Execution of UML-based oil palm fruit harvester algorithm: novel approach

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Abstract: Farmers in rustic India have negligible access to rural specialists, who can investigate edit pictures and render counsel. Deferred master reactions to inquiries regularly achieve farmers past the point of no return. This paper addresses the above issue with the target of building up another calculation to review *Elaeis guineensis* types of oil palm fruit to help agriculturists and analysts using two features namely colour and number of detached fruitlets. The structure outlined can unravel issues of human reviewing evaluating in light of two qualities and anticipate the rate of free unsaturated fat and oil content. Since manual evaluating is inclined to blunder, the nature of oil expelled from substance is low. Hence, there is a need to automate the process. The computerisation of the manual evaluating procedure is finished with the proposed oil palm fruit harvester algorithm calculation using unified modelling language (UML).

Keywords: fruitlets; modelling; *Elaeis guineensis*; oil palm fruit; unified modelling language; UML; free fatty acid.

Reference to this paper should be made as follows: Patkar, G.S., Anjaneyulu, G.S.G.N. and Mouli, P.V.S.S.R.C. (2020) 'Execution of UML-based oil palm fruit harvester algorithm: novel approach', *Int. J. Computer Aided Engineering and Technology*, Vol. 12, No. 1, pp.113–129.

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This paper is a revised and expanded version of a paper entitled 'Palm fruit harvester algorithm for *Elaeis guineensis* oil palm fruit grading using UML' presented at 2015 IEEE International Conference on Computational Intelligence and Computing Research, Madurai, Tamil Nadu, India, 10–12 December 2015.

1 Introduction

With the improvement of quick and solid PC advancements, computerised flag and picture handling calculations have discovered huge application regions, for example, robotisation, safeguard, agribusiness, wellbeing and mechanical technology. In this paper, we concentrate on one particular rural application and propose calculation in view of unified modelling language (UML) and picture handling strategies. The initial segment is the plan and examination of summed up model, calculation for the palm organic product evaluating framework utilising UML. Additionally part examines the usage, testing and results acquired. Taking after segments clarify the inspirations driving this fascinating application abridges the past work and proposes the calculation. India imports palm oil either from Indonesia or Malaysia. Malaysia and Indonesia have assumed an imperative part in the creation of palm oil. The interest for the palm oil is expanding more since it is broadly utilised as a part of cooking, pharceutical items and so forth. Two sorts of oils are created from palm oil organic product:

1 mesocarp oil, which is the wellspring of broadly utilised palm oil
2 portion oil, which resembles coconut oil.

