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NEAR INFRARED SENSING FOR RRIM CLONE SERIES CLASSIFICATION UTILIZING OPTICAL SENSING TECHNIQUE

Nina Korlina Madzhi , Faridatul Aima Ismail, Noor Ezan Abdullah
Fakulti Kejuruteraan Elektrik, Universiti Teknologi MARA,
40450 Shah Alam, Selangor, Malaysia

*Corresponding author's email: nina6875@yahoo.com

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Abstract

This paper focuses on the classification of the selected RRIM 2000 and 3000 clone series based on optical sensing technique. The Near-IR was used as sensing element in order to measure the latex from the top surface that read by photodiode which received the reflected light from the sensor via reflectance index in term of voltage. The raw obtained data was used as input parameter for ANN tool which supervised by scaled gradient backpropagation and the performance was optimized at 25 neurons with 74.4% accuracy.

Keywords: RRIM clone series, latex, NIR, ANN, GUI.

1.0 INTRODUCTION

In year 1877, the rubber tree was introduced in Malaysia and started planted at Kuala Kangsar, Perak [1, 2]. Since then, the rubber product be the most significant sector that influence the Malaysia economy [1]. The rubber sector can be divided into three sector which are upstream, midstream and downstream [3]. Each rubber sectors will carries different activity. For example, upstream sector it more focuses on the cultivation and breeding program and also handle the raw material supplier which is natural rubber latex [1, 3].

In Malaysia, Rubber Research Institute of Malaysia (RRIM) is the one of research institute that implemented the breeding program [4]. The systematic selection of rubber breeding program have been introduced by them in 1982 in order to produce the high yielding latex clone that comply to the market needs [5-7]. Based on the rubber breeding program been held, there are a several of RRIM clone series have been introduced such as RRIM 600, RRIM 900, RRIM 2000, RRIM 3000 clone series and etc. [5, 7]. By having a lots of number of existing clones, its bring difficulty for farmer or unskilled person to recognize the type of clone series. The lack of the information in books and other research paper also cannot help the recognition process. The recognition of the clones was usually done by expertise such as the people who handle the tree clone for more than 10 years [8]. But basically, the expertise can recognize the clone based on the feature characteristics not in latex. By referring to the problem occurred, there are numbers of research were studied and investigated in determination on rubber content such as standard laboratory method (SLM) [9, 10], microwave [11], annular photoelectric [12] capacitive transducer [9, 13], differential scanning calorimetry (DSC) [9, 14], FTIR spectroscopy and TGA technique [9], rotational flow [15], Mooney viscometer [4, 16, 17], titration method [9] and etc. Though, the determination is to find the rubber content, but still its help to give the clue for classification of the clone series. Since NIR is more often used in medical diagnosis [18] compare to the agricultural field, this give an opportunity for this research to discover classification on cloning by applying NIR using reflectance technique. Therefore, the objective of his research are measure the latex of selected clone using NIR led and to classify the clone series using ANN system and vision system.

2.0 MATERIALS AND METHOD

2.1 Latex sampling

The entire samples were taken from Field 4 and 17 of rubber field in Permatang Station located at RRIM Kota Tinggi, Johor. The targeted clones for this research were RRIM 2002, RRIM 2007, RRIM 2008, RRIM 2014 and RRIM 3001 based on the RRIM recommendation and due to the productivity of the clone. There are 1000 samples were collected from those clones and carried 200 per each. Each of tree will go through the same tapping procedure where tapped at 6.00 a.m. in the morning then being collected around 9.00 to 11.00 a.m. every collection session depending on the latex amount that needed. The collection was done in medium yielding period that begins from end of June to mid of July in 2014. Figure 1 shows the specimen case filled with 20ml latex were used in the NIR experiment.

Figure 1. The specimen case of latex

2.2 Optical sensing element

NIR led 950nm wavelength was used in development of the reflectance indicator which paired with the 900-950nm photodiode and signal conditioning. The reflectance technique was used to obtain reflectance index via voltage from the latex surface in order to find the differentiation between the selected clones. The NIR will emit the rays to the latex surface; the photodiode then will collect the reflected ray from the surface. Figure 2 shows illustration of the NIR reflection rays that applied in this research. Each alphabet of A to G shows the fixed parameters used in the experiment; A: barrier to photodiode length: 1.5cm, B: barrier to Near-IR led length: 1.5cm, C: thickness of barrier: 0.3cm, D: height of barrier 1.6cm, E: specimen case diameter: 6.3cm. F: specimen case height: 2.5cm. G: filled specimen case of latex height: 1.2cm. By referring to the illustration, the barrier is use to avoid the photodiode receiving the rays by side and to make sure the rays reflect directly to the opposite object.

