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Image Classification Based On Color Using Thresholding Method

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ABSTRACT

This research aims to categorize images based on color using the method of thresholding. Image classification based on color plays a crucial role in various applications such as object detection, traffic monitoring, and medical image processing. The thresholding method is a popular approach used in image segmentation due to its effectiveness and computational efficiency. In this method, grayscale images are converted into binary images by determining a specific threshold value. This research utilizes the thresholding method to separate pixels based on their color intensity. The research methodology consists of several steps, including dataset collection, image pre-processing, color feature extraction, application of the thresholding method, and class labeling. The study's benefits include object recognition, cost and time reduction in image classification, and improved product quality and income for farmers.

Keywords : *Image classification; Thresholding method; Color; Image segmentation; Threshold value*

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1. INTRODUCTION

The development of knowledge about image processing is now increasingly popular. With the technology in the world of pattern recognition and computer vision, image processing plays a significant role. One very important aspect in various applications is color-based image classification, which allows the identification and separation of objects that have special color characteristics (Hoang, 2020). Color-based classification methods provide very meaningful information in various application contexts, such as object detection, traffic surveillance, medical image processing, and various others (Winoto, 2019). Some of these fruit types are almost similar in color, texture, or even natural shape, making them difficult to distinguish from one another. The development of computer vision technology provides benefits that can be used to overcome this challenge. The use of a simple, easily customizable vision system to recognize and classify Indonesian fruits would be beneficial in this context. In addition, the ease and speed of carrying out this classification and separation task also helps to reduce time and labor costs, which in turn will increase the value of the products sold and increase income for the farmers (Nasution et al., 2022). Image segmentation is the first step taken to identify areas of interest before processing the image. There are various image segmentation techniques available, and one of them is segmentation using threshold values which has several advantages. The threshold method is the simplest approach in dividing regions of interest in color images. Segmentation using threshold values is based on the intensity level of each pixel value in the image (Henila et al., 2020). The Otsu method is used to obtain the optimal threshold value in image segmentation, which produces excellent results by improving the clarity of the writing in the manuscript (Cahyadi et al., 2023). Threshold techniques also work on the assumption that pixels with intensity values falling within a certain range belong to one class, while other pixels belong to another class.

Thresholding is the process of generating a binary image from a grayscale image. In this process, pixels with intensity below a specified threshold value will be set to zero, while pixels with intensity above that threshold will be set to one (Razabni et al., 2020). Thresholding is very popular in segmenting images because it uses a simple comparison technique and has high computational

efficiency (Sumari et al., 2021). Thresholding is a common method used to perform segmentation on gray-level images. This approach is based on the assumption that object and background pixels in an image can be distinguished based on their gray level values. By choosing an appropriate gray-level threshold between the dominant intensity values of the object and the background, the original gray-level image can be converted into a binary form, where the image points corresponding to the object and the background will have values of one and zero, respectively (Heryanto et al., 2020). Fruit classification is a topic that has been widely debated by researchers around the world in recent years. The development of computer plans and systems for perception and classification aims to reduce the dependence on human perception abilities. Accurate analysis of fresh fruits in supermarkets has a very important role in the current context. The visual appearance of fruits and vegetables is a dominant factor for consumers in assessing their quality.

The level of maturity of an apple can be determined based on the color of its skin. The color of the apple skin will change along with the process of fruit maturity (Suradi et al., 2023) (Ciputra et al., 2018) (Saputra, 2019). Malus domestica or what we know familiarly as apples is a type of fruit that grows in sub-tropical areas (Ramadan et al., 2021). The advantage of using the Otsu method lies in its speed and ease of implementation. It uses histogram analysis to automatically find the threshold value, which makes it a fast and simple approach (Sari et al., 2020). On the other hand, the Adaptive method has a more detailed approach. The threshold value in this method is determined by considering the variable window size and the constant mean. There are various mechanisms used to classify fruits and vegetables using computer and machine vision technologies (Gill et al., 2022). Due to the diversity in the shape and size of fruits and the susceptibility they possess, automatic classification becomes very important in this context.