Red shaded mesocarp oil is removed from the organic products in the wake of disinfecting them under weight cooker condition for 60 minutes and this is called unrefined palm oil or crude palm oil. Nuts are isolated after this and part is gotten in the wake of breaking the shells. Thusly bits are ousted for extraction of bit oil. The crude palm oil is bad to cook reason since it contains undesirable chemicals. Since the interest for palm oil is more why not to make most extreme utilise crude palm oil. To get great crude palm oil, just ready class of natural products is to be taken for oil extraction. In this paper oil palm organic product collector calculation is proposed, actualised and tried to take care of the said issue. Since the proposed calculation is in UML, it can be utilised as base by all analysts to execute their review. Computerised evaluating of agribusiness items has been getting uncommon intrigue as of late as the interest for higher quality nourishment items delivered inside a shorter timeframe has expanded. Advertise review of value sustenance items is resolved in view of their numerous elements: shading, surface and appearance. After introductory examination and plausibility investigation of writing review, it is discovered that there is no model composed till now which can be utilised as a structure for building the palm organic product evaluating framework. So in the past paper of our exploration the palm organic product calculation is proposed and structure for oil palm natural product evaluating is created. In Malaysia, explores in computerised reviewing framework have turns into an enthusiasm for some specialist since it has a high potential for another approach later on era. For the oil palm fruit research, there were several report has been published in the past few years. May and Amaran (2011) deals with the ripeness of oil palm fruit using red green blue (RGB) colour model and it grades them into only three categories underripe, ripe and overripe. Roseleena et al. (2011) deals with automated sorting of bunches using image processing techniques. Mohamad et al. (2012) have used HSV colour model and four distance measurements to explore the ripeness factor. Oil palm fruit grading system using RGB digital numbers is also done for bunches by Alfatni (2008) proved that hue colour component decides the maturity value. Sunilkumar and Sparjan Babu (2013) investigated that the L * a * b colour model is ideal for colour-based prediction of oil content. Images in red, green and blue (RGB) colour space were used to analyse the colour of oil palm fruits. Wan et al. (2000) found that the ranges of colour intensity for all ripeness categories were almost the same. The only attribute that could differentiate between ripe category and others was the average of red value. However, later study by Ghazali et al. (2009), discovered that the red components for unripe and underripe categories were almost the same. Thus, red component was not able to distinguish between unripe and underripe categories and could not be an attribute for ripeness classification. Choong et al. (2006) investigated the correlation between the colour of oil palm fruits and their oil content. Similar results were also reported by Hudzari et al. (2010) and Jaffar et al. (2009), in studies of correlation between the colour of oil palm fresh fruit bunch (FFB) and their oil contents. Aziz (1984) found that the shade of each natural product on the group fluctuates marginally with area as organic products on any given bundle do not ready at the same time. Despite this, it has been watched that over 85% of organic products on any group display a comparable level of development, the staying 15% which are hiddenly situated in the inside districts of the pack constitute the undeveloped and parthennocarpic natural products. Omar et al. (2003) investigated a device for fruitlets of the fruit bunch and it requires the fruits to be sliced and the surface of the mesocarp exposed. Keeping in mind the end goal to build the effectiveness and nature of reviewing FFB in palm oil factories, Chen et al. (2002), Blasco et al. (2003) and Abdullah et al. (2004) suggests PC-based innovations, for example, machine vision are important to supplant the conventional evaluating performed via prepared human overseer. Babatunde et al. (1988) examined that overripe organic products create generally most astounding oil content. However, Duke (1983) expressed that over-ready natural products have high free fatty acid (FFA) which demonstrates low nature of the item. Ariffin et al. (2009) found that chemical changes in fruit product surface likewise are in charge of the variability in organic product hues amid maturing process. Since oil discharged from oil cells compartments will combine and cover more extensive surface region especially in the surface of the mesocarp. That is way the more ready organic product is more yellowish and the less ruddy shading and therefore give less red band computerised number. Patkar et al. (2015, 2016) has proposed palm fruit harvester algorithm using two attributes. All the required UML diagrams are given in the paper. The research has been done using several techniques and the most recent one are done by using by using neuro-fuzzy (Jamil et al., 2009). There are also other techniques used to evaluate the grading of oil palm fruit found out by Nureize and Watada (2009) and Abdullah et al. (2001). Literature survey has investigated that till now no researcher has given prototype of algorithm and found out the time complexity of the same. Two features are taken into consideration in the proposed algorithm. The proposed algorithm gives framework using UML and image processing techniques.

2 Materials and methods

This section shows the design of palm fruit harvester algorithm using the data collected after extensive research. Figure 1 show the proposed flowchart and algorithm which can be used as a blueprint for solving the problem of harvesting. The algorithm takes images as an input. Test images are collected from farm of all categories. Once the database is collected, the next step is to give these images as an input to the algorithm. We have combined the P-Tile method which uses prior knowledge and optimal thresholding by Ganzalez and Woods (2002). The first strategy requires information about the range or size of the articles introduce in the picture. The second method uses object and background knowledge. There are four different environmental conditions which will differ the lighting conditions namely: sunny, cloudy, rainy and windy. These conditions threshold values are experimentally calculated using above two methods. All the threshold values T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 and T12 which are used in the algorithm are calculated by experimental setup in controlled environment. Here RGB colour model is used. There is a provision to use any colour model in the framework. For calculating threshold (Th) for various categories, count RED, GREEN, BLUE components of the pixel. Then sum all single components. Example is summed_red_value = 400; number_of_pixels = 100, mean = (summed_red_value) / (number_of_pixels) and display (Rmean, Gmean, Bmean). The algorithm does processing and then outputs any of the three categories namely unripe, underipe or ripe. If the category identified is ripe then next step is to check if it is overripe or not. Then the FFA values are checked with threshold values (Th). Th is calculated after extensive research in the laboratory. If FFA is greater than threshold value then it is overripe category, otherwise it is ripe category. The correct distinction of ripe and overripe oil palm fruit category is important in producing the good quality oil and this algorithm does it. Time complexity of the algorithm plays a very important role in deciding whether the algorithm is efficient or not. Table 1 shows the time complexity of algorithm. After detailed survey it is found that the time complexities of work related to this type of research are not calculated. Time multifaceted nature of a calculation implies the aggregate time required by the program to keep running till its consummation. Time Complexity is most ordinarily assessed by tallying the quantity of rudimentary capacities performed by the calculation. Also, since the calculation's execution may shift with various sorts of information.

Figure 1 Palm fruit harvester algorithm (see online version for colours)

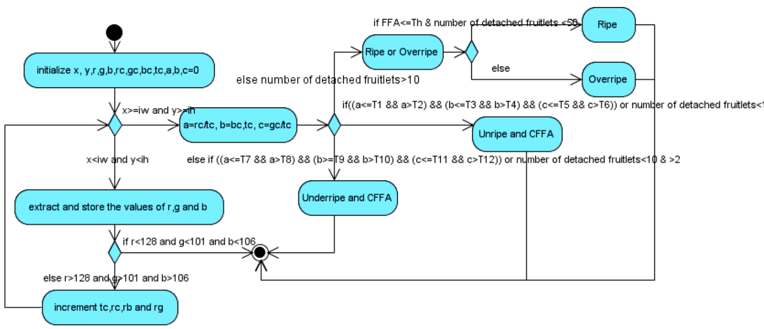


Table 1 Time complexity of algorithm

Case	*If*	*Else*
Best	10 mn + 4 m + 12	14 mn + 4 m + 12
Worst	10 mn + 4 m + 22	14 mn + 4 m + 25
Average	9 mn + 4 m + 17	14 mn + 4 m + 18

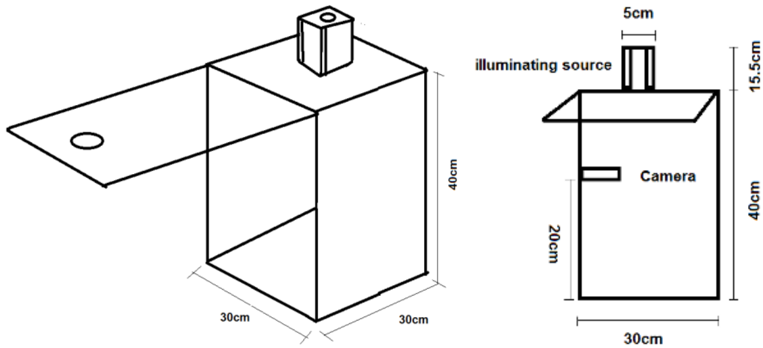
Implementation of oil palm fruit harvester algorithm is done using Visual C++. Since the framework specified is using UML methodology, it can be implemented using any software language. For experimentation purpose the data is collected from the fields and experiment is performed in a controlled environment. Since the prototype given in the algorithm gives flexibility to use different threshold values which suits the environment. After implementation testing is very important to identify whether the implemented product meets the objective of the research or not. The product testing is an investigation conducted to provide farmers and researchers with information about the quality of product or service under test. It also provides an objective, independent view of design to appreciate and understand the risk at implementation of software. Test techniques include, but are not limited to the process of executing a program and application with intent of finding software bugs. Different test cases are written and tested in the following subsection. The grading system setup consists of the following: Controlled environment container with uniform illumination, consisting of image capturing device for capturing images and a workstation for processing and storing of images, systems detailed specifications are mentioned below.

