

Estimation of Banana Fruit Maturity using Image Processing in MATLAB

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Abstract: In the agriculture industry, maintaining a good quality product is important as the product will be marketed in the industry. Nowadays, fruit planting such as banana fruit has been produced in Malaysia's economy. The process of banana fruit sorting and degrading based on its maturity was made before the fruit was marketed into the industry. This work focuses on the estimation maturity of banana fruit using an image processing technique where it can detect the ripeness of banana fruit. The technique used in this work is based on color image segmentation, image enhancement, detection of RGB values and removal of background images. The work considers a set of banana fruit images as samples that are processed using image processing in MATLAB software. A Graphical User Interface (GUI) was developed as interfacing between users and MATLAB. From the analysis of this study, the technique of image processing is able to detect different sample images of banana fruit and estimate the ripeness. This system is able to separate different conditions of banana fruit based on its maturity by detecting the skin color of the banana. The average RGB values of banana fruit are calculated and compared to identify the intensity of RGB on the sample images. The range of average RBG values of the banana fruits shows the intensity of the average value for red (R) is more than 250 pixels, for green (G) is 190-230 pixels and for yellow (Y) is lower than 120 pixels. In this study, a total of 25 sample image that includes 10 yellow, 10 green, 5 yellow and green banana fruit are used where a total of 21 sample images was detected. The accuracy of the system performance is calculated by using the total sample image detected. The accuracy of yellow banana sample images detected is 80%, for green banana is 90% and for the mix of green and yellow banana sample images is 80%. The overall result calculation of system accuracy detection banana fruit sample images is 84% successful rate. Development of this system able to help farmers to estimate the maturity of banana fruit without any damage.

Keywords: Banana Fruit Maturity, Image Processing, MATLAB

1. Introduction

Agricultural sector is one of the important sectors in the industry as it helps to contribute in Malaysia's economy. Nowadays, fruit planting such as banana fruit has been produced in agriculture sector as it still relevance and has a high demand in this country. There is various type of banana fruit with different texture and size. The most common varieties of banana fruit in Malaysia are Cavendish and *Berangan* banana fruit. In 2017, Malaysia has produced the most banana fruit where the production was more than 350000 metric tons (MT) [1]. Banana fruit has become one of the common fruit in Malaysia where it can be eaten as dessert and snacks. The quality of banana fruit is needed as the demand for banana fruits among locals has increased throughout the years [1].

The title of this project is Estimation of Banana Fruit Maturity using Image Processing in MATLAB. This project focuses on image processing techniques which is a process of extracting an image and enhancing the image in order to utilize more information. The technique of image processing is able to observe an object and reduce noise in the image to give a clearer vision for an observation [2]. The manual process of banana fruit sorting takes a lot of time and use human power that causes some errors or mistake during the process. The technologies in MATLAB with image processing from this project are able to sort each banana fruit specifically based on the skin color of banana fruit. This project gives a lot of benefits to farmers and advantages in agriculture to sort out their fruits quickly by detecting the color of banana fruit and maintaining the high quality of products.

The quality of a product is important for every food producer in the industry. The quality of the product that needs to be maintained including the size, characteristic, and condition are important in order to gain the public interest in the market. A good quality product is important to ensure it is safe for the consumer. The scope of this project focuses on image processing and simulation using Graphical User Interface (GUI) in MATLAB. MATLAB software provides an image processing toolbox that was used in this project. This study is limited to analyzing the maturity of banana fruit through an input image. The process of image processing techniques is able to detect the image and estimate the maturity through the color and size of banana fruit. The method used for this project is image segmentation and enhancement to extract more information from the image. The development of this system is able to help farmers to separate and sort banana fruit by its maturity. The GUI of this system is designed for the maturity of banana fruit to be determined.

2. Materials and Methods

In this project, a Graphical User Interface (GUI) is used as interfacing in MATLAB for Image Processing to estimate the maturity of banana fruit. MATLAB software [3] is fully used to develop a GUI of image processing for this project. This section describes the method used in this project and the details of the project was be explain.

