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Comparison of the suitability of the otsu method thresholding and multilevel thresholding for flower image segmentation

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ABSTRACT

The digital representation of flowers, characterized by their vivid chromatic attributes, establishes them as viable candidates for deployment as input imagery within the object recognition paradigm. Within the context of object recognition, the imperative of a proficient image segmentation process is underscored, serving to effectively discern the object from its background and, consequently, optimizing the efficacy of the object recognition process. This research unfolds through a methodologically structured tripartite framework, encompassing the initial stage involving input imagery, the subsequent intermediate phase dedicated to image segmentation, and a conclusive stage centered on the quantitative evaluation of methodological outcomes. The second stage, which focuses on image segmentation, employs the Otsu thresholding and multilevel thresholding methods. The subsequent third stage involves a thorough assessment of segmentation outcomes through the application of quantitative metrics, including peak signal-to-oise ratio (PSNR) and root mean square error (RMSE). Empirical investigations, incorporating a diverse array of floral input images, reveal a conspicuous inclination towards a specific segmentation methodology. Specifically, the Otsu Thresholding method emerges as the more judicious choice relative to multilevel Thresholding, demonstrating superior performance with a diminished RMSE value and an augmented PSNR value, substantiated by an average RMSE value. This research is propelled by the overarching objective of discerning the most optimal method for the segmentation of flower images, particularly in the face of diverse input images. Its significant contribution lies in providing nuanced insights into the discerning selection of segmentation methodologies, attuned to the variability inherent in diverse forms of input imagery, thereby culminating in optimized outcomes within the domain of flower image recognition. Where did these results come from? Please show it in the sub-discussion.

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1. INTRODUCTION

Flowers are digital images that have striking colors, so flowers are a digital image that is easy to use as an input image in the object recognition process. So, in the object recognition process, a good image segmentation process is needed to separate the object from the background to maximize the object recognition process. The results of research [1]–[3] explain that flowers are one of the digital images that have very striking colors, so flowers are one of the digital images that are easy to use as input images in the object recognition process. However, in the segmentation process, it is very necessary to use the right method to overcome the problem of having several different input images. Because in the object recognition process, a good image segmentation process is needed to separate the object and the background so that the object recognition process can be maximized.

Segmentation is an important process needed in the image recognition process for the process of extracting features that we will take as data in a study. Several image segmentation methods can be used in the feature retrieval process [4]–[6]. Taking an image is carried out to obtain the information contained in it with image segmentation techniques used to extract the information contained in the image.

An image is rich in information, but often the image has a decrease in quality intensity, including noise and the colors being too contrasting. For a disturbed image to be represented, the image needs to be manipulated into another image with better quality [7]–[11]. In Heryanto's 2020 research entitled Color Segmentation using the Thresholding Method, Wahana Mat. and Science [12] segmentation was used to determine the cellular anatomy of pleural fluid in the process of characterizing images into cancer or normal categories. This study proposes a research methodology that uses group images to separate objects from other objects by using image segmentation in the pleural fluid of patients suspected of having lung cancer. The thresholding methods used to see the comparison are adaptive thresholding, binary thresholding, and Otsu thresholding [13]–[15].

Thresholding is an algorithm used to segment digital images which will then be read as the segmented image results. The thresholding method works by converting the RGB image color space to Grayscale, segmenting the image using the thresholding method, and performing complement operations so that the object has a value of 1 (white), while the background has a value of 0 (black) and performing morphological operations to perfect the shape of the object in binary image segmentation results [16], [17].

Research conducted [18]–[20] proposed a flower segmentation scheme to overcome several limitations of previous research. To produce a segmentation process using OTSU constraints in the lab color space. The thresholding is performed separately for the three components L, a, and b, and the best result is selected relative to the truth of the ground. The application of the Otsu thresholding and multilevel thresholding methods is a segmentation method that uses the automatic selection of thresholds from gray levels. In this study, measurements were carried out using Peak Signal-to-Ratio (PSNR) and Root Mean Square Error (RMSE) [Vicko Bhayyu]. Meanwhile, research [21], [22] used the Otsu Thresholding method to separate background from objects in digital images.

Meanwhile, in C. Huang's research in 2021 and Siregar in 2019 [23], [24] to improve the timeliness of image segmentation, this paper introduces the fruit fly optimization algorithm (FOA) to OTSU segmentation, creating the FOA-OTSU segmentation algorithm. In the proposed algorithm, FOA seeks the optimal threshold for segmentation. Classical Lena images Flower images, and Cameraman images are used for experimental simulation, and the results are evaluated by signal-to-noise ratio (SNR) and peak signal-to-noise ratio (PSNR) [25]–[27].

