A STATISTICAL ANALYSIS OF LED REFLECTANCE FOR VARIOUS RUBBER SEEDS CLONE

NORLAILA OMAR, HADZLI HASHIM, FAIRUL NAZMIE OSMAN
and AFIF EKRAM DARAMI
Faculty of Electrical Engineering
Universiti Teknologi MARA
40450 Shah Alam, Selangor
MALAYSIA
norlaila350@salam.uitm.edu.my, hadzli120@salam.uitm.edu.my

Abstract - This paper describes an experimental study of rubber seed clones recognition by using reflectance of light. The main objective is to develop sensor systems that can recognize the clones based on colour being reflected by LDR sensor. Rubber seed clones has different textures and colour characteristic though observation. In this project, Light Emitting Diodes (LED) is used as light source and the sensor is light dependent resistor (LDR) for measuring the intensity of light being reflected from a rubber seed. The LDR is combined together with a Wheatstone bridge circuit and operational amplifier to obtain the output voltages. The transmitter and receiver location will be located at a proposed specific angle and distance in order to measure the maximum intensity of light. There are three types of clones that are used as a sample study in this experiment which are RRIM 2024, RRIM 2020 and RRIM 901. The output voltage measurement are then analyzed using recommended statistical test. Results obtained shows that there is strong evidence that these clones can be discriminated from each other based on colour perception using LEDs.


1.0 INTRODUCTION

The rubber industry continues to contribute to Malaysia aspiration to reach the developed status by the year 2020. The export of locally manufactured rubber goods amounting to RM 3.9 billion in 1995 is on the increase. Similarly about RM 1.4 billion of heveawood manufacturing industry is on the increase. In order to ensure continuous supply of quality latex and heveawood to the manufacturers, replanting with higher yielding rubber tree clones is hence very important [1]. Therefore, seeds planted must be from the quality rubber tree series clones e.g. RRIM2000 series.

The fundamental of seed identification is by looking at the seeds and try to match its appearance to the closest appearance photo from a library text. Experienced workers can just look at the shape and texture pattern of the seeds in order to recognize the type of clones. However, these methods will consume time, percentage accuracy and as well as cost in order to train new worker or farmer with regards to the identification of rubber seed clones.

Therefore, this project proposed a scientific approach based on light perception for rubber seed clone recognition. A sensor system is developed using red blue and green light emitting diodes (LED) as the light source while light dependent resistor (LDR) as the sensor. The transmitter and receiver will be located at specific angle and distance from the rubber seed surface. Eventually, intensity of light being reflected will be measured and converted in terms of voltage level.

1.1 Clone Characteristic

Figure 1 below shows the types of clones that are used as samples in this project. The RRIM 2020 seed is small in size, smooth and shining with light brownish seed coat. It can be square to slightly rounded shape. Overall growth and seed...
production of this clone is considered good for both latex and timber production [1, 2]. The seed size RRIM 2024 is medium. It is smooth, shining and brownish seed coat. The shape is square to slightly rectangular. The colour is brighter compared to the other clones. Overall growth and seed production of the clone is below average. This clone is recommended only for latex production [1, 2]. The seed features of RRIM 109 are big and has square shaped of seed. The colour is almost similar to RRIM 2020.

In addition to that, choosing the types of sensor that can be used in this project is equivalently important. The light dependent resistor (LDR) chosen would convert any reflectance light to resistance and later, being converted to voltage via Wheatstone bridge circuit. To increase the output voltage from the bridge is through an operational amplifier circuit. Lastly, SPSS software is used to produce the appropriate statistical plots and tables. The voltage measurements gained are evaluated to find any discrimination between the rubber seeds clone.

### 3.0 METHODOLOGY

The process of analysis on the rubber seed clone can be simplified as below:

![Methodology flowchart](image)

Figure 2 shows the flowchart of methodology in completing this project. Literature review on light dependent resistor (LDR), rubber seed clones, law of light reflectance, Wheatstone
There are three types of rubber seed clones have been selected for analysis. These three clones are RRIM2020, RRIM2024 and RRIM901. Distribution samples of these clones are 30 for RRIM2020, 30 for RRIM2024 and 20 for RRIM901. All samples were collected at Rubber Research Institute of Malaysia (RRIM), Sungai Buloh.

