Combination of Sobel+Prewitt Edge Detection Method with Roberts+Canny on Passion Flower Image Identification

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Combination of Sobel+Prewitt Edge Detection Method with Roberts+Canny on Passion Flower Image Identification

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Abstract. Edge detection is at the forefront of image processing for object detection, so a good understanding of edge detection algorithms is essential. This paper aims to analyze the ability of combined edge detection methods to identify images, through a comparison of two different edge detection methods, namely the combination of Sobel and Prewitt (Sobel+Prewitt) with Roberts and Canny (Roberts+Canny). The analysis process uses a dataset of Passion Flower Images obtained from the United States Department of Agriculture (USDA) Plant Database, Natural Resources Conservation Service (NRCS). The Image dataset was obtained using a Nikon Coolpix 995 camera, JPG format with a resolution of 128x192 pixels. Based on the analysis and testing, the results of the research using the combined edge detection technique of Roberts and Canny resulted in better image identification accuracy compared to Sobel and Prewitt. The average accuracy was 92.84% versus 68.75%.

1. Introducing

The study of images in recent decades is in great demand for research by scientists and academics, one of which is detecting the edges of an image to identify objects and search for edge information from an image [1]. Edge detection is a fundamental problem in image processing, and computer vision is an indispensable task in image processing [2]. Image edges are collections of pixels with significant inequality, which represent important features of the image image and contain information [3]. Edge detection is performed on images whose edges are not symmetrical [4]. Edge detection is one of the most important techniques in the image processing field, which has a major influence on the research of feature extraction, description and subsequent target recognition [5]. Edge detection is carried out for the purpose of analyzing and grouping objects in the image and for further image analysis [6]. Edge detection is divided into two parts, namely first-order edge detection and second-order edge detection [7]. Some of the first-order methods include Sobel [8], Prewitt [9], Roberts [10], and Canny [11]. Whereas second-order edge detection is like Laplacian of Gaussian (LoG) [12].

In this paper, the edge detection discussed is the first-order edge detection with a combination of the Sobel and Prewitt (Sobel+Prewitt) method which will be compared with the combination of the Roberts and Canny (Roberts+Canny) method. Based on the combination of these methods, it will be analyzed which combination of methods is the best and most accurate in identifying Passion Flower imagery.

Many studies have been carried out using edge detection methods to solve many image identification problems, it is evident from the growing breadth of research related to it. P Vinista and M M Joe (2019) modified the Sobel algorithm for better image edge detection. In this paper, various characteristics of edge detection methods (Sobel, Prewitt, Laplacian, and Roberts edge detection) were analyzed and studied then compared with the modified Sobel method with a threshold value of 100. Based on the comparative analysis it was found that the Sobel edge detection method worked well. compared to other edge detection methods. The results showed that the detection of the modified Sobel edges took less time to detect the edges of the various sampled images [13]. R Chetia, et al (2021) In his paper introducing an edge detection algorithm with an improved Sobel quantum technique with an emphasis on non-maximum and double threshold techniques to represent the new improved quantum method. The process of analyzing a series of edge pixel counts, simulation results, and circuit complexity is carried out to realize the edge detection quantum algorithm. Further comparisons were made with the classical method and several existing quantum edge detection methods. As a result, the proposed algorithm can achieve a significant increase in edge information and circuit complexity [14]. Subsequent research suggests an edge detection design using the Sobel filter on the Field Programmable Gate Array (FPGA) board. The Sobel algorithm was designed using the Verilog lipoprotein exploitation structure synthesized by Genus Irama and supported using Irama Innovus. The FPGA implementation verifies the effectiveness of the normal image exploitation application. The proposed architecture reduces the complexity of power, delay, and space compared to the other three architectures used in this study. The Sobel algorithm was chosen because it can produce a reasonable range for the similarity of the software used. The results obtained from this study are that the Sobel technique gives better results than the other methods and produces several positive values [15].

Based on these related studies, this paper proposes an edge detection method for identification of Passion Flower image objects using a combination of Sobel and Prewitt (Sobel-Prewitt) with a comparison of the combination of the Roberts and Canny (Roberts-Canny) methods so that later it can be used as a reference or information by academics for the development of further research.

2. Methodology

2.1. Experiment Dataset

This paper uses five datasets of Passion Flower Imagery obtained from the United States Department of Agriculture (USDA) Plant Database, Natural Resources Conservation Service (NRCS). The Image dataset was obtained using a Nikon Coolpix 995 camera, JPG format with a resolution of 128x192 pixels [16]. Based on the five datasets of the Passion Flower Image obtained, five datasets will be added, copied from the initial five images by flipping them horizontally, which will later be used as the test image dataset.

1 2 3 4 5

Figure 1. Image of Passion Flower (Initial Dataset)

6 7 8 9 10

Figure 2. Image of Passion Flower (Flip Horizontal)

Source : USDA Plant Database

The five Passion Flower images presented in Figure 1 are original images obtained from the USDA Plant Database. This image dataset will be used for training data. Meanwhile, the five Passion Flower images presented in Figure 2 are additional images that have been flip horizontally based on the original image (Figure 1). The five images presented in Figure 2 are used as test data so that the combination of edge detection methods can be used to identify Passion Flower Images well.

2.2. Research Stages

In general, the steps taken to explain the flow of research written in this paper can be seen in Figure 3.

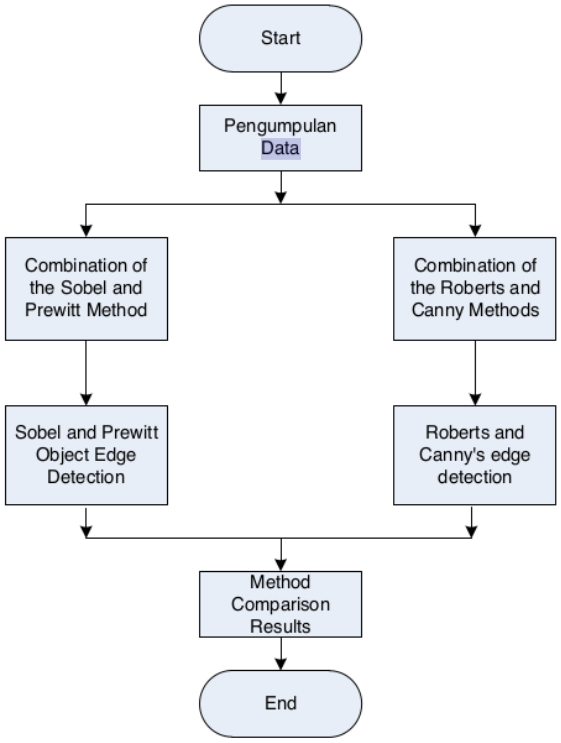


Figure 3. Research Stages

Figure 2 is a research stage starting from data collection. The dataset used is a Passion Flower image dataset consisting of 10 images, five standard images (based on figure 1) will be used for training data, and 5 Passion Flower images that have been flipped horizontally (figure 2) are used for test data. The next stage is implementing a combination of the Sobel and Prewitt (Sobel + Prewitt) methods and various Roberts and Canny (Roberts + Canny) methods using the Matlab 2019a application. Each Passion Flower image dataset will be tested one by one by entering the program code in Matlab. Based on the program code that has been documented in Matlab, it will produce two groups of object edge detection images for each trained and tested image. Group 1 is the object edge detection image resulting from the combination of the Sobel + Prewitt method. Group 2 is the object edge detection image resulting from a variety of the Roberts + Canny method. The next stage is to analyze the results of the detection of object edges from each method that has been combined to obtain valid comparison results; at this stage, the results of the comparison of the two combination methods will be known, and it can be selected and concluded which combination of methods is best for edge detection.

3. Results and Discussion

3.1. Image Pair of Training Data and Test Data

Based on the Passion Flower image presented in Figure 1 and Figure 2, the dataset is first paired between the training data and the test data. Image 1 (training data) is paired with Image 6 (test data), Image 2 (training data) is paired with Image 7 (test data), Image 3 (training data) is paired with Image 8 (test data), Image 4 (training data)) paired with Image 9 (test data) and Image 5 (training data) paired with Image 10 (test data). For more details, each pair of images can be seen in Figure 4.

Figure 4. Image Pair of Training Data and Test Data

Then the simplification process is by changing the color intensity to grey (grayscale). Next, do edge detection through the Passion Flower image that has been determined in figure 4 using a combination of the Sobel + Prewitt and Roberts + Canny methods, which creates a binary image. Perform the segmentation process using the two combinations of these methods to get the resulting image so that the object that has been segmented will be visible. In the image, you will see an object gap surrounded by lines on a hidden gradient. The result of segmentation is to analyze the results of identifying the Passion Flower image, which results from the processing of the two combination methods. Because the program built will be used to identify Passion Flower images, an identification analysis is taken from the database, which is directly compared based on the scanning results. The identification results of the two combinations of edge detection methods (Sobel + Prewitt and Roberts + Canny) based on figure 4 can be seen in table 1 to table 5.

3.2. Segmentation Results Combination of Sobel + Prewitt Method

Table 1. Result of Passion Flower Image Segmentation with Combination of Sobel + Prewitt Method

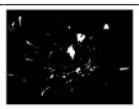
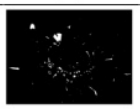
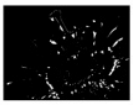
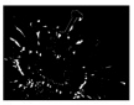
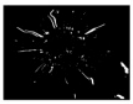
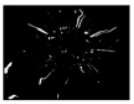
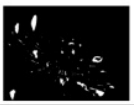
Original Image	Image Processed	Segmentation (a)	Segmentation (b)	Database Image (Pixel)	Test Image (Pixel)	Accuracy (%)	Error	Identification
				342	323	94,44	5,56	Matching
				163	110	67,48	32,52	Not Matching
				663	735	90,20	9,80	Matching
				103	187	55,08	44,92	Not Matching

Original Image	Image Processed	Segmentation (a)	Segmentation (b)	Database Image (Pixel)	Test Image (Pixel)	Accuracy (%)	Error	Identification
				205	561	36,54	63,46	Not Matching
Average						68,75	31,25	40,00

In Table 1, it can be explained that the average accuracy value for the overall test results of the Passion Flower image using the Sobel + Prewitt method is 68.75%. Of the five trials conducted, the Sobel + Prewitt method was only able to identify 2 Passion Flower images correctly and failed to identify 3 Passion Flower images with an average error value of 31.25%. The minimum number of pixels produced is 103 pixels in the image database, and the maximum is 663 pixels. Meanwhile, the minimum and a maximum number of pixels produced in the test image are 110 pixels and 735 pixels. Overall the results of identification using a combination of the Sobel + Prewitt method are 40%.

3.3. Result of Segmentation Combination of Roberts + Canny Method

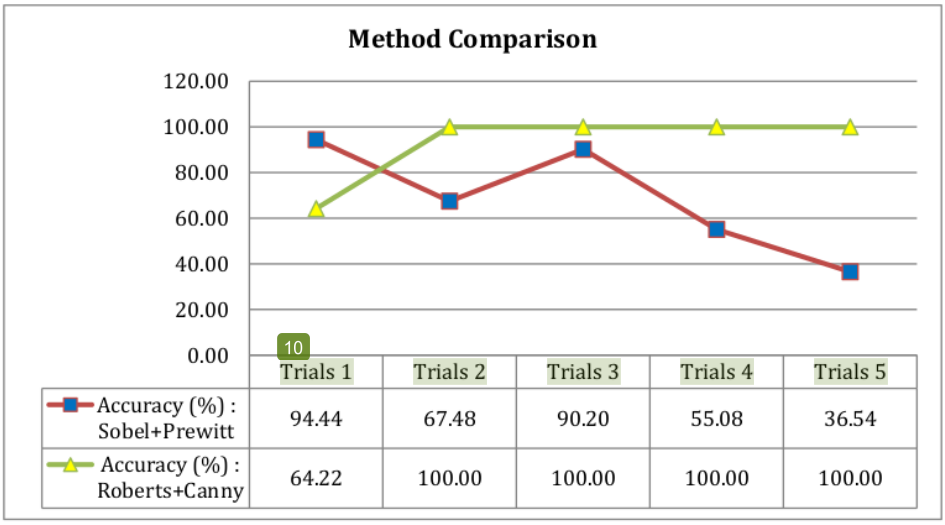
Table 2. Result of Passion Flower Image Segmentation with the Combination of the Roberts + Canny Method

