CORRELATION BETWEEN OIL CONTENTS ESTIMATION AND SIZE OF OIL PALM FRUIT USING DIGITAL IMAGERY

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Abstract – The objective of this paper is to make a correlation between oil content and the size of the palm oil fruit. There are 30 sample are taken to be tested. We only concentrate at three categories of ripeness that are ripe, overripe, and under ripe. Image from various sample of oil palm fruit were acquired using digital camera with a proper lighting and angle. Then every sample will passed through image processing and analysis. We use PCI Geomatica to analyze the images. We also use the chemical analysis of the palm oil to get the oil content of each sample. This study indicates that the size of the palm oil fruit of ripe have shown a good correlation with the oil palm content as compared to overripe and underripe sample.(result).Its hopes that this research will help increase the efficiency of grading quality of harvesting.

Keywords- Digital Image, PCI Geomatica Software, Chemical Analysis.

1. INTRODUCTION

The oil palm (Elaeis Guineensis), which originated from West Africa, was introduced to Malaysia in 1870 as an ornamental plant. It was use as a crop until 1917, when it was grown commercially. Today oil palm is leading agricultural crop in Malaysia covering about two million hectares or a third of total cultivated area in Malaysia. Palm oil products are employed in numerous food and non food application. They can use as frying media and for making margarine, shortenings, soap and oleo chemicals product. The choice of palm oil species is also important. Malaysia has used the species that a hybrid of Dura X Pisifera (D X P) which produced Tenera heredity. This species gives high production because it has a thick mesocarp and high oil content compared to dura and pisifera species. This paper only concentrates at tenera species because of it advantages and it also very available in Malaysia. The samples were taken at MPOB Bangi. Three kind of ripeness are chosen that are ripe, overripe and under ripe. The samples are captured by digital camera with proper lighting technique and angle with constant distance between the camera and the fruit. The chemicals analysis is also done at MPOB Bangi .The sample are extracted to get the oil content .The % of oil content are calculated in order to make a correlation. The chemical analysis must be done immediately because the content of oil might change, so the results that will get will less accuracy.

The palm oil images are analyzed using the PCI Geomatica Software to obtain the size of the sample. PCI Geomatica software is capable of image display enhancement manipulation and restoration.

2. METHODOLOGY

This paper discusses the study samples, the image and data collection and the computer systems itself. Explanation about the camera and scanning system is done. The methods of image processing are implemented to get the results. Correlation between the size of the fruit and the oil contents estimation determined by with chemical composition is done. Figure 2.1 illustrates the flow chart on how the project was developed.

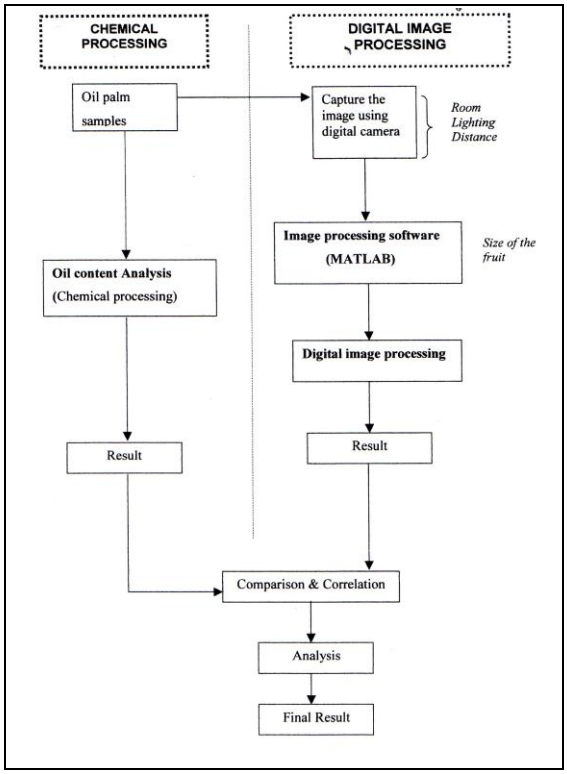

Figure 2.1: Flow chart for overall process

Fruitlets sampling is carried out in this research because oil palm fruits have different ripeness stage. The oil palm fruits can be ripe, under ripe, overripe, black bunch or empty bunch. For this study we use 3 types of oil palm fruit which are known as ripe, under ripe and over ripe because this ensures a good cross- selection across the board. A Nikon macro-lens camera was used to acquire image of these fruitlets.

A total of 30 samples, made up 10 samples each of ripe, over ripe and under ripe fruitlets were taken from MPOB, Bangi Selangor. Images of these fruitlets captured in a room with a proper control environment such as lighting, distance and height from camera to object. The setting of this image acquisition system is shown in figure 2.2.

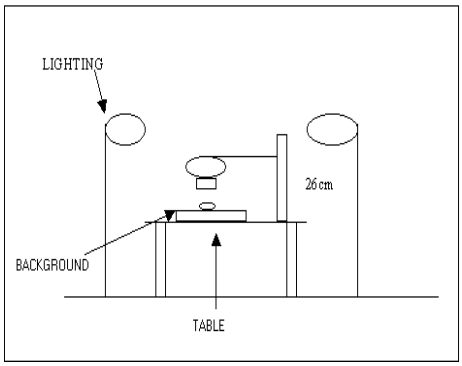

Figure 2.2: Image Acquisition Setting

The hardware system had been performing in order to capture an image, the process of data, display the image and to do statistical analysis. Camera Nikon CCD RGB Single Chip is used to grab the image of the sample oil palm fruits with speed 60 and aperture 16. Computer system involved CPU to do image processing and statistical data analysis. Beside that, the lighting set up used Elinchrom Professional Studio Flash System 50. The pictures need to scan in order to convert them into digital form. For scanning procedures, the specifications of the scanner that has been used such as Scanner type, the resolution and the scan speed are very important.

PCI Geomatica 8.0 application software was used for the digital image processing and analysis. PCI Geomatica 8.0 software is capable of image display, enhancement, manipulation and restoration. The steps implemented are Image captured using Nikon camera, then the image scanning by using specific scanner. The image import to PCI Geomatica 8.0 software in image processing.

Oil content analysis was done at the chemical lab of Malaysian Palm Oil Board (MPOB). In order to see correlation between shape properties with oil content, chemical processing were carried out to know the oil content for every sample. Formula to measure the oil content is shown below: -

% Oil = Wt of Oil / Wt of mesocarpX 100%
Where:
Wt oil = weight of oil
Wt sample = weight of mesocarp

The oil content that been extracted using this chemical processing is determined in percentage

(%). This analysis is repeated until the entire sample is done. Then from these results, we can correlate the oil content values by comparing against the size of the three types of fruit that were used.

3. RESULT AND DISCUSSIONS

A chemical analysis was done to determine the amount of oil content in the oil palm fruit. This analysis was conduct at MPOB chemical Lab at Bandar Baru Bangi, Selangor by MPOB staff. This process was done for three separate kinds of ripeness of fruit, which is known as *ripe*, *over ripe*, and *under ripe* fruit. This is because each fruit gives different amount of oil content. The results from the lab chemical processing of these three different kinds of fruit is are shown in Table 3.1.

Sample	Oil Content Ripe (%)	Oil Content Overripe (%)	Oil Content Under ripe (%)
1	6.16	11.60	8.14
2	26.57	22.75	6.45
3	6.33	9.07	9.91
4	18.21	9.84	7.12
5	11.36	17.04	7.60
6	21.56	14.80	3.83
7	19.96	13.69	5.75
8	9.61	14.55	5.54
9	16.37	19.22	6.04
10	13.76	16.33	7.29
Mean	14.99	14.89	6.77

Table 3.1: Oil Content of Ripe, Overripe and Under ripe Fruit.

From the table, the mean of the oil content in ripe fruit is 14.99%, while for under ripe fruit the oil content is 6.77%. In over ripe fruit is 14.89%. The range mean of the oil content between ripe and over ripe not much different because the content of oil not liable to change. Despite, the fruitlet changes from over ripe to ripe. The different both of this fruitlet is the
content of FFA (Free fatty acid). The content FFA in over ripe fruitlet is higher than fruitlet of ripe. Hence, the quality of the oil palm fruit over ripe is not quiet good than the content oil of ripe. The oil content in under ripe also is less because this fruitlet do not have much oil in their mesocarp and the fruitlet are too young.

Image processing in this study used Class Labeling and Aggregation Image. The Class Labeling is used to separate the image and the background with various color while the Aggregation is used to merge the various color become two color only that is the Image and the background. Then the image is processed to MLR Classifier to obtain the the size of the image.

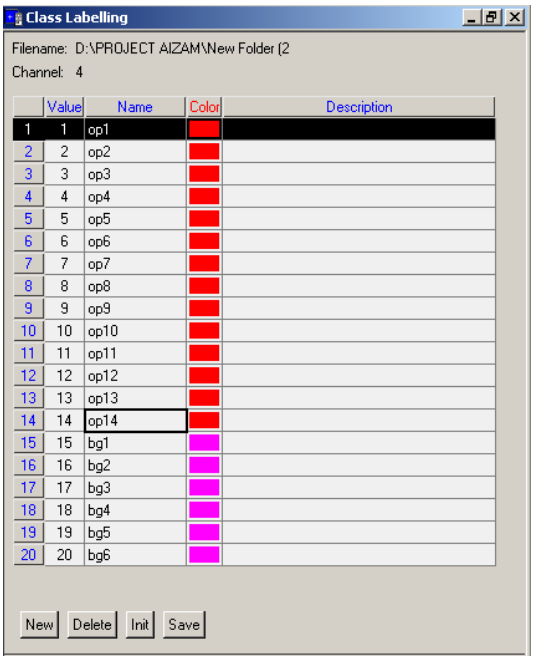

Figure 3.1: Class Labelling Process

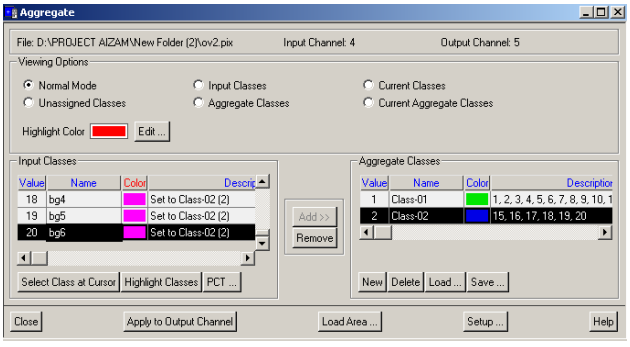

Figure 3.2:Aggregate Process

Category	Ripe	Over ripe	Under ripe
Sample	Size(m^2)		
1	232722	233668	261883
2	324705	327995	230766
3	233477	182866	279818
4	285706	199451	235312
5	282755	285803	238846
6	317714	263080	171440
7	297382	249276	206528
8	275033	253712	205326
9	284255	291166	216720
10	283059	282071	235829
Mean	281680.8	256908.8	228246.8

Table 3.2: Size for Ripe, Over Ripe and Under Ripe Fruits

Table 3.2 shows the mean of size of these three different of fruit. The mean of the ripe fruit is higher than the other it is because the ripe fruit is much bigger than the overripe and the under ripe fruit while the mean of under ripe fruit is smaller because of the size of the fruit is small and it is too young.

Analysis for the Ripe Palm Oil Sample

Sample	Size(m^2)	Oil Content (%)
1	232722	6.16
2	324705	26.57
3	233477	6.33
4	285706	18.21
5	282755	11.36
6	317714	21.56
7	297382	19.96
8	275033	9.61
9	284255	16.37
10	283059	13.76
Mean	281680.8	14.99

Table 3.3: The Size and the Oil Content of the Ripe Fruit

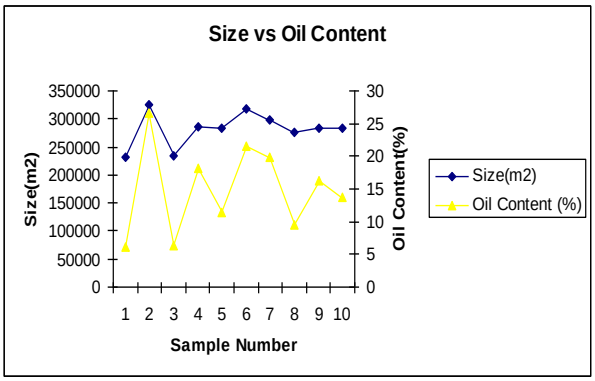

Figure 3.3:Graph Size of the Ripe Fruit and the Oil Content(%).

The relationship between the sizes of the ripe fruit compared oil content (%) is illustrated in figure 3.3. The samples of this graph is just for one type of sample only which is from sample 1 to 10 only. The oil content represented by the yellow line while blue line represented the size.

From the figure 3.3, we can say that for the ripe fruit there is a good relationship between this parameter. It shows that when the value of oil content increases the value of the size is also increase continuously.

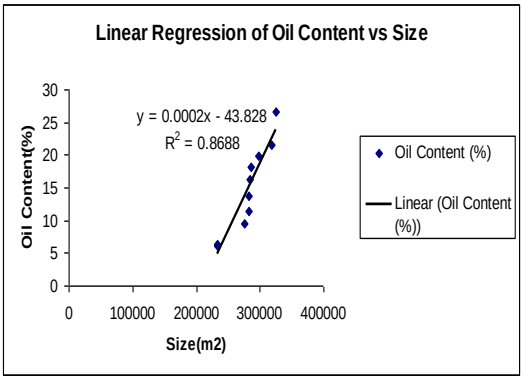

Figure 3.4: Linear Regression of the Size of ripe fruit.

The correlation analysis results can be classified qualitatively. The qualitative classification can lead to a unique differentiation of the different ripeness category. The value correlation of ripe is represented by R^2= 0.8688. This value shows that is the high correlation between these two parameters because value of R^2 is near to1.

Accuracy Assessment

Sample	Size (x_1)	%Oil Content (y_1)	(y_2)	Oil % (y_3)	Accuracy %
1	232722	6.16	2.72	55.84	44.16
2	324705	26.57	21.11	20.55	79.45
3	233477	6.33	2.87	54.66	45.34
4	285706	18.21	13.31	26.91	73.09
5	282755	11.36	12.72	11.97	88.03
6	317714	21.56	19.71	8.58	91.42
7	297382	19.96	15.65	21.59	78.41
8	275033	9.61	11.18	16.34	83.66
9	284255	16.37	13.02	20.46	79.54
10	283059	13.76	12.78	7.12	92.88
				Mean	75.60

Table 3.4: Accuracy assessment of the ripe fruit.

$Y_1 = \frac{Oil(g)}{Sample\ (g)} \times 100\%$

$Y_2 = 0.0002x - 43.828$

$Y_3 = \frac{y_1 - y_2}{Y_1} \times 100\%$

Accuracy = $(100\% - y_3)$

Table 3.4 Show the accuracy assessment of the ripe fruit sample. The value is between 44.16% and 92.88%. The mean accuracy is 75.60%.

Analysis for the Overripe Palm Oil Sample

Sample	Size(m^2)	Oil Content (%)
1	233668	11.60
2	327995	22.75
3	182866	9.07
4	199451	9.84
5	285803	17.04
6	263080	14.80
7	249276	13.69
8	253712	14.55
9	291166	19.22
10	282071	16.33
Mean	256908.8	14.89

Table 3.5: The Size and the Oil Content of the Overripe Fruit

Analysis of the overripe fruit was also made.The samples of this graph is combination of one type of sample also, which is from sample 1 to 10 for overripe fruit show in figure 3.5 below.

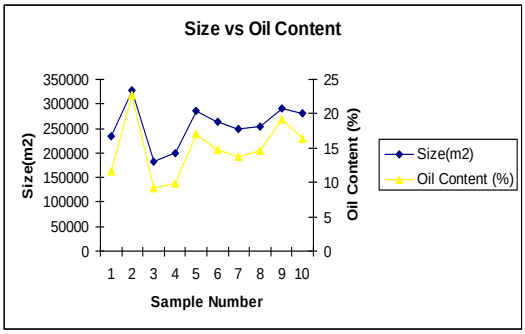

Figure 3.5: Graph Size of the Overripe Fruit and the Oil Content(%).

Figure 3.5 show that there is a significant relationship between these two parameters. We can see that when the graph of oil content increases the graph of size is also increase continuously.

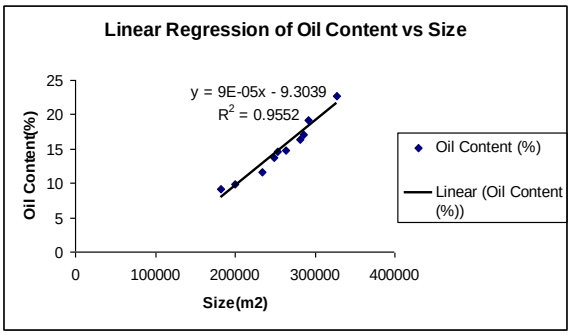

Figure 3.6: Linear Regression of the Size of Overripe fruit.

The linear regression is also done for the overripe sample and it is shown in figure 3.6. We can see that the value of R^2 is 0.9552.The value is higher than the ripe sample. So, there is also a correlation between these two parameters.

The accuracy assessment of the overripe sample is shown in table 3.6 below. The value is between 78.83 and 98.88 and the mean is 92.33. This value is better than the ripe sample.

Accuracy Assessment

Sample	Size (x_1)	%Oil Content (y_1)	(y_2)	Oil % (y_3)	Accuracy %
1	233668	11.60	11.73	1.12	98.88
2	327995	22.75	20.21	11.16	88.84
3	182866	9.07	7.15	21.17	78.83
4	199451	9.84	8.65	12.09	87.91
5	285803	17.04	16.43	3.57	96.43
6	263080	14.80	14.37	2.91	97.09
7	249276	13.69	13.13	4.09	95.91
8	253712	14.55	13.53	7.01	92.99
9	291166	19.22	16.90	12.07	87.93
10	282071	16.33	16.08	1.53	98.47
				Mean	92.33

Table 3.6: Accuracy assessment of the Overripe fruit

$Y_1 = \frac{\text{Oil(g)}}{\text{Sample (g)}} \times 100\%$

$Y_2 = 9E\text{-}05x - 9.3039$

$Y_3 = \frac{y_1 - y_2}{Y_1} \times 100\%$

Accuracy = $(100\% - y_3)$

Analysis for the under ripe fruit

Sample	Size(m^2)	Oil Content (%)
1	261883	8.14
2	230766	6.45
3	279818	9.91
4	235312	7.12
5	238846	7.60
6	171440	3.83
7	206528	5.75
8	205326	5.54
9	216720	6.04
10	235829	7.29
Mean	228246.8	6.77

Table 3.7: The Size and the Oil Content of the under ripe Fruit

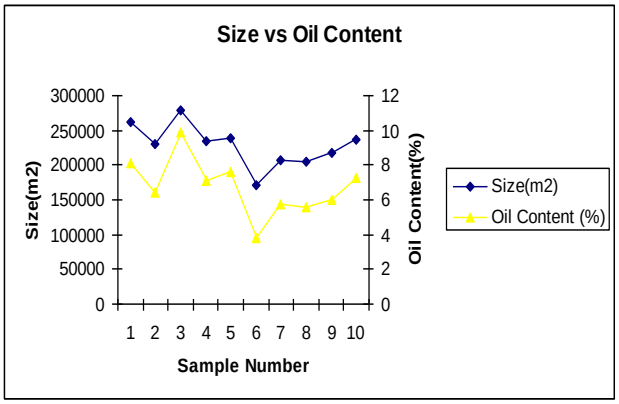

Figure 3.7: Graph Size of the under ripe Fruit and the Oil Content (%).