1 Camera specifications: resolution: camera 640 × 480 px (1.3 MP), mounting position: as shown in Figure 2.

2 CFL tube configuration: 11 watt, 220V, 50 Hz (Phillips).

3 Controlled environment container specifications: Box dimensions: 30 × 30 × 40 cm^3, distance of CFL from fruit: 40 cm, distance of webcam from fruit: 20 cm.

Figure 2 Dimensions of controlled environment container



The unwanted background is removed as it is not really required. The region of interest is the fruit itself without the background. The background is the noise to the image and it has to be removed. The background can be either made white or black as required.

Figure 3 Background elimination and histograms of images (see online version for colours)

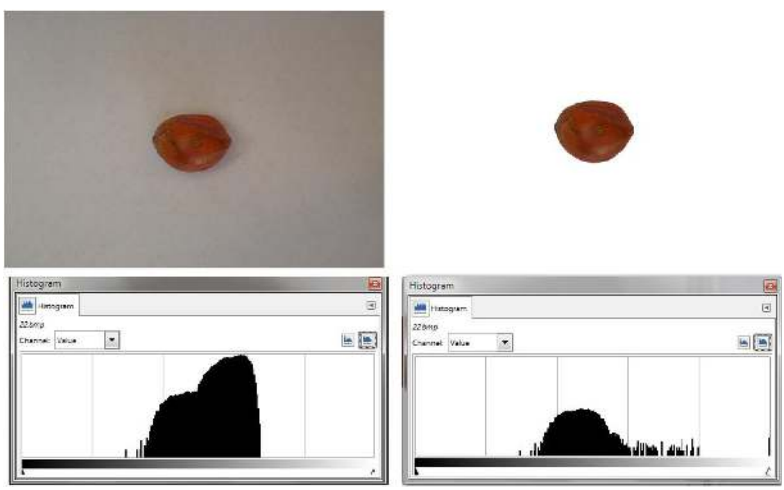


Figure 3 shows the histogram for original image and the histogram of the original image with eliminated background preserving only the fruit. First select single pixel; then extract RGB values and lastly set the threshold for RGB. Threshold value was set by following way: Image was captured without the fruit, with proper illumination. Image pixels were checked manually and found that background pixel were in the range of red = 128, green = 101 and blue = 106. Next this threshold was manually programmed to eliminate those pixels in the above range. Pseudo code is as follows:

The basis for feature extraction is the number of detached fruitlets and colour factor obtained. The threshold values are set for red colour and the matched against the RGB values being processed.

Palm oil contains high concentration of saturated fat, explicitly; 16-carbon saturated FFA. There is a chemical procedure for estimation of FFA content. This procedure is carried out in chemical laboratory for 200 fruits from different categories.

```
for ( x = 0; x < image1->Width; x++)
{for ( y = 0; y < image1->Height; y++)
{k = k + 1;
this->progressBar1->Value = k;
Color pixelColor = image1->GetPixel(x, y);
r = (int)pixelColor.R; // First channel RED
g = (int)pixelColor.G; // Second channel GREEN
b = (int)pixelColor.B; // third channel BLUE
if (pixelColor.R > 128 && pixelColor.G > 101 && pixelColor.B > 106)
{
image1->SetPixel(x, y, Color::White);
```

3 Results and discussions

3.1 Image capture

Figure 4 shows how camera is activated and image is captured. It also shows different test cases for the image capture window.

Figure 4 Captured image and test case 1 (see online version for colours)

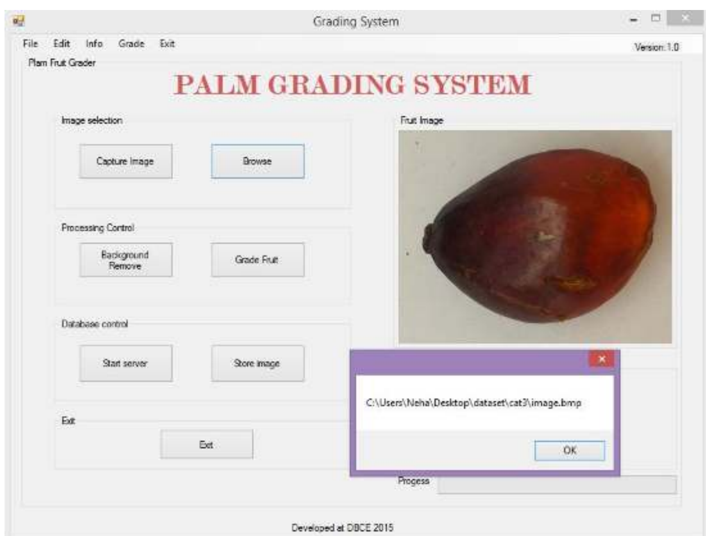
Figure 4 Captured image and test case 1 (continued) (see online version for colours)

Test name	*Capturing image*
Description	Capturing image of image at real time
Input	Trigger to system camera(click capture button)
Expected output	Image of fruit should be clicked
Observed output	Image is clicked
Remark	Successful

3.2 Browsing existing image from the system memory

If database of images are available then we can browse and select images. We visited oil palm farm and collect 50 samples of each category. There we total 200 oil palm fruits of unripe, underipe, ripe and overripe category. Each fruit is rotated 20 degrees and then picture is taken. There were total 900 images captured from each of the category. In total we have 3,600 live images. Figure 5 shows the browsing operation with its test case.

Figure 5 Browsed image from system memory from the specified path and test case 2 (see online version for colours)

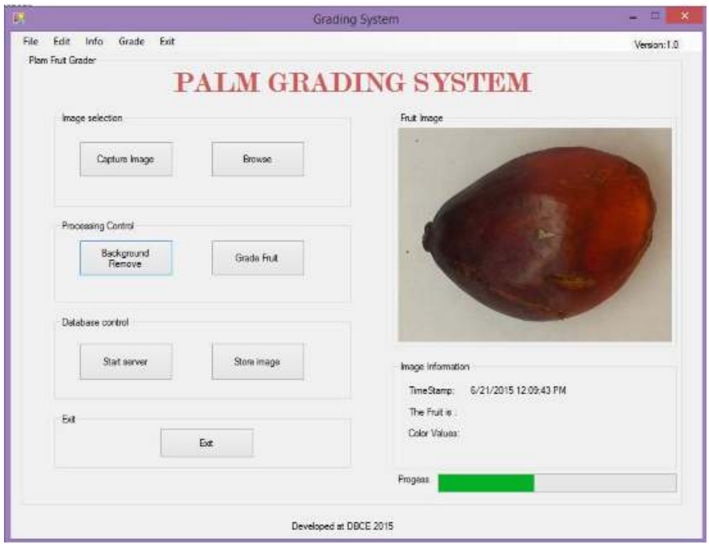


Test name	*Browsing image*
Description	Selecting pre-existing image for system memory
Input	Click browse button
Expected output	Should allow browsing to any location of system memory
Observed output	Images can be browsed
Remark	Successful

3.3 Background elimination process

This step is necessary to remove unwanted details from the image. Figure 6 and Figure 7 shows the output of background subtraction along with the test case.

Figure 6 Background elimination process and test case 3 (see online version for colours)



Test name	*Background removal*
Description	For extracting only the image and removal of background
Input	Captured image
Expected output	Background should be eliminated
Observed output	Background is eliminated
Remark	Successful

3.4 Grading fruit

When grade fruit button is clicked, the palm fruit harvester algorithm triggers and it grades oil palm fruit in any of the four previously mentioned categories.