3.1 Hardware Development

In order to measure the reflectance of light, a model hardware cover has been designed as in Figure 3, to make sure that all the reflected light from the seed are captured by the sensor. Therefore, a zinc plate is used as a cover from the light source to the seed and direct to the the sensor. This is to make sure that maximum reception at the LDR. In addition, the room light also can affect the outcomes of the analysis. Thus, the analysis has been done while the room light is OFF.

In this project, both angle has been determined which are $i = 30^\circ$ and $r = 30^\circ$. Furthermore, the distance between the seeds and the light source also important. Therefore, the best distance has been calculated which is $a = 9\text{cm}$ while the distance between the seed and the LDR sensor is $b = 5.2\text{ cm}$ as shown above. There are three types of colour that has been used in order to do the analysis which is red, green and blue. Each types of colour have six ultra-bright light emitting diode (LED) with a supply voltage depends on the calibration of the voltage maximum at oscilloscope. The greater the current, the higher the LED intensity. So, before the experiment, light intensity need to be calibrated by adjusting the voltage supply to make sure that the amount of light intensity for all three types of colour are equal.

![Figure 3: The hardware cover](image)

The schematic cover design is depicted in Figure 4. It shows the position of the LED and LDR as well as correct angle used for maximum light incidence and reflectance. Besides, the best angle of reflection is very important in order to get the best outcomes regarding to the intensity of light from the rubber seeds. The different in angle affected the intensity of light. According to the law of reflection angle of incidence ($i$) is equal to the angle of reflection ($r$) [3,4] as Figure 5.
3.2 Sensor Circuit Development

The most important element in this project is the sensor. The sensor used is light dependent resistor (LDR). The resistance of the LDR decreases as the intensity of the light falling on it increases. An LDR is made of a high-resistance semiconductor Cadmium Sulphide as shown in Figure 7. Cadmium sulphide (CdS) cells rely on the material's ability to vary its resistance according to the amount of light striking the cell [5]. The amount of light that reflected from the rubber seed is then converted to resistance.

Then, the variations of resistance are changed to variations of voltage by using the Wheatstone bridge concept [6]. It consists of a common dc source of electrical current and a galvanometer that connects two parallel branches, containing four resistors, three of which are known.

The values of resistor $R_1$, $R_2$ and $R_3$ are 47kΩ. Resistance of $R_x$ depends on the intensity of light. Thus, the voltage is calculated as in equation (1).

\[
V_{\text{out}} = \frac{R_x}{R_x + R_1 + R_2 + R_3} V_{\text{in}}
\]  

(1)

The amplifier gain $= \frac{R_f}{R_x} = \frac{47k\Omega}{15k\Omega} = 3.133$

The voltage output from the Wheatstone bridge is small and with negative polarity. Therefore, an inverting amplifier is used in order to reverse the polarity while amplified the voltage [7]. In this project, the suitable output voltage has been calculated by using equation (2). Thus the $R_f$ and $R_1$ used are 47kΩ and 15kΩ. After that the circuit is connected to the oscilloscope in order to measure the root mean square voltage. Lastly, these data are later analysed using the SPSS software.

4.0 RESULTS AND DISCUSSION

An analysis on the data has been done by using the SPSS software. Two major tests which are error plot and ANNOVA multiple comparisons are being applied for detecting any significant discriminating result.
4.1 Error Plots

The resultant error plot is shown in Figure 10 and Figure 11, respectively. The error plot shows that the variation of the sample population mean of the output root mean square (V_{rms}) value for red (R), green (G) and blue (B) LED with respect to the three types of rubber seed clones respectively.

![Figure 10: V_{rms} RGB error plot](image)

From observation of Figure 10, there is an overwhelming discrimination of green component for all seed clones. As for R, only RRIM2024 is clearly different from the other two clones. RRIM2020 is seen to be slightly located at the same range with RRIM901. While for B component, all the locations are much closer together, however, RRIM2020 is again can be seen to discriminate from the rest. Table 1 shows the actual measurement of mean values for all types of clone with respect to the RGB colours. These values justify the rationales given above.