So, the current research carried out by researchers is looking for the right method for the image segmentation process in flower images using several input images. Then, several input images are carried out using segmentation methods, namely the Otsu thresholding method and multilevel thresholding. Measurements of the results of the segmentation method are carried out using Peak Signal-to-Ratio (PSNR) and Root Mean Square Error (RMSE), which aims to find out the results of which method is appropriate to use for the segmentation process. So, the research title was raised in the form of a comparison of the suitability of the Otsu thresholding and multilevel thresholding methods for flower image segmentation.

2. METHOD

The research process carried out by researchers consists of 3 (three) stages, including the image input stage, the image segmentation process stage, and the measurement stage of the segmentation method. At the input image stage, in the form of a color image which is converted into a grayscale image, for the segmentation stage 2 (two), otsu thresholding and multilevel thresholding methods are used and the measurement stage uses

Peak Signal-to-Ratio (PSNR) and Root Mean Square Error (RMSE). The stages of the method used following the waterfall method in the research process can be seen in Figure 1.

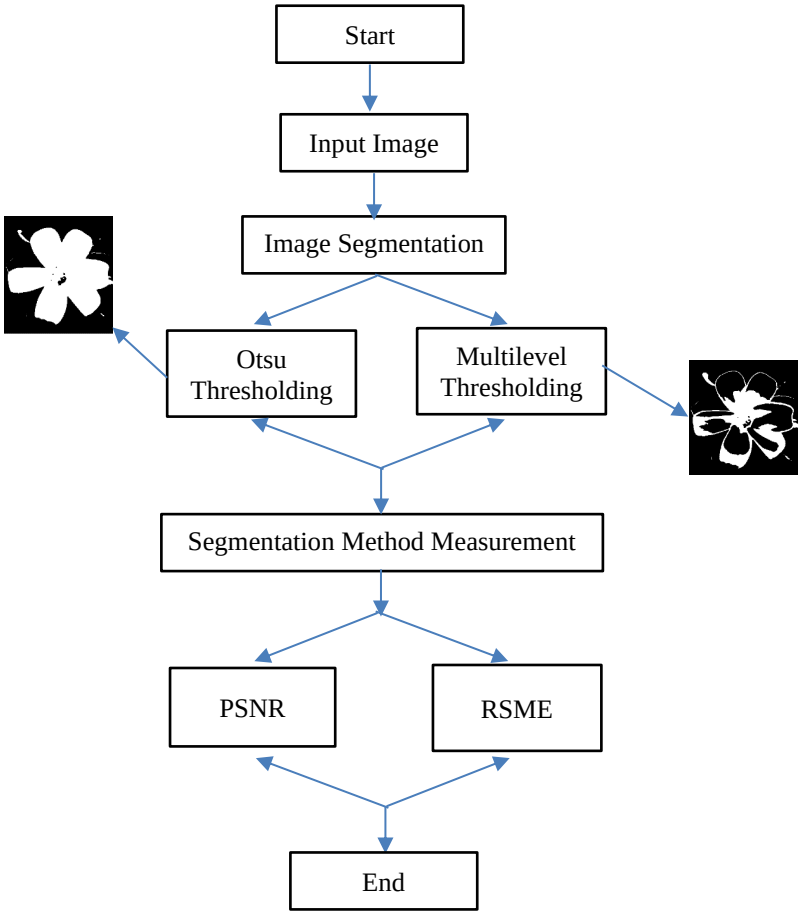


Figure 1 Research stages

Input Image Stage

At the image input stage, the image is determined to determine the input image that will carry out the image segmentation process. The flower input images used are 4 types of flowers, including yellow kenikir flowers, white jasmine flowers, red eforbia flowers, and 09.00 flowers. The images of each flower can be seen in pictures 2, 3, 4, and 5.

Figure 2 Yellow kenikir flower

Figure 3 White jasmine flowers

Figure 4 Red eforbia flower

Figure 5 Flowers at 09.00

Image Segmentation Stage

The image segmentation process is carried out using 2 methods, Otsu thresholding and multilevel thresholding. For the initial stage before image segmentation is carried out, the input image is processed from RGB image to grayscale image. The purpose of filtering is to carry out the segmentation process so that the results are optimal.