2.1 Development of Project

This project is conducted according to the flowchart shown in Figure 1 where it started by understanding the main problem and providing a final solution. To complete this study, research about image processing was made before developing the system in MATLAB software. A study was made by making research about the past study related to image processing and identifying suitable algorithms that can be used in this project. The article and research paper used were cited in the literature review in this study as references.

By making research, various techniques of image processing were identified where it was used as a process to detect the maturity of banana fruit. The technique of image processing includes image enhancement, image segmentation, plotting a histogram, and color classification. The algorithm and programming are written and tested in MATLAB software using the graphical user interface. The process of data collection and observation comes after the programming of image processing in

MATLAB is successful. An image of banana fruit is used as an input image in the graphical user interface. The input image undergoes the process of image processing in GUI and the observation of the image was recorded. A different sample image is used to test the coding used in GUI for a better result in this study.

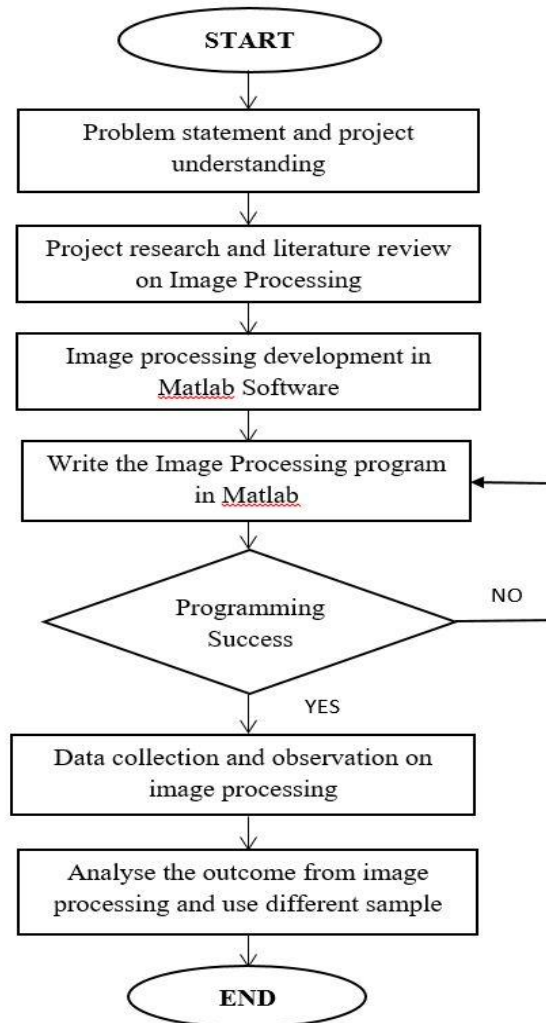


Figure 1: Flow Chart of Project Development

2.2 Development of Graphical User Interface

A Graphical User Interface is a feature in MATLAB software that can build apps and program a system graphically. It allows users to design the layout of a system by encoding the program in each of the functional widgets provided. For GUI apps in MATLAB, it provides widgets such as switch button, graph and various functions that can display an output graphically to the user. This feature can be found in MATLAB software by inputting the command “guide” in the command window and choosing the GUI feature in the windows.

The system of image processing to detect the maturity of banana fruit was designed using Graphical User Interface in this project. This system is used as interfacing of user and MATLAB to get information graphically. By using this system, users able to separate an unripe and ripe banana easily. This project gives benefits to farmers in agriculture to separate and sort their products while maintaining the quality of products.

Figure 2 shows the Graphical User Interface of image processing for the process of estimating banana fruit maturity detection. This system is used to observe a sample image of banana fruit and extract the information based on the output at the modified image. The input of the sample image was shown on the Original Image and the modified image shows the effect of the image processing technique used on the sample image as an observation.

