

# Edge Detection Model Performance Using Canny, Prewitt and Sobel in Face Detection

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**Abstract:** Detection of objects in the form of objects, humans and other objects at this time has been widely applied in many aspects of life. The help of this technology can facilitate human work, one of which is facial detection to get information about a person's identity. Face identification and detection is closely related to Data Mining science with Image Processing sub-science. This facial detection and recognition can use several technical approaches, one of which is to use edge detection. Edge detection is one of the basic operations of image processing. In the image classification process, edge detection is required before image segmentation processing. There are several methods that can be used to perform edge detection such as Canny, Prewitt and Sobel. These three methods are methods that have accurate and good detection results, with the advantages of each method having its own added value. From the results of previous studies that stated these three methods have good results, it became interesting to conduct a comparative study of these three methods in detecting edges in facial images. Edge detection applied to this study identifies facial images, and will get similarities with the original image from the result analysis process, and is reinforced by measurement results using the Mean Square Error error degree. The final result of this study states that this study the most optimal Mean Square Error measurement results obtained the final results in the Canny method of 10, the Prewitt method of 41 and Sobel of 29. These results show that the value of the Canny method has the smallest Mean Square Error value, which indicates that the Canny method on facial image edge detection has the most optimal results.

**Keywords:** Edge Detection, Canny, Prewitt, Sobel, Image Processing

## INTRODUCTION

The process of automatic detection using artificial intelligence is currently very much in application and efficacy. One example that feels the benefits is by detecting vehicle license plates that can be used to identify violations that have been committed and send warnings or reprimands to motorists through the detection of vehicle license plates. Another example is how the application of face detection can be used to facilitate self-identity identification as is done at several stations to carry out the registration and checking process before traveling using train transportation modes. Features embedded in smartphones that are commonly used by many people in everyday life also apply facial recognition technology or face recognition. Some of these things are one of the applications of the detection process using artificial intelligence or Artificial Intelligence. In the realm of face detection, the face is indeed one part that can represent a person's identity. Based on the shape of the face, or the contours of a person's face can reflect or provide an information picture in the form of gender which in some ways can help the process of identification and also identity recognition. The sophistication and use of technology that can help in aspects of human life as the nature of technology certainly has details that can be explored more deeply.

Science in the process of identification and face detection is closely related to Data Mining science with Image Processing sub-science. This facial detection and recognition can use several technical approaches, one of which is to use edge detection. Edge detection is one of the basic operations of image processing. The edge is the boundary of an object. In the image classification process, edge detection is required before image segmentation processing (Sundararajan, 2017). The object boundary of an image can be detected by the difference in its grayness. The purpose of edge detection is to analyze and group features in an image, and perform further analysis of the image. In doing this edge detection there are several methods that can be used including Canny, Prewitt and Sobel. These

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three methods are edge detection methods that can be used for further image analysis processes (Singh, 2018). In this study, a comparative process of these three methods will be carried out in carrying out the edge detection process on digital images.

These three methods are good methods in carrying out the edge detection process on digital images. The Sobel method has advantages and is the most widely used because of its simplicity and efficacy in reducing noise before performing edge detection calculations. While the prewitt method takes principles from laplacian and gaussian functions known as functions to generate HPF and produce accurate detection results (Moser & Zerubia, 2018). The Canny algorithm is one of the modern edge detection algorithms that has good character detection, good character localization, and clear response with one response for each edge (Sundararajan, 2017). Basically, these three methods have their own advantages, so this study will be compared from all three in the same case in testing the edge detection of facial images to identify gender.

## LITERATURE REVIEW

To strengthen the position of research that will be carried out, some of this previous research becomes a reference in the process of literature studies carried out. The process of sex or gender recognition can be applied with the Convolutional Neural Network (CNN) algorithm as in research that applies one of the architectures in CNN, namely VGG16 and LeNet, the results of this study that compares the two architectures produce research with the conclusion that the VGG16 architecture produces better accuracy due to the Rectified Linear Unit (ReLU) on the VGG16 architecture (Musthofa Galih Pradana, 2023). The architecture in CNN itself can be modified or customized, such as in research that compares two architectures or models that are custom themselves by applying ADAM Optimizer in CNN, the results show that the value of model 1 has advantages compared to model 2 because the stride value is smaller, the smaller the accuracy value will be better (Pradana et al., 2023). In the context of optimizers in image detection, the comparison of ADAM and SDGM in rice image classification concludes that ADAM optimizer results are better than SDGM (Saputro et al., 2022). Edge detection studies comparing Sobel, Prewitt and Robert and Canny showed that Canny's end result had the most superior end result in aircraft imagery detection (Yasir et al., 2022). The application of detection using Canny showed the best indirect recognition rate results at a threshold value of 0.107% with an Equal Error Rate (ERR) value of 45%, while the best direct recognition rate at a threshold value of 0.104% with an Equal Error Rate (ERR) value of 50% (Toni Wijanarko Adi Putra, Eko Siswanto, 2021).

The process of detecting edges on faces comparing Sobel's method, Roberts and Prewitt obtained the final detection conclusion that Sobel's method produces image outlines that show more clear patterns and match the original image (Novia Wulan Dari, 2022). Face detection by applying Dlib and OpenCV can precision images, adjust facial movements, and result in testing on landmark facial points being more accurate, which can be demonstrated during processing on OpenCV Dlib (Sejati & Mardhiyyah, 2021). The face detection process using Sobel and Canny showed that Canny's final results had better results in different conditions (Chyad et al., 2021). Face detection with the Prewitt method shows good results in detecting the edges of the face image, but without the help of image sharpening, Prewitt edge detection cannot work well in detecting edges, therefore many edge detections must be assisted by image sharpening (Manapa et al., 2022). Detection on human organs, apart from the face can also be done from the hand line, the experimental results showed that palm recognition using Canny and Sobel edge detection CNNs for training data resulted in an accuracy rate of 96.5% for 200 classes (Putra et al., 2021).

The image of a car vehicle in a reference study comparing the methods of Robert, Sobel, Prewitt and Laplace resulted in the final conclusion that the Sobel method was better than the other three methods, both with the addition of binary and inverse Sobel methods showed good edge detection results (Ummah & Yannuansa, 2020). In flower imagery, Roberts and Canny's method resulted in better image identification accuracy compared to Sobel and Canny, which was 92.84% compared to 68.75% (Wanto et al., 2021). Comparison of some of these methods in varied data such as vehicle and animal imagery shows edge detection results with the Canny technique can result in MSE and PSNR values at the best values (Khairudin et al., 2023). The Prewitt method can be optimized using fractional derivatives of Caputo and Caputo-Fabrizio, experimental results show that the proposed method has a better definition of edges than those obtained by traditional filters indicated by better visual quality (Asumu et al., 2020).

## METHOD

### 1. Research Stages

This research is carried out one step by step, there are 3 parts in this research stage, namely problem research, solution, result and evaluation. Step by step has its own functions and roles. The following are the details of each stage :

- a. Problem Research

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At this stage is the first step by doing many activities to understand the literature from previous researchers. By taking many references from previous researchers, it can make researchers better understand what has been done and researched by previous researchers, so that the opportunity to develop research with new research ideas becomes more open. On the other hand, the next stage that can be done in this case is to collect data. The data used is secondary data, using a person's facial image from the male and female gender classification.

b. Solution

The second stage of this study is to find solutions to the problems experienced, the problem of comparison of the three edge detection methods which will be carried out using the prewitt, sobel, and canny methods producing output in the form of edge detection results from the three methods.

c. Evaluation

The evaluation stage is the last stage in this study, by measuring the edge detection process carried out by three methods, namely prewitt, sobel, and canny. The result will be measured error rate using Mean Square Error.