The purpose of the research for color-based image classification is to determine the effectiveness of the thresholding method in color-based image classification, to analyze the work of the thresholding method in separating objects based on the specified color range, and to identify factors that affect the success of the thresholding method in color-based classification.

2. LITERATURE REVIEW

2.1. Image Classification

Image classification is one of the main components in the field of computer vision, which aims to classify images into classes based on visual features such as color, shape, and texture. In recent developments, image classification has been widely utilized in various fields such as agriculture, industry, health, and security systems. (Khan et al., 2021).

2.2. Importance of Color in Image Classification

Color is a key visual feature often used in image classification due to its ease of extraction and its role in distinguishing objects. The representation of color in various color spaces, such as RGB, HSV, and CIELab, affects classification accuracy. (Zhang et al., 2020) stated that the use of color information in plant classification is very effective, especially when used in conjunction with an appropriate segmentation method.

2.3. Metode Thresholding

Thresholding is a simple segmentation technique that separates the object from the background based on a certain threshold value on the pixel intensity or color. (Al-Ameen et al., 2021) color-based thresholding in HSV space gives better results than RGB space under non-uniform lighting conditions. Although the Otsu method has long been developed, modern research still uses it, either as the main method or combined with other color processing techniques.

2.4. Color Thresholding Based Classification

Some recent studies apply color-based thresholding for object classification. (Kumar et al., 2022) developed a fruit classification system using thresholds on Hue and Saturation values, which resulted in high accuracy under controlled lighting conditions. (Nurfadhilah et al., 2021) also applied color thresholding in a camera-based garbage classification system, showing that this method remains relevant if well calibrated.

3. METHOD

The Thresholding Method for Color Based Image Classification can be seen in the following figure:

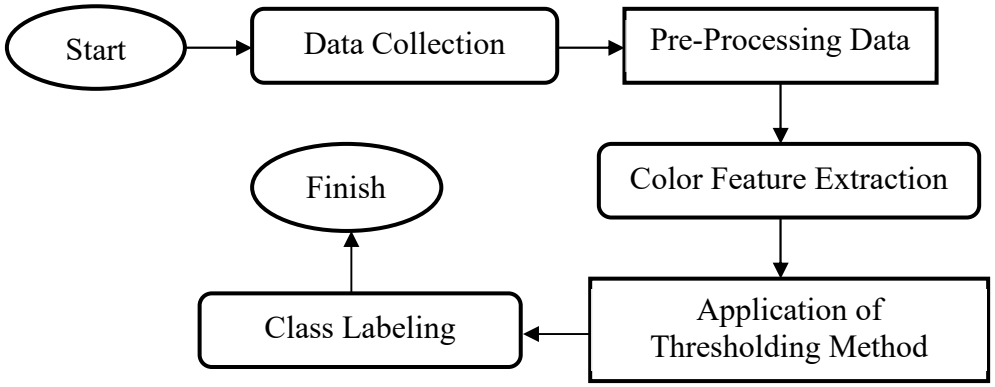


Figure 1. Flowchart of Thresholding Method on Image Classification Based on Color

3.1. Data Collection

First, collect the image dataset that will be used in the research. This dataset should include images that represent the various categories or classes that you want to classify based on color.

3.2. Pre-processing

This pre-processing involves operations such as noise removal, histogram smoothing, and contrast enhancement to ensure that the images in the dataset are ready for thresholding.

3.3. Color feature extraction

Some commonly used color features include color histograms, color spaces such as RGB or HSV, or texture features related to color.

3.4. Application of thresholding method

Thresholding method involves using a threshold value to separate image pixels into two classes based on their intensity values.

3.5. Class labeling

After applying the thresholding method, the next step is to label the images in the dataset based on the classes defined by the threshold value.