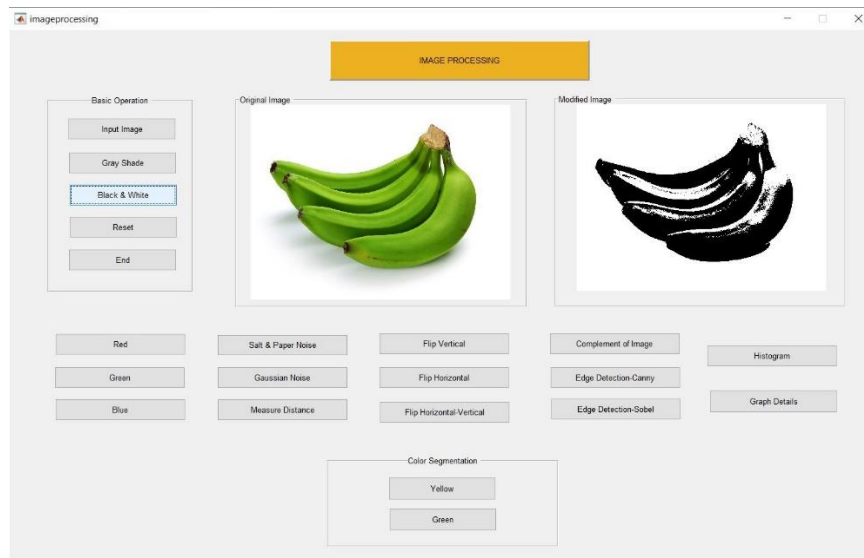


Figure 2: GUI of Image Processing

3. Results and Discussion

The technique of image processing used in this project by inputting a sample image of banana fruit into the GUI system. The system analyzes the image and detects the maturity of the banana fruit. This section shows the analysis of the result from image processing in GUI. The result obtained was explained.

3.1 Results

The technique of image processing is conducted one by one in the Graphical User Interface (GUI) by starting with the basic operation of the input image. The sample image of Banana fruit can be changed into gray shaded or black and white for a clearer view of the image. A feature of the measure is added in order for the user to measure the size of the sample image in pixel value. Figure 3 shows the modified image of banana fruit which has been changed into black and white, gray-shaded and measured in pixel value.

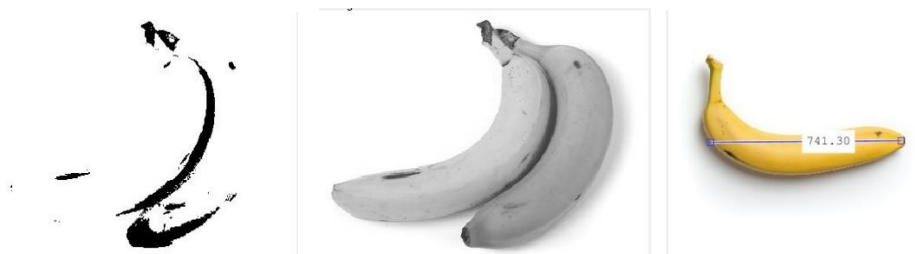


Figure 3: Sample Image In Black And White, Gray-Shaded And Measured In Pixel Value

The image in Figure 4 shows the histogram of the banana fruit sample. The histogram shows the data of a color scale from light to dark. The color scale is between 0 to 255 which is the Red, Green, Blue (RGB) value in computer color code.

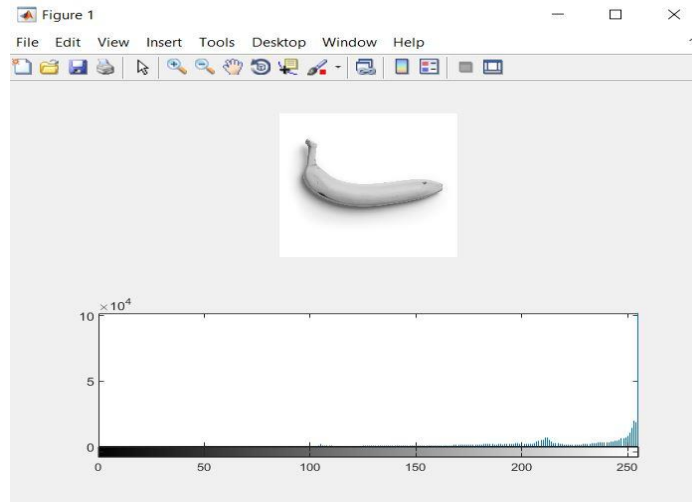


Figure 4: Histogram of Banana Fruit

Next, the image shown in Figure 5 (a), (b), and (c) is the image of banana fruit is changing into Red, Green and Blue. This technique is a basic of image processing to get an RGB sample image of banana fruit in the GUI system.

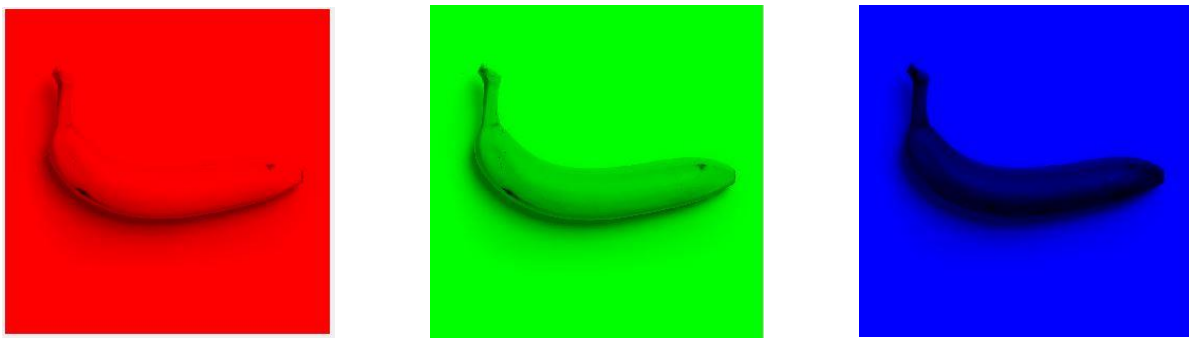


Figure 5: RGB images (a), (b) and (c)

The process of image processing then continues with the complement of image and edge detection. This technique is used on the sample image to get a clearer and sharper image of banana fruit. The modified image is shown in Figure 6 (a) complements the image, (b) edge detection-canny, and (c) edge detection-Sobel. The sample image of banana fruit shows the image is sharper than the original image. This process helps to observe the image easier.

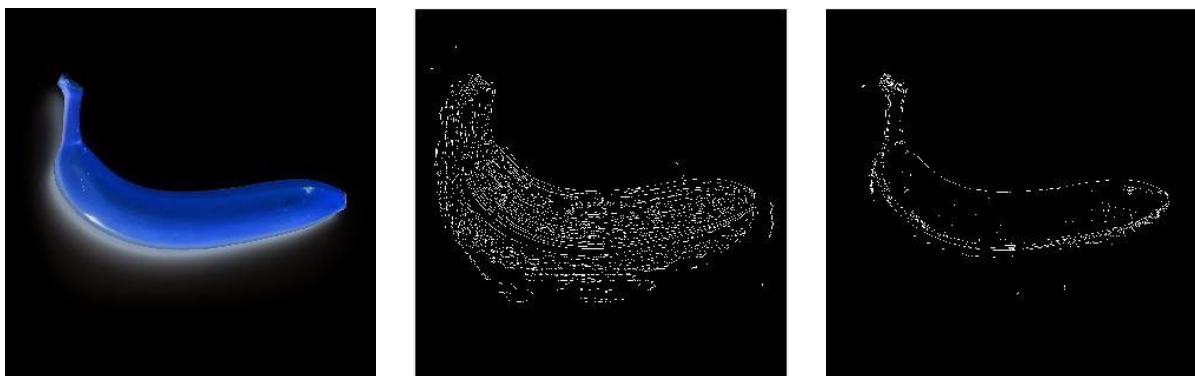


Figure 6: Complement and Edge Detection of images

The image in Figure 7, the image shows the detection of yellow banana fruit in the sample image. The region of yellow banana was clicked and processed to be sorted. The RGB value of the region selected in the image is shown in the command window in MATLAB Figure 8.

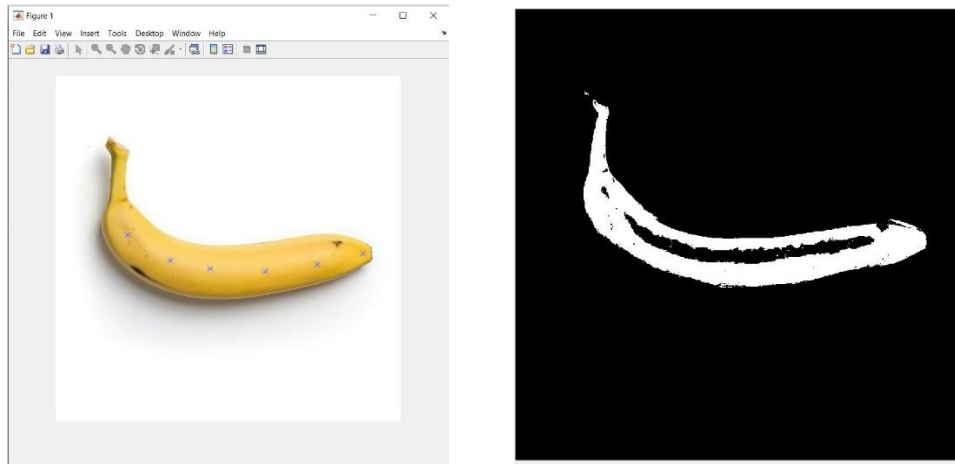


Figure 7: Color Sorting Of Banana Fruit



Figure 8: RGB Value Of Selected Region On Banana Fruit

The process of color detection on banana fruit images is then repeated on a mix of both yellow and green sample images. A sample image that contains the different conditions of banana fruit is used to separate the banana. Figure 9 shows the sample image of banana fruit being separated. The RGB value of the selected region is shown in Figure 10.

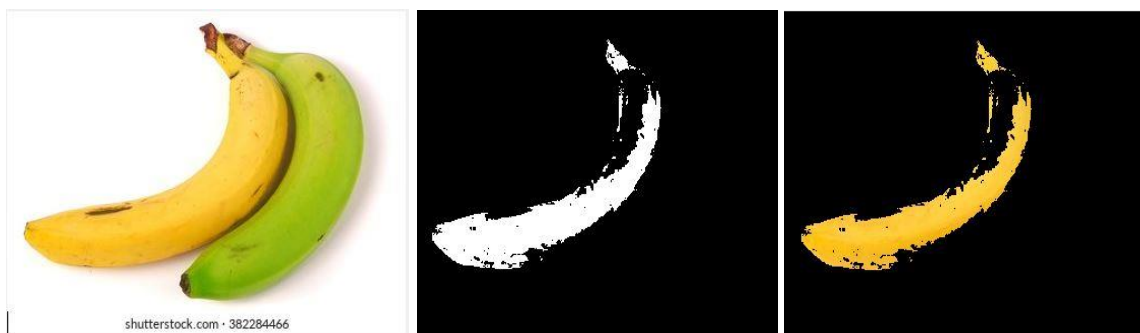


Figure 9: Sample Image Of Mixed Banana Fruit

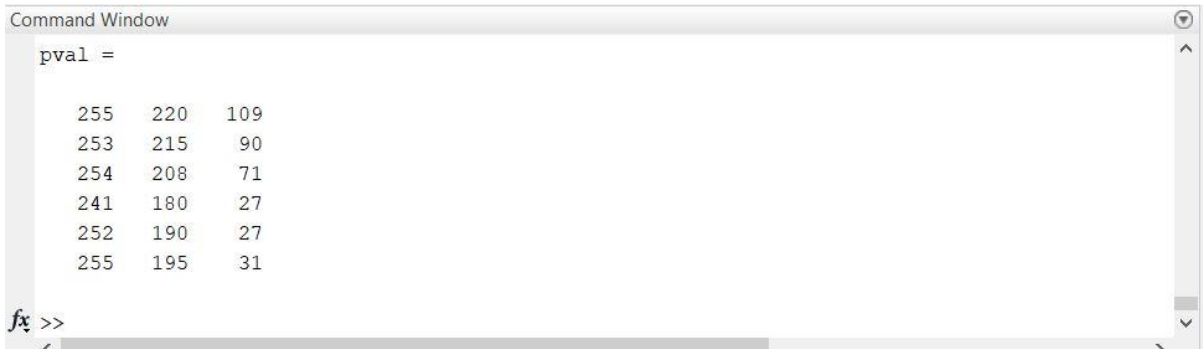


Figure 10: RGB Value Of Selected Region On Banana Fruit

3.2 Analysis of average RGB values of banana fruit

An observation of the data using the RGB values from each of the banana fruit sample images is made on the first five sample images. The average of RGB values was compared in order to identify the average intensity of the RGB on the sample image in pixel. Table 1 below is to show the result of the average RGB values of the sample images.

Table 1: Range of RGB Average Values Of Banana Fruit

| No of Sample Images | Average value of R | Average value of G | Average value of B |
|---------------------|--------------------|--------------------|--------------------|
| 1 | 251.33 | 209.33 | 106.67 |
| 2 | 253.33 | 227.17 | 117.67 |
| 3 | 251.67 | 192.50 | 74.83 |
| 4 | 252.83 | 238.33 | 119.17 |
| 5 | 253.83 | 226.00 | 115.67 |

From Table 1, it shows that the intensity of average value for R (Red) is more than 250, the average value for G (Green) in between of 190 to 230, and for average value of B (Blue) is lower than 120. The average value of RGB is calculated by using Eq.1:

$$Average\ Value\ of\ RGB = \frac{Pval}{6} \quad Eq.1$$

3.3 System performance accuracy

In this project, the accuracy of the image processing system in Graphical User Interface (GUI) to detect sample images of banana fruit is calculated. The analysis of the system performance is important in order to get an accurate result. The total of banana fruit sample images used in this project is 25 samples, where there is 10 Yellow, 10 Green and 5 of them is the combination of yellow and green banana in one sample image. The result detection of banana fruit samples is shown in Table 2.

Table 2: Banana Fruit Sample Images Detected By The System

| Type of Banana Fruit | Total Number of Sample Images | Total Number of Sample Images Detected |
|----------------------|-------------------------------|--|
| Yellow | 10 | 8 |
| Green | 10 | 9 |
| Yellow and Green | 5 | 4 |

From Table 2, it shows that a total of 8 yellow banana is detected which the accuracy of detection is 80%. As for green banana there is 9 samples detected which brings 90% accuracy of the system. Lastly the mix sample images of yellow and green banana detect 4 out of 5 sample images where the accuracy is 80%. The total amount of sample images detected if 21 out of 25. It shows that this system

is able to identify the sample images of banana fruit with a success rate of 84% accuracy. The calculation of the system performance accuracy is calculated using Eq.2:

$$\% \text{ Accuracy} = \frac{\text{Total of Sample Images Detected}}{\text{Number of Sample Images}} \times 100\% \quad \text{Eq.2}$$

4. Conclusion

The technology of Image Processing has been widely used for the past few years. From all the research and analysis, it can be concluded that the technology of image processing can be used to estimate the maturity of Banana fruit. The result and simulation of the image processing technique in the MATLAB software in this study have shown that the sample images were detected, and the performance of the system was calculated. The result shows that using the technique of image processing, can separate banana fruit based on its maturity. At the end of this study, the system of an image processing technique using the graphical user interface (GUI) was created and able to make it easier for a user to analyze a sample image. This system is beneficial to the Agricultural sector of our country by maintaining the high quality of a product. Overall, the technique of image processing in the system can be used to estimate the maturity of Banana fruit by analyzing the sample image.

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