Figure 7 Image after background elimination (see online version for colours)

Figure 8 Grading the image and test case 4 (see online version for colours)

Figure 8 Grading the image and test case 4 (continued) (see online version for colours)

Test name	*Grading fruit*
Description	Grading fruit according to the average values of RGB
Input	Background removed image
Expected output	Should displays averaged RGB values of the target fruit and the category
Observed output	Displays averaged RGB values of the target fruit and the category
Remark	Successful

3.4.1 Starting grading process

Figure 9 shows grading process for all the cases. The grading process helps to find out the red, green and blue values along with the predicted FFA contents. The company takes 1 day to carry out the chemical analysis and perform grading of fruits.

The next step is to store the values calculated by grading process by starting online server for further analysis. Starting the local server control panel is shown in Figure 10.

Figure 9 Calculated mean values of RGB for one fruit (unripe, ripe and overripe category) (see online version for colours)

Figure 9 Calculated mean values of RGB for one fruit (unripe, ripe and overripe category) (continued) (see online version for colours)

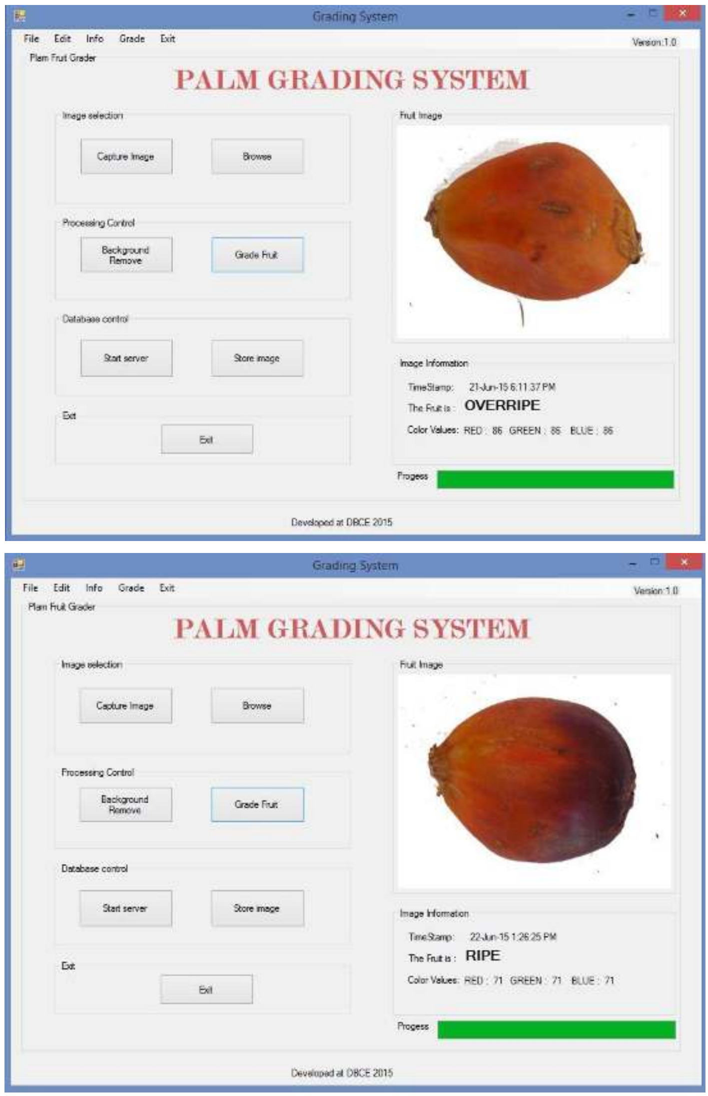
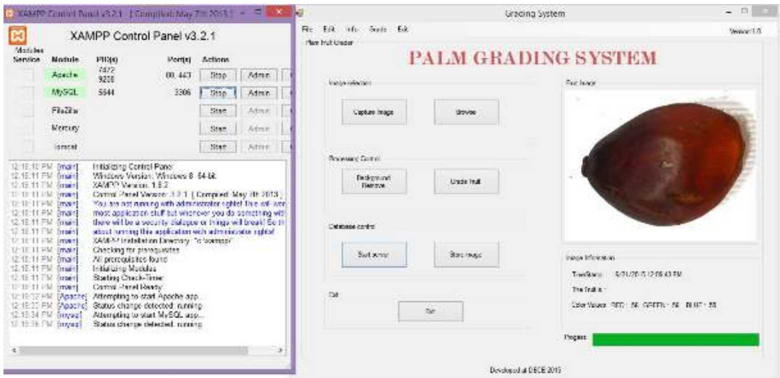