The filtering stage for the 4 flowers used uses the octave application by changing the image into grayscale form. For the next stage, the results of the filtering process are carried out in the image segmentation stage using the Otsu Thresholding method and multilevel thresholding, which is carried out using multilevel thresholding. In research conducted by [28], [29], Otsu Thresholding consists of several stages that begin with carrying out the conversion process from a color image to a grayscale image using the average value of the R, G and B values:

$$L(x,y) = \frac{(R(x,y)+G(x,y)+B(x,y))}{3} \quad (1)$$

The next stage is to calculate the probability distribution of the gray values of the image pixels : -

$$pi = \frac{ni}{N} \quad (2)$$

Where :

ni = number of pixels in the third gray

N = total number of pixels

Segmentation Method Measurement Stage

After carrying out the image segmentation process of 4 types of flowers using 2 methods, the results were then measured using measurements. Which is used to make measurements using peak signal-to-ratio (PSNR) and Root Mean Square Error (RMSE) [30]–[32] the measurement formula can be seen in equations 1 and 2.

$$\begin{aligned} PSNR &= 10.log_{10}\left(\frac{MAX_1^2}{MSE}\right) \\ &= 20.log_{10}\left(\frac{MAX_1}{\sqrt{MSE}}\right) \\ &= 20.log_{10}(MAX_1) - 10.log_{10}(MSE) \end{aligned} \quad (3)$$

Information :

SSEw = Weighted sum of Squares

W = Total weight of the population

N = Number of observations

wi = Weight of the i-th observation

ui = Error associated with the ith observation

3. RESULTS AND DISCUSSIONS

In the research process carried out by researchers, the researchers follow the stages that have been created in the research method, including:

Inpit Image Stage

At this stage, before the image segmentation stage is carried out, the input image is changed from an RGB image to a grayscale image. The resulting image results can be seen in Table 1.

Table 1 Results of the Filtering Process

Flower Name	Image Color	Grayscale Image
Yellow Kenikir Flower		
White Jasmine Flowers		
Red Eforbia Flower		
Flowers at 09.00		

Segmentation Stage

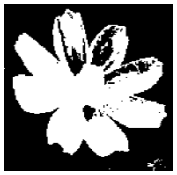
For the input image segmentation stage, the resulting image is changed from an RGB image to a grayscale image which is used to process the image using the Otsu thresholding and multilevel thresholding methods. When using the Otsu thresholding method, changing the grayscale image to the Otsu thresholding process as in the source code can be seen in Figure 6.

```
function hasil_otsu = otsu(citra)
    pkg load image

    i=imread(citra);
    i_gray=rgb2gray(i);

    t=graythresh(i_gray);
    hasil_otsu=im2bw(i_gray,t);

    imshow(i),title('citra asal');
    figure,imshow(i_gray); title('citra gray');
    figure,imshow(hasil_otsu),title('citra hasil_otsu');
 end
```

Figure 6. Otsu thresholding

The image segmentation process was carried out on 4 (four) flower images, which can be seen in Table 2.

Table 2 Results of the Segmentation Process

Flower Name	Citra Grayscale	Otsu Thresholding	Multilevel Thresholding
Yellow Kenikir Flower			
White Jasmine Flowers			
Red Eforbia Flower			
Flowers at 09.00			

Measurement Stage

The process of measuring image segmentation results was carried out using Otsu thresholding and multilevel thresholding methods on 4 (four) types of flowers. Measurements were performed using Peak Signal-to-Ratio (PSNR) and Root Mean Square Error (RMSE). Research [33] shows that the Otsu Thresholding method is better than the Multilevel Thresholding method when evaluated using the RMSE and PSNR values. The results of this research show that measuring the peak signal-to-ratio (PSNR) value using the Multilevel Thresholding method is better than the Otsu thresholding method with a value of 4.8344. Meanwhile, measuring the root mean square error (RMSE) value in the Otsu thresholding method is better than the

Multilevel Thresholding method, which is 1.2904. The results of each flower measured can be seen in Table 3.

Table 3 Peak Signal-to-Ratio (PSNR) and Root Mean Square Error (RMSE) Measurement Results

Flower Name	Otsu Thresholding		Multilevel Thresholding	
	PNSR	RMSE	PNSR	RMSE
Yellow Kenikir Flower	4.7712	1.2904	4.8344	1.2810
White Jasmine Flowers	4.7712	1.1994	4.7746	1.1989
Red Eforbia Flower	4.7711	1.1882	4.7954	1.1849
Flowers at 09.00	4.7711	1.2223	4.7819	1.2208

4. CONCLUSION

The segmentation process is necessary for the object recognition process; therefore, this research was carried out to determine the correct method for use in the segmentation process. The Otsu thresholding and multilevel thresholding methods were compared to find a good method. The results of the two methods showed that the measurement of the peak signal-to-noise ratio (PSNR) value using the multilevel thresholding method was better than the Otsu thresholding method, with a value of 4.8344. Meanwhile, the root mean square error (RMSE) value in the Otsu threshold method is better than that in the Multilevel Thresholding method, which is 1.2904.

Suggestions for further research; it is necessary to improve the quality of the input image, which can be done to obtain better image segmentation and produce a better flower object.

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