Original Image	Image Processed	Segmentation (a)	Segmentation (b)	Database Image (Pixel)	Test Image (Pixel)	Accuracy (%)	Error	Identification
				2933	4567	64,22	35,78	Not Matching
				6398	6398	100,00	0	Matching
				6660	6660	100,00	0	Matching
				17725	17725	100,00	0	Matching
				5318	5318	100,00	0	Matching
Average						92,84	7,16	80,00

In Table 2, it can be explained that the average accuracy value for the overall test results of Passion Flower images using the Roberts + Canny method is 92.84%. Of the five trials conducted, the Roberts + Canny method was able to identify 4 Passion Flower images correctly and failed to identify 1 Passion Flower image with an average error value of 7.16%. In the image database, the minimum number of pixels produced is 2933 pixels, and the maximum is 17725 pixels. Meanwhile, the minimum and a maximum number of pixels produced in the test image are 4567 pixels and 17725 pixels. Overall the results of identification using the Canny method are 80%.

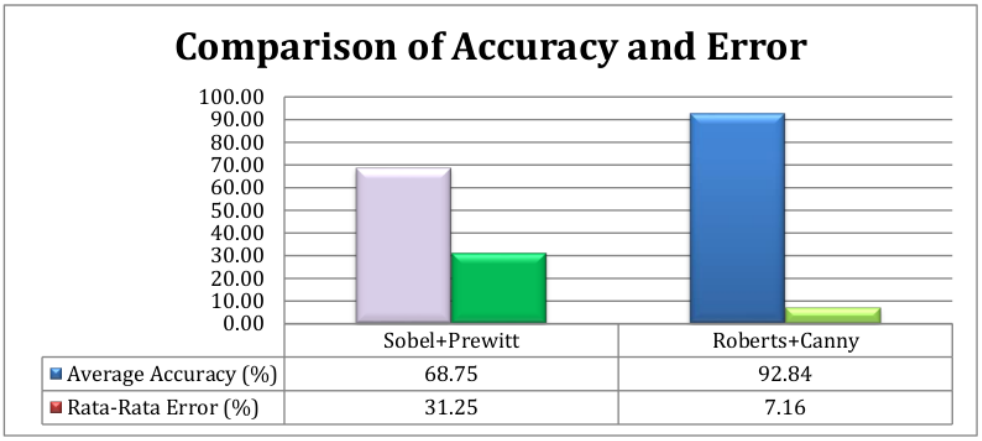
3.4. Comparison Chart

Comparing each method of the five trials Passion Flower image and comparing the average accuracy and error values for each method are depicted in graphical form, which can be seen in Figure 5.



	Trials 1	Trials 2	Trials 3	Trials 4	Trials 5
Accuracy (%) : Sobel+Prewitt	94.44	67.48	90.20	55.08	36.54
Accuracy (%) : Roberts+Canny	64.22	100.00	100.00	100.00	100.00

Figure 5. Comparison Accuracy Graph (5 Trials)



	Sobel+Prewitt	Roberts+Canny
Average Accuracy (%)	68.75	92.84
Rata-Rata Error (%)	31.25	7.16

Figure 6. Comparison Graph on Accuracy and Error

Based on the information presented in Figures 5 and 6, it can be concluded that the combination of the Roberts + Canny method has better accuracy than the Sobel + Prewitt method. This is evidenced by the results of image identification which reached 92.84% or 24.10% better than the Sobel + Prewitt method, which resulted in an average accuracy of 68.75%. The Roberts + Canny Method's combination is also superior in pixel count in detecting Passion Flower images.

4. Conclusion

Based on the results of the experiment and analysis, the research explains that object identification using the edge detection process of Passion Flower images using the Roberts + Canny method produces better identification than the Sobel + Prewitt method. It can be seen that the results of the resulting segmentation are clearer. The results of combining the two methods can help identify the object of the Passion Flower image even though it has different shapes and dimensions.

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