

# Implementation of the Laplacian of Gaussian Algorithm in Edge Detection Image Processing of Zebra Cross Damage on Highways in the Langkat Regency Area

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## Abstract

Walking is part of the traveler's movement and is the simplest means of transportation, but it is in a weak position and prone to conflict or accidents when they mix with other modes of transportation. To protect pedestrians, special facilities are needed, one of which is a crossing place (zebra crossing) that is able to serve according to pedestrian needs. Based on Law No. 22 of 2009 concerning Traffic Polytechnic Land Transportation Bali 46 Cross and Road Transportation, article 131 paragraph (2), it is stated that "Pedestrians are entitled to priority when crossing the road at the crosswalk". One of the important meanings for human life is the Way. Roads are used as a means of transportation that has a very useful role in efforts to develop human life. In 2018, based on statistical data, the number of motorized vehicle users in Indonesia is increasing every year to reach 146,858,759 units. The impact that occurs is that there are many Zebra Cross roads damaged with conditions that are very troubling and worrying for road users. Among the causes of zebra crossing being damaged will be traffic accidents where the vehicle does not lag obeying the path of the vehicle following the predetermined lane. So this study detects image processing with the Laplacian of Gaussian algorithm with edge detection making it easier for the government to improve traffic signs of zebra crossing images on highways that are worthy of improvement so that accidents do not occur. The results of this study illustrate the image of being able to see damaged zebra crossings with calculations of the Laplacian of Gaussian algorithm.

**Keywords:** *Image, Zebra Cross, Laplacian of Gaussian*

## 1. Introduction

One of the important meanings for human life is the road. Roads are used as a means of transportation which has a very useful role with the development of transportation systems, especially land in Indonesia is increasingly rapid today. Based on data from the Central Statistics Agency (BPS), the number of motorized vehicle users in Indonesia every day is increasing. Data in 2018 the number of motorized vehicles in Indonesia reached 141,992,573 units. [Highway] Walking is part of the traveler's movement and is the simplest means of transportation, but it is in a weak position and prone to conflict or accidents when they mix with other modes of transportation. To protect pedestrians, special facilities are needed, one of which is a crossing place (zebra crossing) that is able to serve according to pedestrian needs [4].

Edge detection in an image is done to find the dividing line of an object in the image. Generally, edge detection is the initial process of image segmentation leading to the identification of objects contained in the image. Image segmentation is part of the image processing process which is a way to divide an image into regional groups that aim to isolate an object in the image. Objects that have been segmented can be carried out the process of extracting image characteristics, where steps aim to distinguish between objects from one another. Image processing techniques play an important role in every aspect of its development which is widely used in processing and detecting images. Edge detection methods are widely used in solving problems, including Opertaor Sobel, Roberts Operator, Canny Operator, Prewitt Operator, Laplacian Operator and Laplacian of Gaussian [1].

## 2. Research Methods

### 2.1. Edge Detection

A edge is a set of connected pixels that are at the boundary between two regions. Edges need the ability to measure gray-level transitions in a precise way. Edge detection is the process of determining changes in apparent different intensities within an image plane. Edge detection serves to obtain the edge of the object, by utilizing drastic changes in intensity values at the boundary of two areas [7].

## 2.2. Citra

An image is a representation (image), resemblance, or imitation of an object. An image can be defined as a two-dimensional function,  $f(x,y)$ , where  $x$  and  $y$  are the flat-plane coordinates, and the value of the function  $f$  in each coordinate pair  $(x,y)$  is called the intensity or grey level of the image at that point. If  $x,y$  and  $f$  are all finite, and the values are discrete, then the image is called a digital image (digital image) [6].

## 2.3. Zebra Cross

Walking is part of the traveler's movement and is the simplest means of transportation, but it is in a weak position and prone to conflict or accidents when they mix with other modes of transportation. To protect pedestrians, special facilities are needed, one of which is a crossing place (zebra crossing) that is able to serve according to pedestrian needs. Based on Law No. 22 of 2009 concerning Lalu Lintas Journal of Transportation and Logistics Technology Volume 1 No 1, June 2020, Pages 45-50, p-ISSN 2716-2990 Bali Land Transportation Polytechnic 46 Cross and Road Transportation, article 131 paragraph (2), it is stated that "Pedestrians have the right to get priority when crossing the road at the crosswalk" [4].