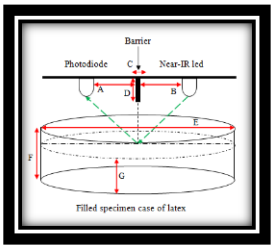

Figure 2. The illustration of Near-IR led rays reflection

2.3 Identification system

The identification system starts with the analysis using the entire raw data of 1000 samples. All samples will go through the basic analysis such as normality test, error bar plot and the one-way ANOVA. The ANN system is used to differentiate between each clone based on the reflectance index via voltage of the latex. The data were trained using ANN toolbox supervised by scaled gradient backpropagation. In ANN, the

optimized model was decided using a confusion matrix [19]. Table 1 shows the division data of training, validation and testing (70:10:20) for ANN toolbox which used in this research. The output of the ANN system is classification of RRIM 2002, RRIM 2007, RRIM 2008 and RRIM 3001 and defined as 1000, 0100, 0010 and 0001.

Table 1. The ANN toolbox data division for training, validation and testing

Case	Training : 70%	Validation: 10%	Testing: 20%	Output
RRIM 2002	560	80	160	1000
RRIM 2007	560	80	160	0100
RRIM 2008	560	80	160	0010
RRIM 3001	560	80	160	0001

3.0 RESULTS AND DISCUSSION

3.1 Reflectance Measurement

The data was successfully collected using NIR sensing indicator based reflection technique via voltage. The developed indicator consists of NIR led, photodiode and signal conditioning. The experiment was done in a month and setup at Dry Rubber Content Laboratory located at RRIM Kota Tinggi, Johor. The experiment started at 11.00 a.m. until 5.00 p.m. every slot session as the same day as the samples being collected. The finalized raw data was used in this research is 1000 samples from five different clones (200 each).

Figure 3 shows the bar chart of the mean for five selected clone. Based on the figure, it can be observed that every clone have the specific value that be differentiate. A part of that, the bar chart also showed RRIM 2014 has the higher voltage value amongst other clones. The second higher value followed by RRIM 2008, RRIM 2007, RRIM 3001 and the lowest value was RRIM 2002. Based on the Figure 3, this finding can be relate to the previous research [12] which said, there is a proportional relationship between the latex and the voltage; when the rubber content in the latex the increase voltage also increase. This can be conclude that RRIM 2014 shows the highest rubber content amongst other while RRIM 2002 will be the lowest of the rubber content in the latex.

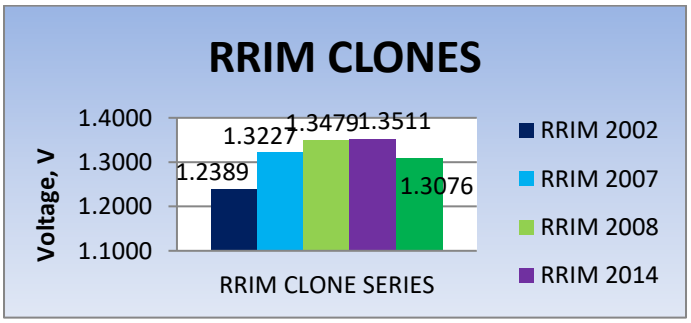

Figure 3. Bar chart of RRIM clone series

3.2 Classification using ANN

The data have been used in the classification part was the obtained result from the final analysis [20] that proved only four clone can be decided used for next application since there are significant different between them. The clones of RRIM 2002, RRIM 2007, RRIM 2008 and RRIM 3001 then were trained using ANN toolbox with ±0.5 fixed threshold. The data was trained using 10 different hidden layer sizes which are 3, 7, 15, 18, 21, 25, 32, 35, 47, and 50 neurons. Each of the hidden layers was trained seven times in order to get the best optimized accuracy as shown in Figure 4. Figure 4 shows the best optimized accuracy which obtained from each hidden layer size as stated before. Based on the line graph, the highest accuracy belongs to the hidden layer of 25 neurons with 74.4% and will be used in development of vision system. The ranking then followed by 21 neurons for 73.8%, 18 neurons for 72.5%, 7 neurons for 71.9%, 32 and 35 neurons for 71.3%, 50 neurons for 70.9%, 15 neurons for 70.0%, 47 neurons for 69.4% and the lowest is 3 neurons with 68.1%.