### Table 1: Descriptive Statistics for V_{rms}

<table>
<thead>
<tr>
<th>LED</th>
<th>Clone</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>2020</td>
<td>30</td>
<td>6.81</td>
<td>8.24</td>
<td>7.4223</td>
</tr>
<tr>
<td></td>
<td>2024</td>
<td>30</td>
<td>2.20</td>
<td>4.30</td>
<td>3.1543</td>
</tr>
<tr>
<td></td>
<td>901</td>
<td>20</td>
<td>5.87</td>
<td>7.32</td>
<td>6.5340</td>
</tr>
<tr>
<td>Blue</td>
<td>2020</td>
<td>30</td>
<td>7.05</td>
<td>9.28</td>
<td>8.4307</td>
</tr>
<tr>
<td></td>
<td>2024</td>
<td>30</td>
<td>6.34</td>
<td>7.99</td>
<td>7.0280</td>
</tr>
<tr>
<td></td>
<td>901</td>
<td>20</td>
<td>7.03</td>
<td>8.41</td>
<td>7.7645</td>
</tr>
<tr>
<td>Red</td>
<td>2020</td>
<td>30</td>
<td>8.06</td>
<td>9.17</td>
<td>8.5960</td>
</tr>
<tr>
<td></td>
<td>2024</td>
<td>30</td>
<td>4.49</td>
<td>6.30</td>
<td>5.4783</td>
</tr>
<tr>
<td></td>
<td>901</td>
<td>20</td>
<td>6.99</td>
<td>8.78</td>
<td>8.1180</td>
</tr>
</tbody>
</table>

4.2 ANOVA Test

The previous assumption can be further proved by applying an ANOVA t-test. The One-Way ANOVA with confident interval set to 95%, compares the mean of one or more groups based on one independent variable (or factor) where [8],

**Null Hypothesis:**

H₀ = There are no significant differences in the mean voltage (V_{rms}) between the rubber seeds clones.

**Alternative Hypothesis:**

H₁ = There is a significant difference in the mean voltage (V_{rms}) between the rubber seeds clones.' mean

The multiple comparison parameters shown in Table 2, implies and confirmed that there is an overwhelming significant different in the measurements between the types of clones. The p-value gained in each test is found to be less than 0.05. Thus, the null (H₀) hypothesis can be rejected and the alternative (H₁) hypothesis can be accepted.

### Table 2: Multiple comparisons
5.0 CONCLUSION

The three types of rubber seed clones RRIM 2020, RRIM 2024, and RRIM 901 are being tested in order to observe the differences among the clones in terms of voltage. The samples of the above clones are analyzed using a red, green, and blue LED reflectance technique along with a sensor as a receiver. Data taken from the samples are tested with statistical error plots and ANOVA t-test. From the error plot observation, the range of population mean root mean square voltage for the three types of clones is marginal and slightly different from each other. The results are reinforced by the measured p-values using ANOVA t-test where there is strong evidence to conclude that the different types of clones will produce different variation of voltage. Since all the p-values are below 0.05 means that the voltage between the clones are significantly different. If considering producing a low cost reflectance sensor system, therefore it is highly recommended only green LED is used since it gives marginal discrimination results in the ability to identify the rubber seed clones. The data in Table 3 shows that the mean and voltage range that can be utilized as reference in developing an intelligent identification model in the next stage of development.

Table 3: Statistic for \(V_{\text{rms}}\)

<table>
<thead>
<tr>
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<td>6.5340</td>
</tr>
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</table>

6.0 FUTURE DEVELOPMENT

Based on the result, the experiment has produced some promising results and will be published soon. Extension to this work involves intelligence software e.g. Fuzzy or PIC as the controller in order to process the output voltage from the sensor and display the result using the LCD display. However, it is recommended that the sensitivity of the sensor circuit could be improved by placing 2 or 3 LDR sensor at the receiver. Therefore, the small variation of light intensity will make a better difference in voltage. Hence, the percentage accuracy of the system will increase. Besides, to ensure that the data from the analysis are accurate, more rubber seeds sample are needed for each type of clones.

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References:


