Melon Diameter Estimation for Sorting System Based on Image Processing

Syamsiar Kautsar[1], Budi Hariono[2], Rizza Wijaya[2], Aulia Brilliantina[2], Elok Kurnia Novita Sari[2], Risse Entikaria Rachmanita[1] and Muhammad Yunus[3]
[1]*Department of Engineering, Politeknik Negeri Jember, Indonesia*
[2]*Department of Agricultural Technology, Politeknik Negeri Jember, Indonesia*
[3]*Department of Health, Politeknik Negeri Jember, Indonesia*

Keywords: Melon, Image Processing, RGB, Diameter.

Abstract: Human visual perception of melon quality is complex because it depends on many internal and external factors. One critical internal factor is each farmer's visual perception, which usually varies. Sorting is choosing between good yields and poor yields. While grading is the grouping of harvested crops that have been sorted. Sorting and grading depend on market demand. The Sorting Equipment was measured w x l x h = 100cm x 60cm x 100 cm and is made of an aluminum frame and covered by a red polycarbonate board. Inside the sorting box, two cameras are pointing at a melon cup. The melon cup consists of a circular board connected to a servo motor so that it can rotate the melon position. It aims to obtain several shooting angles for the test data. 3 LED lights lead to the melon container at an angle of 45 degrees with a distance of +-60 cm. Based on the research that has been done, the results of the estimated diameter after testing have a deviation of 1.32 cm.

1 INTRODUCTION

Melon is a fruit plant belonging to the Cucurbitaceae family, melon fruit comes from the Persian Hot Valley or the Mediterranean area, which is the border between West Asia and Europe and Africa, so this plant can be widely spread to the Middle East and Europe. In the 14th century, melons were brought to America by Columbus and are commonly grown in Colorado, California, and Texas. Finally, melons spread worldwide, especially in tropical and subtropical areas, including Indonesia. Melon is an annual plant that grows creeping, similar to the cucumber plant. But in its cultivation, melon plants can be propagated on bamboo poles (ajir) (Kim K Kim K Kim H and Lee K, 2006).

Human visual perception of melon quality is complex because it depends on many internal and external factors. One critical internal factor is each farmer's visual perception, which usually varies (Tournier J, 2019).

While the external factor is the object's composition in relation to light reflection, environmental lighting, illumination distance and angle, and viewing position. Postharvest handling involves collecting, sorting, classifying, packaging and storing fruit based on predetermined sizes and quality standards. The steps for each post-harvest activity are as follows (Droby S and Wisniewski M, 2018):

a) Collection

The melons that have been harvested are collected in one place to be sorted immediately. Transport from the farm to the collection point must be carried out carefully.

b) Sorting and Classing (Grading)

Sorting is choosing between good yields and poor yields. While grading is the grouping of harvested crops that have been sorted. Sorting and grading depend on market demand. The elements to be considered in sorting/selection (Dewi T Risma P and Oktarina Y, 2020).

After sorting, melons are then grouped and weighed for grading based on fruit weight and physical appearance. The classification of melons is divided into three classes. Meanwhile, young, overripe, bruised, deformed and other fruits are classified as off-grade (outside class). Consumer

Kautsar, S., Hariono, B., Wijaya, R., Brilliantina, A., Sari, E., Rachmanita, R. and Yunus, M.
Melon Diameter Estimation for Sorting System Based on Image Processing.
DOI: 10.5220/0011761700003575
In *Proceedings of the 5th International Conference on Applied Science and Technology on Engineering Science (iCAST-ES 2022)*, pages 295-299
ISBN: 978-989-758-619-4; ISSN: 2975-8246

perception is important to be fulfilled, so the results of agriculture and plantations must be adjusted to the standard (Kurnianto M Wibowo M Hariono B Wijaya R and Brilliantina A, 2020).

2 RELATED WORK

An image is a two-dimensional Value function f (x,y), where x and y are spatial coordinates and f at a point (x,y) is the brightness level of an image at a point. An image is obtained from capturing the strength of the light reflected by the object. The image as the output of the recording device can be an analog or a digital image. Digital image processing is a process that aims to manipulate and analyze images with the help of computers. The analysis process in image processing involves visual perception with input data and output data obtained in the form of images of the observed object. Image processing techniques can include several aspects such as image sharpening, highlighting specific features of an image, image compression, and correction of out-of-focus or blurry images (Chen H, 2021).

The step in digital image processing begins with capturing or capturing images (image acquisition) using sensors in the form of cameras, scanners, etc. Then proceed with the preparation process (preprocessing), such as the process of changing the size (image resizing) or quality improvement (image enhancement) before finally being used for a specific purpose. The next step is to divide the image into its constituent parts (segmentation). This process is done to separate the desired object apart from other objects. Because the result of the segmentation process is the boundaries between the object to be observed further with other objects, it is necessary to make further observations (representation and description) to show that the area within the boundary is the actual object being observed. The last stage of image processing is recognition and interpretation and interpretation). Recognition is the process of assigning a label to an object based on the information provided by its descriptor. In contrast, interpretation includes giving meaning to an object, a set of recognizable objects.

Image classification can use various algorithms, such as KNN (Z E Fitri A Baskara A Madjid A M N Imron, 2022), or Neural Network (R Y Adhitya A Khumaidi S T Sarena S Kautsar B Widiawan and F L Afriansyah, 2020). An artificial neural network (ANN) is a network of a group of small processing units modeled based on a human neural network. ANN is an adaptive system that can change its structure to solve problems based on the information flowing in the network. One part that needs to be considered in using ANN is the selection of training methods and ANN architecture. An ANN architecture that is too small will result in poor problem modeling, while an ANN that is too large will cause over-fitting and long computation time (Wijaya R Hariono B Saputra T W and Rukmi D L, 2020).

3 SYSTEM DESIGN

The Sorting Equipment was measured w x l x h = 100cm x 60cm x 100 cm and is made of an aluminum frame and covered by a red polycarbonate board. Inside the sorting box, two cameras are pointing at a melon cup. The melon cup consists of a circular board connected to a servo motor so that it can rotate the melon position. It aims to obtain several shooting angles for the test data. 3 LED lights lead to the melon container at an angle of 45 degrees with a distance of +-60 cm. The lamp power supply uses a variable power supply to regulate the light intensity in the sorting box. This aims to get the right light for shooting in an enclosed space. Figure 1 is a sorting box design.

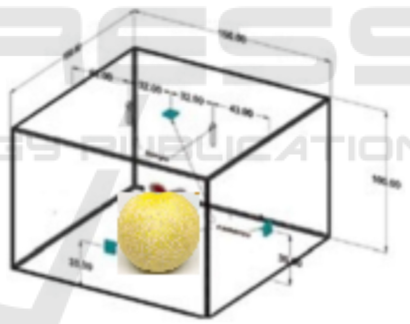


Figure 1: Sortir system design.

Taking pictures using 2 Logitech C922 cameras with HD 1080P video specifications at 30Fps/720P at 60FPS. 1 camera to take side view pictures, and another to take top view pictures. An ATMega328 microcontroller is also connected serially to the computer to adjust the servo working angle on the melon dish. The computer for image processing has 1GB of Intel Core i5 graphics specifications and 8GB of RAM. Figure 2 is a system block diagram of the sorting system used on this paper.

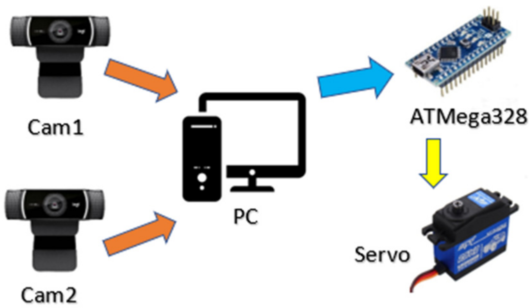


Figure 2: Block Diagram System.

The captured image has a resolution of 640x480. Image processing for diameter estimation consists of several stages. The first is capturing & saving images. After that, the image will be cropped according to the melon position in the image. The cropped image is converted to an HSV image. HSV(Hue, Saturation, Value) is a component that represents the color of visible light wavelengths (red, orange, yellow, green, blue, purple). The advantage of HVS is that it consists of the same colors that are captured by the human senses. In comparison, the colors formed by other models such as RGB result from a mixture of primary colors. The RGB to HSV conversion process uses equation 1 (Abdulrahman A A Rasheed M and Shihab S, 2021) (Suryaningsih W Bakri A Kautsar S Hariono B Brilliantina A and Wijaya R, 2022).