The detailed description of the stages of this research is shown in Fig. 1.

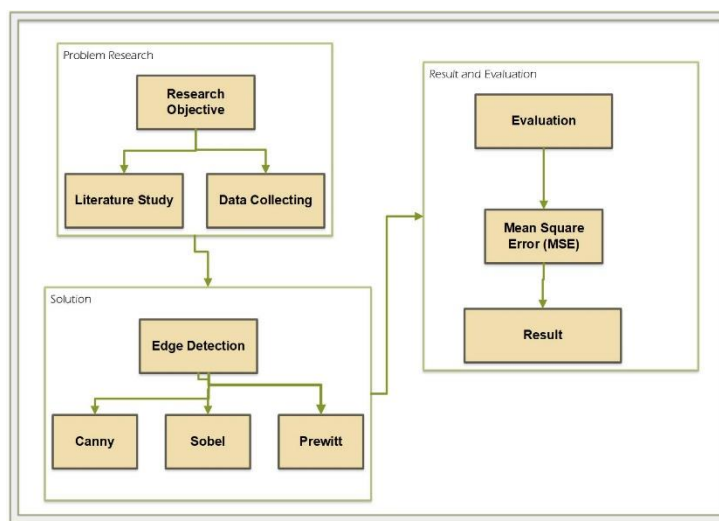


Fig. 1. Research Stage

## Theory

### Edge Detection

Edge detection is one of the important stages in digital image processing that aims to find the boundary or edge of objects in the image. This method is used to identify significant changes in pixel intensity between different regions in an image. Edge detection is important in many applications, including medical image processing, pattern recognition, and computer vision (Kovalevsky, 2019).

### Canny

The Canny method involves several stages in edge detection, including image smoothing with Gaussian filters, gradient calculation, non-maximum suppression, and applying thresholds with the hysteresis method. The first step in Canny's algorithm is to implement a Gaussian filter on the image to eliminate noise. Then proceed to perform edge detection on the image with one of the existing edge detection algorithms, such as Sobel or Prewitt. The next step is to divide the existing lines into 4 separate colors with their respective angles, then reduce each border to make it thin (non maximum suppression). The last step is to carry out the binaryzation process based on the given low & high threshold values (Vivian Siahaan, 2018).

### Prewitt

The Prewitt operator is used to detect edges by calculating the gradient of the image in the horizontal and vertical directions. This operator uses a 3x3 kernel for convolution with the image (Asmara, 2018).

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**Sobel**

The Sobel method also uses a 3x3 convolution kernel to calculate image gradients in horizontal and vertical directions. The kernel combination is used to calculate the absolute distance of a gradient but can also be applied separately to calculate each vertical and horizontal process. To calculate the gradient distance, the following equation is used : (Asmara, 2018)

$$|G| = \sqrt{Gx^2 + Gy^2} \quad (1)$$

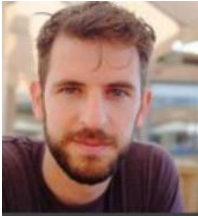







To calculate the direction of the resulting outline, the equation is used :

$$\theta = \arctan(Gx/Gy) \quad (2)$$

**RESULT**

This research conducted an edge detection process using the python programming language, where the images used were taken from secondary data as much as 10000 data. The data used in this study will be carried out an edge detection process with each method used, namely using Canny, Prewitt, Sobel. The image dataset used can be seen on Table 1.

Table 1. Dataset

Original Image	Label	Original Image	Label
	Male		Female
	Male		Female
	Female		Male
	Female		Female

\*name of corresponding author

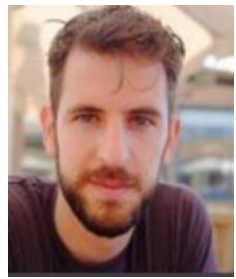





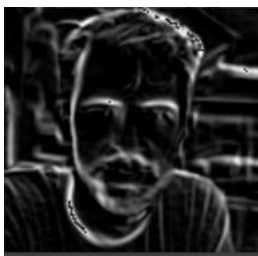











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The results of the edge detection process from the image data used are carried out by the edge detection process with all three methods and produce images from each method shown in Table 2.