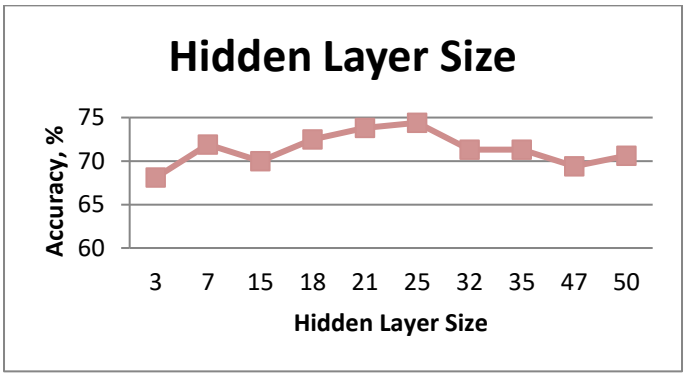

Figure 4. The line graph of selected hidden layer size

Each hidden layer size will have produced their owned confusion matrix and the accuracy will depend to a data set. In this research, the confusion matrix for the best hidden layer obtained was shown in Figure 5. From the confusion matrix, the percentage accuracy can be found directly or it also can be calculated from the information within it. As shown in the table of confusion matrix, the percentage accuracy of hidden layer size of 25 neurons was 74.4%.

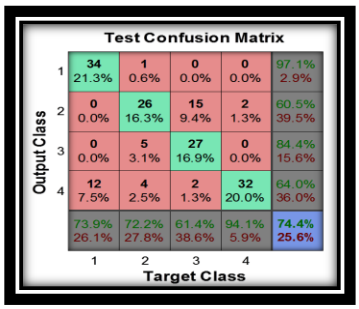

Figure 5. Confusion matrix table for the best optimized testing accuracy with hidden layer of 25 neurons

Table 2 is the summarization of the confusion matrix information by calculation for each clone. The table also described the performance of the four selected clones consists of sensitivity, specificity and accuracy. By referring to the table, RRIM 3001 shows the highest sensitivity, 94.1% while the highest specificity, 99.1% is belongs to the RRIM 2002 same goes to the accuracy, 93.1%. However, based on

the three term of performance, the most needed to be focused and considered is percentage accuracy. As a result, the system could more differentiate RRIM 2002 compare to other clones.

Table 2. The performance of four selected clones

Model performance indicator: threshold ±0.5 Model: scaled conjugate gradient backpropagation ANN (Input : Output: Hidden Layer): 01: 04: 25				
Clones:	RRIM 2002	RRIM 2007	RRIM 2008	RRIM 3001
Sensitivity (%)	73.9	72.2	61.4	94.1
Specificity (%)	99.1	86.3	95.7	85.7
Accuracy (%)	93.1	83.1	86.25	87.5

Receiver operating characteristic (ROC) is used to described the true positive rate (TPR) versus the false positive rate (FPR) across the multiples thresholds. Figure 6 shows the ROC curve for hidden layer of 25 neurons at the fixed threshold ±0.5 which consists of blue line (RRIM 2002), green line (RRIM 2007), moss-green line (RRIM 2008) and red line (RRIM 3001). Based on the curve, the blue and red line shows the nearest line to the ideal point (0, 1) which means the highest point of the sensitivity and specificity for classification of the clone as shown by orange arrow.

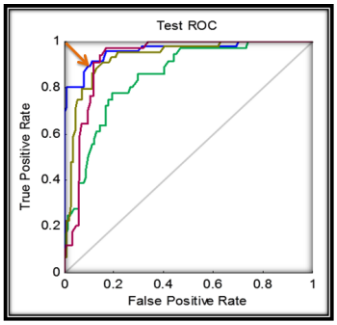

Figure 6. Receiver operating characteristic curve

4.0 CONCLUSION

The issues of identifying clone series by depending on the color, texture and other more now can be solve after several analysis have been done to. The significant information have been gathered from the result had almost successfully answer the objective of this research. There are a few finding was collected at the early stage of the analysis which showed the differentiation between the clones. This finding then being noted and the data then trained for further application such ANN system. The obtained result shows the best optimized hidden layer of 25 neurons with percentage accuracy of 74.4%. The confusion matrix then been studied to find the performance of the system for each clone. From four clones (RRIM 2002, RRIM 2007, RRIM 2008 and RRIM 3001) have been used, only two clones showed the best performance in classification which are RRIM 2002 and RRIM 3001.

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