$$H = \begin{cases} 0^\circ & \Delta = 0 \\ 60^\circ \times \left(\frac{G'-B'}{\Delta} mod6\right) & , C_{max} = R' \\ 60^\circ \times \left(\frac{B'-R'}{\Delta} + 2\right) & , C_{max} = G' \\ 60^\circ \times \left(\frac{R'-G'}{\Delta} + 4\right) & , C_{max} = B' \end{cases} \quad (1)$$

$$S = \begin{cases} 0 & , C_{max} = 0 \\ \frac{\Delta}{C_{max}} & , C_{max} \neq 0 \end{cases}$$

$$V = Cmax$$

Gradient separation is performed based on the min-max HSV value. It aims to obtain the threshold value for color cropping. After the HSV limit is determined, the appropriate pixel classification is carried out to display the circle shape as an estimate of the diameter in the main image. Figure 3 is a programming flowchart in this study. The programming language used is python with additional OpenCV features for image processing (Abdulrahman A A Rasheed M and Shihab S, 2021).

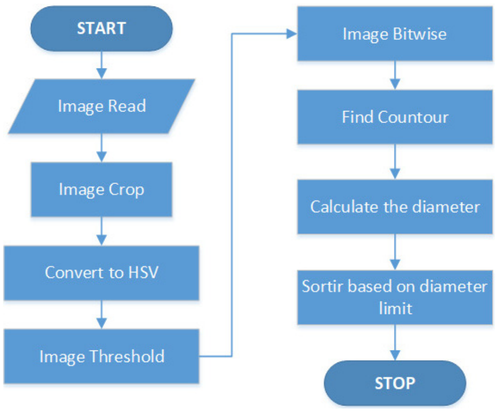


Figure 3: Flow Chart Melon Sortation.

4 RESULT AND DISCUSSION

4.1 Hardware Realization

Figure 4 is the result of making a sorting box used to identify melons. The choice of red color aims to obtain a contrasting background with the color of the melon dominated by green to facilitate image processing. In the early stages of testing the servo performance based on the input value from the PC. An image data retrieval program was created based on angles of 0º, 30º, 60º, 90º, 120º, 150º, and 180º simultaneously. Figure 5 shows the image's data based on the different servo angles. Based on Figure 5, the servo can work according to the given value.

Figure 4: Machine Hardware.

Figure 5: Capture test result.

4.2 Calibration

Image calibration is performed. It aims to compare the pixel size to the actual distance. Calibration of the image using a board equipped with a line 24 cm long. The board is placed in the center of the melon cup. Capture images on each camera and then the calibration process is carried out. Figure 6 is an image during the calibration process.

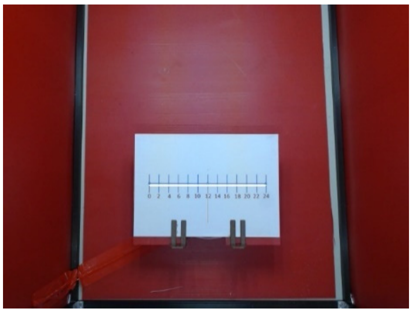


Figure 6: Calibration process.

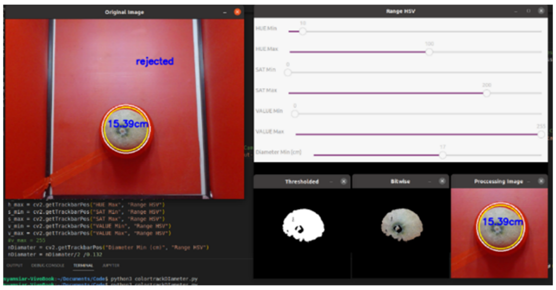
Based on the obtained pixel value, on the top camera, 24 cm in actual distance is represented by 182 pixels. Using the linear equation according to equation 2, we get an equation to calculate the actual distance to the camera as in equation 3.

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1} \quad (2)$$

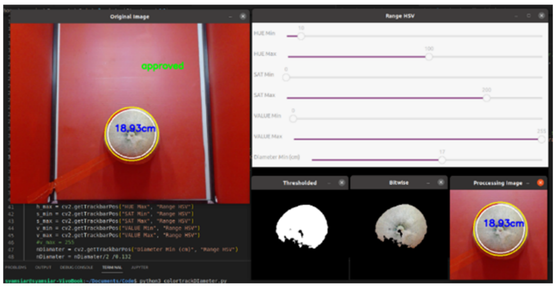
$$diamater = 0{,}132 * 2 * radius_{pixel}$$

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1} \quad (3)$$

The last stage is creating an if then rule for determining the diameter of the melon. If the diameter estimate is less than the threshold, the rejected status will appear on the screen. Figure 7 is the result of melon image processing to determine the size of the melon diameter according to the sorting limit (use the diameter limit of 17cm). 10 melons were used for testing (figure 8) with accurate sizes as shown in table 1. Based on the test results, the system can work according to the settings made in the shortener application. However, there is a difference in the diameter estimation through image processing and direct measurement using a ruler. This is due to the fruit contour not being fully moon, while image processing takes the diameter from the outermost radius point of the melon. However, for the sorting process, the user can set the minimum diameter size through the application so that the sorting process can be done flexibly.



a)



b)

Figure 7: a) melon with diameter <17cm, b) melon with diameter >=17cm.

Figure 8: Melon for testing.

Table 1: Diameter Estimation Data.

Data	Circumference (cm)	d = Cir / pi (cm)	Estimation Diameter (by picture - cm)	Deviation (cm)
1	53	16,88	17,96	-1,08
2	52	16,56	17,8	-1,24
3	50	15,92	17,76	-1,84
4	48	15,29	15,6	-0,31
5	45	14,33	15,39	-1,06
6	55	17,52	18,93	-1,41
7	50	15,92	17,88	-1,96
8	48	15,29	17,01	-1,72
9	47	14,97	16,09	-1,12
10	49	15,61	17,11	-1,50
			average	-1,32

5 CONCLUSIONS

Based on the research, the results of the estimated diameter after testing have a deviation of 1.32 cm. The algorithm can detect fruit with gradations of green to yellow (depending on the level of fruit maturity). However, the error in the estimation of diameter measurement is even more significant if the contour of the melon is not ideally round. In future research, additional algorithms are needed to process uneven contours.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the financial support of this work by grants from PNBP, State Polytechnic of Jember. The author also thanked the P3M and Information Technology Department, State Polytechnic of Jember, which has supported and assisted in completing this research.

REFERENCES

Kim K Kim K Kim H and Lee K, 2006 Risk Assessment and Symptoms of Musculoskeletal Disorders in Melon Farm Workers **4**, 4 p. 385–397.

Tournier J *et al.*, 2019 for medical image processing and visualisation MRtrix3 : A fast , flexible and open software framework.

Droby S and Wisniewski M, 2018 Postharvest Biology and Technology The fruit microbiome : A new frontier for postharvest biocontrol and postharvest biology *Postharvest Biol. Technol.* **140**, March p. 107–112.

Dewi T Risma P and Oktarina Y, 2020 Fruit sorting robot based on color and size for an agricultural product packaging system **9**, 4 p. 1438–1445.

Kurnianto M Wibowo M Hariono B Wijaya R and Brilliantina A, The Analysis of Consumer Perception on Quality of Soybean Milk Used Importance Performance Analysis Method The Analysis of Consumer Perception on Quality of Soybean Milk Used Importance Performance Analysis Method p. 0–7.

Chen H *et al.*, Pre-Trained Image Processing Transformer p. 12299–12310.

Wijaya R Hariono B Saputra T W and Rukmi D L, 2020 Development of plant monitoring systems based on multi-camera image processing techniques on hydroponic system *IOP Conf. Ser. Earth Environ. Sci.* **411**, 1.

Abdulrahman A A Rasheed M and Shihab S, 2021 The Analytic of Image Processing Smoothing Spaces Using Wavelet The Analytic of Image Processing Smoothing Spaces Using Wavelet.

Suryaningsih W Bakri A Kautsar S Hariono B Brilliantina A and Wijaya R, 2022 Prototype of Integrated Mini Exhausting System for Fish Canning Process *IOP Conf. Ser. Earth Environ. Sci.* **980**, 1.

Z E Fitri A Baskara A Madjid A M N Imron, 2022 Comparison of Classification for Grading Red Dragon Fruit *JURNAL NASIONAL TEKNIK ELEKTRO* **11,** 1 p. 43-49, doi:10.25077/jnte.v11n1.899.2022

R Y Adhitya A Khumaidi S T Sarena S Kautsar B Widiawan and F L Afriansyah, 2020 Applied Haar Cascade and Convolution Neural Network for Detecting Defects in The PCB Pathway *International Conference on Computer Engineering, Network, and Intelligent Multimedia (CENIM),* p. 408-411, doi: 10.1109/CENIM51130.2020.9297996.