## 2.4. Laplacian Algorithm of Gaussian (LoG)

The Laplacian operator of Gaussian is a combination of the Gaussian operator and the laplacian operator. A second-order edge detection that is increasingly less sensitive to noise is the Laplacian of Gaussian (LoG). This is due to the use of Gaussian functions that smooth the image and have an impact on noise reduction in the image. As a result, the operator reduces the number of incorrectly detected edges. [1] Laplacian Of Gaussian is one of the edge detection operators developed from the second derivative. This Laplacian Of Gaussian operator has a directional omny nature (not horizontal and not vertical). This operator is very sensitive to noise located at the edge points. Before performing edge detection, a filter process is first carried out that can weaken noise. This Laplacian Of Gaussian operator is formed from the Gaussian Filter process followed by the Laplacian operation [5].

The way LoG operators work is that images are convoluted with gaussian operators aimed at blurring and weakening noise. However, this defocusing causes widening of the edges of the object. Then, the laplacian operator is applied to find the intersection point with the x-axis in the second derived function corresponding to the peak in the first derived function. Then, the location of the edges is obtained from the resolution of the subpixels using linear interpolation. The LoG operator obtained by convolution with the equation is the Mexican hat filter because it looks like a hat commonly used by Mexicans. The Laplacian of Gauss (LoG) method is performed by determining the edges of the image using a derived order second. The laplacian operator provides sensitivity to noise in each part of the pixel. The equation for the derivative  $f(x,y)$  is [1]:

1.Steps in the Laplacian of Gaussian algorithm:

$$\nabla^2 f(x,y) = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} \quad (1)$$

So we get the second derivative of  $f(x,y)$ :

$$\begin{aligned} \tilde{N}^2 f(x,y) &= 4f(x,y) - f(x+1,y) - f(x-1,y) - f(x,y+1) - f(x,y-1) \\ \text{LoG}(y,x) &= -\frac{1}{\pi\sigma^4} \left[ 1 - \frac{x^2+y^2}{2\sigma^2} \right] e^{-\frac{(x^2+y^2)}{2\sigma^2}} \end{aligned} \quad (2)$$

Generated by conducting convolution of the Laplacian matrix

$$\nabla^2 f(x,y) = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 4 & 1 \\ 0 & 1 & 0 \end{bmatrix} * \begin{bmatrix} f(x-1,y+1) & f(x,y+1) & f(x+1,y+1) \\ f(x-1,y) & f(x,y) & f(x+1,y) \\ f(x-1,y-1) & f(x,y-1) & f(x+1,y-1) \end{bmatrix} \quad (3)$$

Then a gaussian filter is carried out

$$g(x,y) = e^{-\frac{x^2+y^2}{2\sigma^2}}$$

The function of the gaussian filter is to blur the image and remove noise. So the Laplacian of Gaussian operator is obtained from convolutions.

$$\nabla^2 g(x,y) = \left( \frac{x^2+y^2-2\sigma^2}{\sigma^4} \right) * e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (4)$$

with:

$\sigma$  = Value of standard deviation of distribution ( $\sigma = 1.4$ )

$e$  = Exponential value (2.71828183)

## 2.5. Matlab

Matlab (Matrix Laboratory) is a software developed by Mathworks, Inc. by utilizing matrix in its use. One of the uses of Matlab in general is for development in the field of computing, namely programming / software development. So that Matlab can be applied in medical imaging technology, especially medical images from digital radiography. The application of Matlab utilization in medical imaging technology has developed through algorithms that continue to be developed with various objectives, ranging from identification / detection, segmentation, simulation even to the development of medical device programming. Matlab applications in medical imaging technology,

especially digital radiography, include in the segmentation process with the aim of detecting abnormalities, simulation and program development [8].

### 3. Results And Discussion

Edge detection in zebra cross damage imagery can be processed with one of the edge detection methods, namely laplacian of Gaussian. Edge processes show object boundaries because edges are useful as a process of segmentation and identification of an image object. The initial process of detecting the edge of zebra cross damage imagery with the laplacian of gaussian method is by selecting zebra cross damage images to be sampled. After selecting the results of the zebra cross damage image, the image is then inputted into the matlab application.

Furthermore, grayscale is the process of converting color images into images with grayish color levels (grayscale). Then the image will be processed with the laplacian of gaussian method and obtain information on the scale of damage to the zebra crossing. Testing in this study used sample data taken from image shooting with jpg extension format as much as one sample data. The following is a sample image of the study below:



**Fig. 1:** Zebra Cross in disrepair

### 4. Testing

In making the system to detect the edges of this object, the author used the Matlab program and the design was done on the Windows 11 operating system. Here the author uses one of the zebracross damage images [3]. The direct program display is in the form of the main display of Matlab, where the results of the display process of the Laplacian of Gaussian edge detection image processing program on zebra crossing highways can be seen in the picture below:

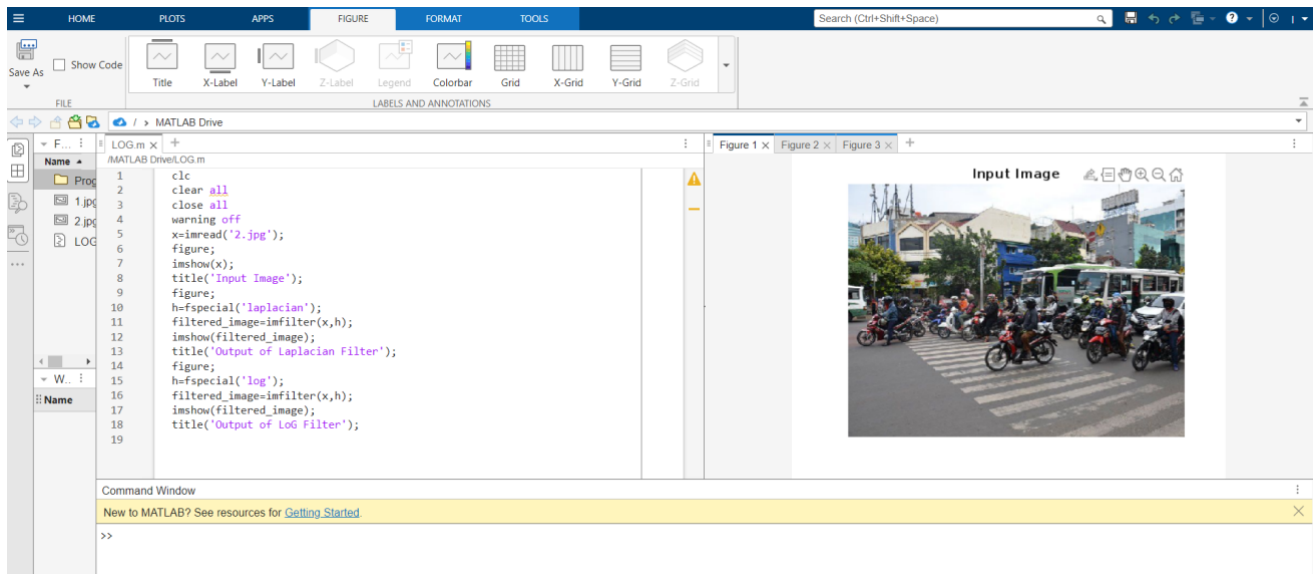


Fig. 2: Results Image input process

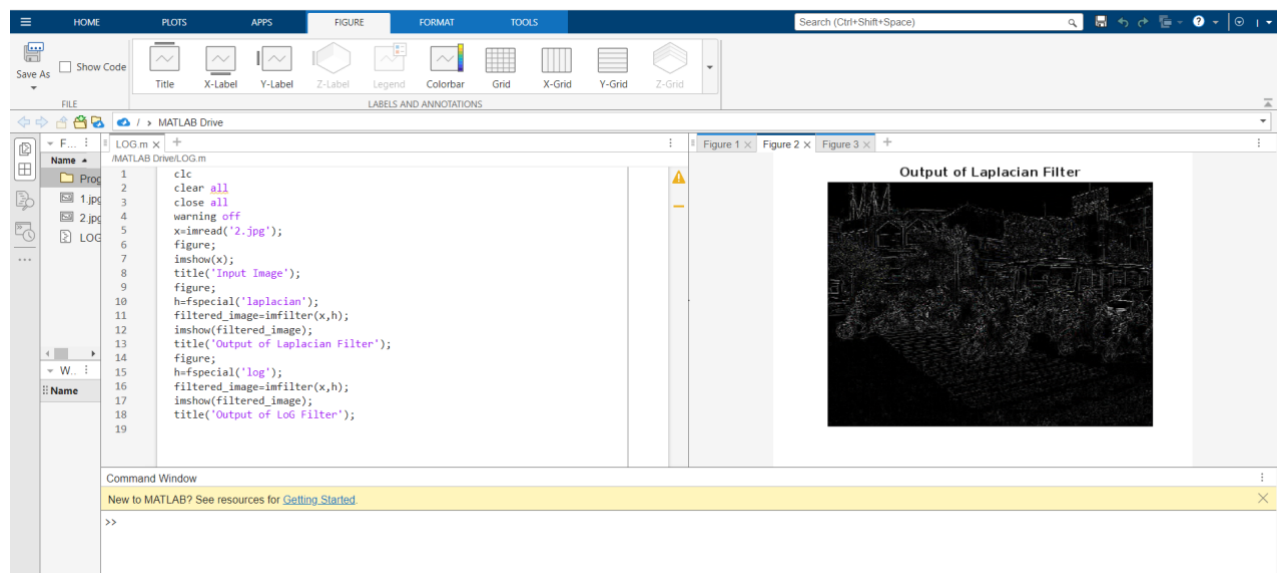


Fig. 3: Filter laplacian output results

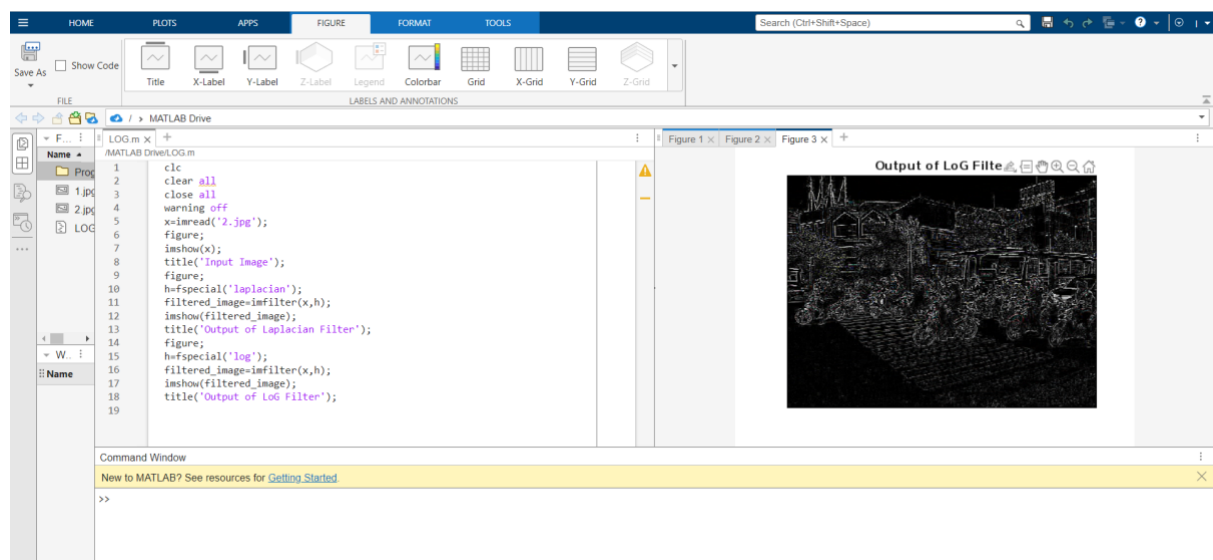


Fig. 4: Output Laplacian of Gaussian results

In making this application, the author uses the first method, where the original image is first carried out by the Gaussian filter after the filter process is complete, the results of the filter image are detected at the edges using the laplacian of gaussian method. So the results of

the program above are provisions for damage to zebra crossing at one of the traffic signs so that the results of edge detection will be carried out zebra crossing repairs around the langkat regency highway.

## 5. Conclusions

The Laplacian Of Gaussian (LoG) method was successfully applied in this study so that it could be used as a tool to detect the edges of the Image On Zebra Cross Damage, so that users in this case the langkat district highway area could evaluate to repair zebra crossing. The results of image texture testing using the Laplacian Of Gaussian (LoG) Method, show maximum and satisfactory results, so that users will be much easier, more effective, and efficient in determining the state or condition of the zebra cross highway. This research provides knowledge to the community and government of Langkat district about the importance of a computerized system in detecting crucifixions on highways.

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