Figure 10 Starting server control panel and test case 5 (see online version for colours)



Test name	*Starting server*
Description	Starting a server directly through applications, as the localhost displays its control panel.
Input	Trigger to start server
Expected output	Localhost should display its control panel
Observed output	Localhost displays its control panel
Remark	Successful

Figure 11 Storing values into database and test case 6 (see online version for colours)

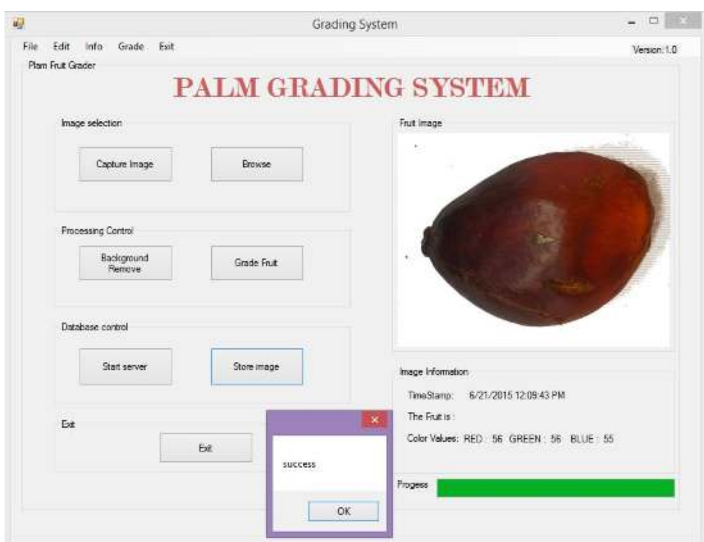


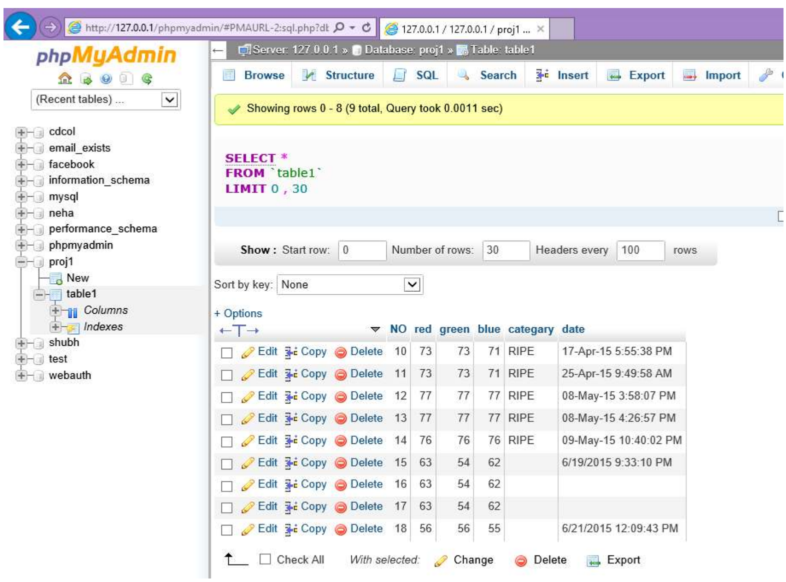
Figure 11 Storing values into database and test case 6 (continued) (see online version for colours)

Test name	*Storing image and values of RGB in database*
Description	Stores values of RGB and the image into database
Input	SQL query
Expected output	Values of RGB and the image should be saved into database
Observed output	Values of RGB and the image are stored into database
Remark	Successful

3.5 Storing the image and the value into database is shown in Figure 11

Database table storing details is shown in Figure 12.