4. RESULTS AND DISCUSSION

4.1 Data

In the test stage based on the results by detecting the color of the apple skin which has values that aim to facilitate the classification of apple skin color during the maturity period. In the image processing process here, a sample image taken from a survey in a supermarket is used. The image used is Fuji Alfa type apple, but only as an example in image processing and cannot be applied in the system to identify objects. This is because to identify an object, two images of objects that are similar but have color differences are required, such as distinguishing between Gala and Ambrosia apples. Both objects have similar physical characteristics, but have different color variations. In processing images here, a sample image is used from a survey to a supermarket and the image used is Fuji Alfa type apple, which is only used as an example of image processing, it cannot be used in system applications to identify an object, because to identify an object, two images of objects that are similar but have different colors are needed, for example distinguishing between Gala and Ambrosia type apples. Both objects have similar physical characteristics, but have various color differences.

Figure 2. Fuji apple

Figure 3. Red Del Washington apple

Figure 4. Green Apple

4.2 Data Pre-Processing

At this stage will determine the use of threshold values to separate pixels based on color intensity in the image. With the amount used in the test is an image with jpg format. From the image obtained in the RGB-valued survey, it is then converted into Tresholding where the samples taken are ripe apple images and raw apple images.

4.3 Color Feature Extraction

In the color feature extraction stage, the original image is extracted into images with red, green, blue and grayscale colors. At this stage, the original image has crossed the threshold so that the colors in the original image change to red, green, and blue image colors.

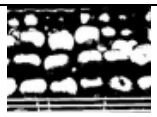
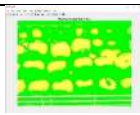
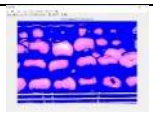
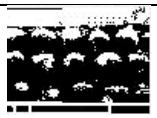
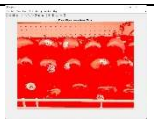
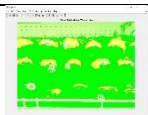
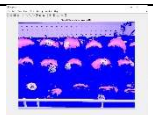
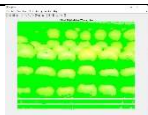
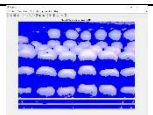
4.4 Application of Thresholding Method

Using the thresholding method, an image can be divided into different regions based on its intensity. For example, in a thresholding binary image, pixels with higher intensity will be assigned white values, while pixels with lower intensity will be assigned black values. This can be used to separate objects from the background or focus on specific regions in the image.

4.5 Class Labeling

Class labeling based on threshold values is referred to as binarization. In the context of image processing, binarization is the process of converting an image into a binary image by dividing it into two distinct classes, namely object and background, based on a specified threshold value. In binarization, each pixel in the image is assigned a value of 0 or 1, which represents either the background or the object. Pixels with intensity above the threshold value are designated as objects, while pixels with intensity below the threshold value are designated as background.

Table 1. Appendix of Experimental Results

Original Image	Citra Thresholding	Citra Red	Citra Green	Citra Blue	Description
					The pixels in this image have crossed the threshold value and are designated as objects.
					The pixels in this image do not cross the threshold value and are set as the background.
					The pixels in this image have crossed the threshold value and are designated as objects.

When compared with image classification research based on color, it can be seen that both have a connection in the use of images and color analysis in the field of agriculture. For example, a comparative study of indirect classification techniques of skin color was identified through a filtering process in the HSV color space. In a study on the classification of coffee bean maturity, it was found that the comparison of the combination of features from the RGB and HSV color spaces as parameters in the classification gave the highest accuracy value (Rabbani et al., 2021). Specifying HSV values in the low-high range is useful for providing tolerance to variations in color brightness in objects acquired by the camera. Thus, colors will still be detected despite having different brightness levels.

5. CONCLUSION

Thresholding methods can be effectively used to classify images based on color. However, determining the right threshold can be challenging. Lighting variations and color variations in objects such as apples can affect image classification. Therefore, selecting the optimal threshold is essential to obtain accurate classification results. This research has benefits in object recognition, cost and time reduction in image classification, and improving product quality and income for farmers. Thresholding methods can be used in various application contexts that require image classification based on color.

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