Table 2. Result Edge Detection

Original Image	Canny	Prewitt	Sobel
			
			
			
			

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From the edge detection results above, it shows the image of each method, namely Canny, Prewitt and Sobel, it can be concluded at a glance, namely the results of Canny's image have a better level of similarity than the other two methods, namely Prewitt and Sobel. These results are still obtained at a glance, or initial observations, then validation with definite values is needed to prove the results of observations. In the next stage, testing will be carried out using the Mean Square Error value.

### DISCUSSIONS

Tests carried out on facial images were measured by applying Mean Square Error. The results obtained in this study are presented as a sample of 6 data with details on Table 3.





Table 3. Testing Result

Original Image	Mean Square Error		
	Canny	Prewitt	Sobel
	10	66	36
	12	64	42

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	14	69	29
	17	63	38
	15	41	46
	11	58	45

The results of MSE value testing are visualized on Fig. 2.

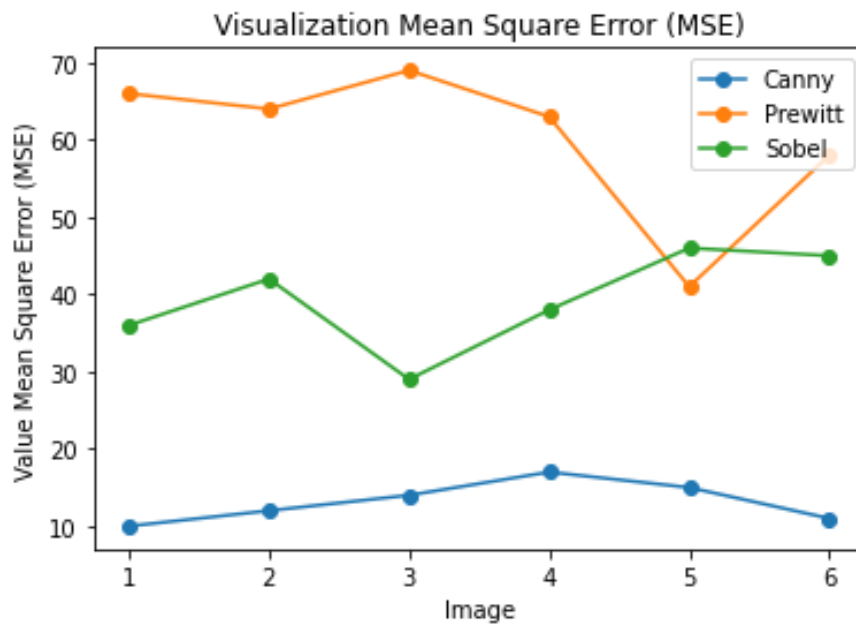


Fig. 2. Visualization MSE

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The results of the Mean Square Error (MSE) test state that of the three methods, the best results are always obtained in the Canny method with the MSE value that is closest to zero, or the most optimal. So that the comparison of these three methods results in the final conclusion of the Canny method in the case of detection of the edges of the facial image has the proven advantage of the most optimal MSE value.

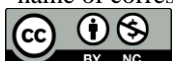
### CONCLUSION

This research in conducting a series of edge detection trials can conclude the following: Images that have visual similarities from observations are shown in the Canny method which has similarities in the edge detection process. The result of measuring the degree of error using Mean Square Error (MSE) obtained the most optimal result or the value closest to zero is the Canny method with the most optimal value at value 10. The suggestion in further research that can be done is to enrich and multiply the quantity of image types from various types of categories.

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