosen as 50000 for iteration, 0.3 for learning rate & 0.4 for momentum). Results showed that a ANN configuration including one hidden layer with twelve neurons in the hidden layer had the best structure for prediction of weight of bamboo shoot. The MSE for this optimal configuration was 0.1147. There is no theoretical reason to ever use more than two hidden layers [3]. It is strongly recommended that one hidden layer be the first choice for any practical feedforward network design.

Table 1 Error parameters in the prediction of weight of bamboo shoot with different neural network configurations

Hidden layers	Neuron in each hidden layer	MSE
1	2	0.1215
1	4	0.1216
1	6	0.1234
1	8	0.1232
1	10	0.1187
1	12	0.1147
1	14	0.1151
1	16	0.1199
2	2	0.2027
2	4	0.1261
2	6	0.1237
2	8	0.1244
2	10	0.1234
2	12	0.1208
2	14	0.1327
2	16	0.1243

To assess the credibility of prediction from the optimalANN (trained with 10,000 iterations) presented in Table 1,the predicted data versus the actual data used for testing were plotted (Fig. 9) and the coefficients of determination(R^2) were determined. The R^2 value for optimal ANN wasacceptable (0.7508) and the results showed fairly agreement between the predicted and the actual values. If we want more accuracy more inputs should be added into input layer such as length or high of bamboo shoot.

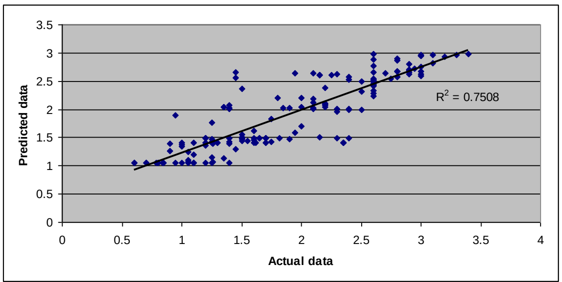

Fig. 9 Predicted data versus actual data for the test data set

We can distribute neural network configuration to mathematical equation by eq.(1) as follows

$W = 1.2503\,a_1 - 0.7863\,a_2 - 4.7877\,a_3 - 7.4447\,a_4 - 8.3371\,a_5 - 9.86\,a_6 - 6.0074\,a_7 - 5.4283\,a_8 + 7.7567\,a_9 - 2.5869\,a_{10} - 5.5901\,a_{11} + 6.0818\,a_{12} - 0.3924$ (3)

Where;

$$a_i = \frac{2}{1+\exp(-2n_i)} - 1 \quad \text{when } i = 1, 2, \ldots, 12 \qquad (4)$$

$n_1 = -14.4097\,M + 19.4172$
$n_2 = -13.007\,M + 18.6337$
$n_3 = 13.2076\,M - 17.2785$
$n_4 = -66.2786\,M - 3.1891$
$n_5 = 11.4935\,M - 15.8761$
$n_6 = -52.1211\,M + 11.0336$
$n_7 = -27.8525\,M + 17.5422$
$n_8 = 8.3409\,M + 23.934$
$n_9 = -11.6546\,M - 12.3068$
$n_{10} = 13.1319\,M + 16.8151$
$n_{11} = -35.1571\,M - 25.9861$
$n_{12} = 54.8663\,M - 23.8417$
W = weight of bamboo shoot
M = mean diameter of bamboo shoot

CONCLUSION

An ANN model was developed for investigating the relation between weight and mean diameter of bamboo shoot. The optimal model consisted of one hidden layer, with twelve neurons in hidden layer, and was able to produce weight of bamboo shoot values with an MSE of 0.1147 . The R^2 value of curve between the values which predicted by optimal ANN and the actual values was acceptable (0.7508)

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