Figure 3.7 show that there was a relationship between this parameter as explained in ripe and the overripe sample.

Linear Regression of under ripe sample is shown in figure 3.8 below. The value of R^2 is 0.9731 meant that high correlation can be made between these two parameters.

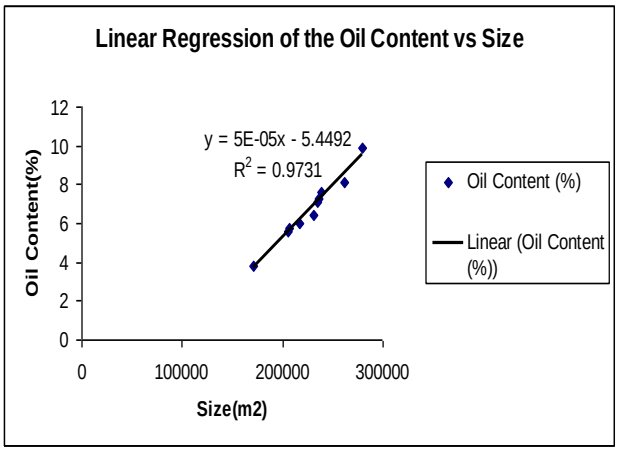

Figure 3.8: Linear regression of the size for under ripe fruit.

Accuracy Assessment

Sample	Size (x_1)	%Oil Content (y_1)	(y_2)	Oil % (y_3)	Accuracy %
1	261883	8.14	7.64	6.14	93.86
2	230766	6.45	6.09	5.58	94.42
3	279818	9.91	8.54	13.82	86.18
4	235312	7.12	6.31	11.38	88.62
5	238846	7.60	6.49	14.61	85.31
6	171440	3.83	3.12	18.54	81.46
7	206528	5.75	4.88	15.13	84.87
8	205326	5.54	4.82	13.00	87.00
9	216720	6.04	5.39	10.76	89.24
10	235829	7.29	5.45	25.24	74.76
				Mean	86.57

Table 3.8: Accuracy assessment of the under ripe fruit

$Y_1 = \frac{Oil(g)}{Sample\ (g)} \times 100\%$

$Y_2 = 5E\text{-}05x - 5.4492$

$Y_3 = \frac{y_1 - y_2}{Y_1} \times 100\%$

$Accuracy = (100\% - y_3)$

Table 3.8 show the accuracy assessment for the under ripe samples. The values is between 74.76 and 94.42.The mean is 86.57.

4. CONCLUSION

The analysis of the correlation between oil contents estimation and size of oil palm fruit using digital imagery was presents successfully. This study was conducted to represent the correlation between size properties of the oil palm fruit and the amount of oil content within the fruit. From the analysis, we found that this study achieved its main of testing the use of digital image processing to estimates oil content of the oil palm fruit. The results show that image processing is capable to do this task. We also found there are high correlations between sizes of the fruit with oil content because the size of the fruit influent the oil content in the fruit. So the big fruit have great size and the percent of oil content is higher.

5. FUTURE DEVELOPMENT

There are some recommendations to improve this study in the future. As stated earlier, all the experiments were carried out in a room under control environment, which involved static conditions and with fixed distance. So for the next study, this process should be done in the real field area by considering more parameters. For example we should include weather, types of species and illumination conditions. In this study, we used an analog camera; thus subsequent scanning of the pictures may have introduced some errors that affect the accuracy. In order to reduce the errors, a digital camera maybe the better way. This is because a digital camera can capture images directly in digital form. In this study, we used size properties as a parameters to estimates the oil content. Future studies can use more parameters such as texture and shape to get more accurate result. The number of samples tested is also important. In this study, we used 30 samples; 10 samples for each category. Larger number of samples to get a better results and accuracy can also be tried out.
The results of this research can be used to program the harvesting robot as we can send this as an input to the robot arm to harvest the best quality of the bunches to get the maximum palm oil quality. This will help the oil palm industry to achieve optimum productivity of harvesting palm oil.

6. ACKNOWLEDGEMENT

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7. REFERENCE

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