Figure 12 Details stored into database (see online version for colours)



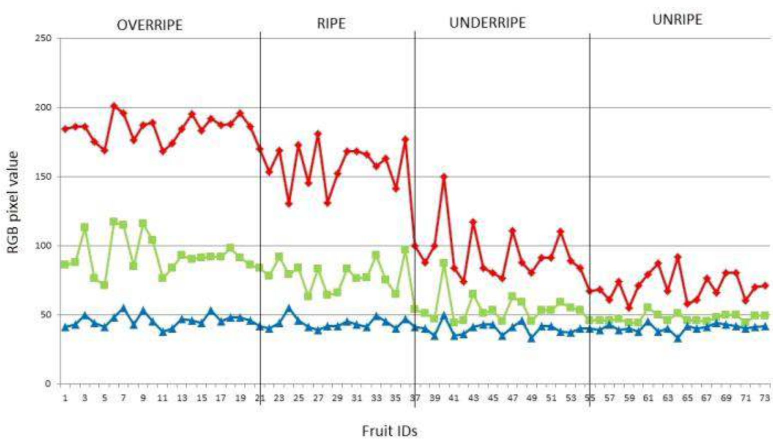
3.6 Testing

Testing of the software is done for following cases.

- *Best case:* using the mentioned setup and even condition grading process functions accurately with best results. For best results, it is recommended to grade the fruits before 24 hours from harvesting.

- *Average case:* if the face of the fruit is repositioned, it will result in slight variation in grading result. To overcome this we have taken images from different angles and tested the same.
- *Worst case:* the system will not identify damaged or naturally spoiled fruits. Any colour changes to the fruit will result in inaccurate grading results. Change in image resolution will also give different grading results. It is recommended to use same camera as mentioned in system setup. It does not identify different types of fruits. It is observed that as the fruit ripens its red blue and green values increases although red is the prominent colour there is comparative increase in blue and green components also. To differentiate categories of fruit, along with red colour green and blue also plays an important role. The FFA content also increases and fruit grows in its maturity level from unripe to overripe. Figure 13 shown clearly illustrates the growth of colour component of various fruit starting from unripe category to the overripe category.

Figure 13 Output of graphical comparisons of the categories of palm fruit categories along with different values (see online version for colours)



Sr no.	*Red*	*Green*	*Blue*	*Category*	*FFA conent*
1	55–92	44–55	33–45	Unripe	3.3–4
2	74–117	47–65	33–50	Underripe	4–4.5
3	100–180	54–93	39–55	Ripe	4.5–5
4	170–201	70–117	38–55	Overripe	> 5

4 Conclusions

The framework designed using UML methodology for automated grading of oil palm fruits can be used with many different colour models. Since oil palm trees have thorns and it is not possible to cling on the trees to cut the fruit, this invention will surely help farmers in harvesting. Oil palm fruit harvester algorithm uses two features colour and number of detached fruitlets. It has been implemented and tested using different test cases. It is found that the number of detached fruitlets also plays a very important role in grading along with colour feature. The time complexity of algorithm is O (mn) which is better since it is quadratic. The prototype designed using UML will help researchers and farmers in proper grading which helps in extraction of good quality oil.

5 Future work

The framework can be tested with different languages and time complexity can be calculated and compared. Also different ingredients can be predicted. Working model based on this paper can be developed.

Acknowledgements

This study is selected for International Competition on Oil Palm Mechanisation (ICOPM3) organised by Malaysia Palm Oil Board (MPOB), Malaysia. The authors would like to thank Godrej Agrovet Limited, Goa for providing valuable information and data gathering process.

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