Various Edge Detection Techniques on different Categories of Fish

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ABSTRACT
Edge detection is the most frequently and important used operations in image analysis. The edges of the image defined the boundaries and regions of the image. In this paper several edge detection techniques have been applied on Equalized image of different categories of Fishes like Fresh water fish, Salt water fish, Poisonous Fish, Dangerous fish and all fishes are belongs to different fish family and fish classification in image processing using different filters which are basically based on gradient method like Sobel, Prewitt ,Roberts ,Log Based and Canny edge detector . Canny Method gave better performance among all other methods like Sobel, Prewitt, Roberts, Log. The Experimentation done in software MATLAB 12.0

Keywords
Edge Detection, Gradient based edge detection, Laplacian based edge detection

1. INTRODUCTION
Edge detection in image processing identifying edges in an image. It could be use as the pre-processing step which reduces the amount of data to be processed. Edge is the area of major change in the luminous, image intensity or contrast and locating areas with strong intensity contrasts is known as Edge Detection. Edge detection is used in extracting information or data about the image. E.g. location of objects present in the image, their shape, size, image sharpening and enhancement [4]. Edge detection is used for image segmentation based on abrupt changes in image intensity. In a continuous image, a sharp intensity transition between neighbouring pixels is considered as an edge [1].

Below mentioned are the following steps that are used as a part of edge detection:

- **Image Smoothing**: Image smoothing is a noise reduction step and it is used to reduce the noise by filtering the image for improving the performance of edge detector.
- **Detection:** This step involves extracting all points that are possible to become edge point.
- **Edge localization**: This step involves identifying true set of member points and that comprises an edge [1].

We mainly use two types of operators in edge detection which are:

1.1.Gradient Based Edge Detection
The gradient method detects the edges in the terms of maximum and minimum or horizontal or vertical in the first derivative of the image. Roberts, Sobel, and Prewitt are the popular edge detection operators. As they are all defined on a 3x 3 pattern grid they are efficient and easy to apply but sensitive to noise.

1.2.Laplacian Based Edge Detection
The Laplacian method considered zero crossings in the second derivative of the image to find edges. Zero crossing is the sure location of edge detection,Eg. LOG, Canny.

1.3.Gradient
The digital image is based on first-order derivatives and its first derivative depends on various approximations of the 2-D gradient. Change in the value or gray value is gradient operator. Gradient is also indicating the presence of edge. The gradient of an image f(x, y) at location (x, y) can be defined as a vector shown in the below equation. [10]

$$\nabla f = \begin{bmatrix} Gx \\ Gy \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial x} \end{bmatrix} \quad (1)$$

The magnitude of edge detection of this vector, denoted, where

$$\nabla f = \text{mag}(\nabla) = [G^2 x G^2 y]^{1/2} \quad (2)$$

This quantity gives the maximum rate of increase of f(x, y) per unit distance .The direction of the gradient vector is an also considered as an important quantity. Direction angle of the vector at (x, y) can also be denoted in vector analysis as,

$$\propto (x, y) = \tan^{-2} \begin{pmatrix} Gx \\ Gy \end{pmatrix} \quad (3)$$

An image is based on obtaining the partial derivatives while computation of the gradient and at every pixel location. Edge detection is also depend on the pixel value. Let the 3 x 3 area shown in Fig. 1 (a) represent the gray levels in a neighbourhood of an image. [9, 10] One of the simplest ways to implement a first-order partial derivative at point z5 is to use the following Roberts cross-gradient operators

$$G_x = (z_9 - z_5)$$

And

$$G_y = (z_8 - z_6)$$

For an entire image these derivatives can be implemented by using the masks shown in Figure 1 (b). Masks of size 2 x 2 are awkward to implement because they do not have a clear centre.[9,10] An approach using masks of size 3 x 3 is given by

$$G_x = (Z_7 + z_8 + z_9) - (z_1 + z_2 + z_3)$$

And

$$G_y = (z_3 + z_6 + z_9) - (z_1 + z_4 + z_7)$$

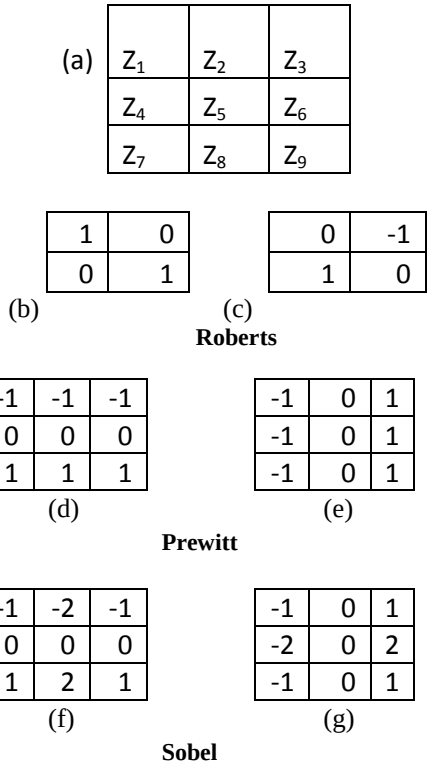


Figure1: A 3 X 3 region of an image (the Z's are gray – level values) and various Masks used to compute the gradient at point labelled Z5.

2. EDGE DETECTION TECHNIQUES

2.1.Traditional Edge Detection techniques:

- **Robert's cross Edge Detection**

It is a classical method and has no smoothing filter, and they are only based on a discrete differential operator. It is sensitive to noise It give more weightage to the centre pixel. It is also based on the principle that difference on any pair of mutually perpendicular direction can be used to calculate the gradient. Difference between diagonally adjacent pixels is used to process the image [3].In which the derivative output will go zero if no change in the gray value and if variation in gray value or pixel value then indicate the edge.

- **Sobel Edge Detection**

Sobel operator [2] is used in image processing techniques for edge detection. It is efficient and simple approach but it is less sensitive to noise because the 3X3 convolution mask smoothes the image by some amount, but it produces thicker edges rather than thin, So edge localization is poor .This operator is based on convolving the image with a integer valued filter in horizontal and vertical and in the terms of computations it comparatively cost-effective. Move the operator all across image which is called and carried out the convolution. The operator uses two 3×3 kernels which are convolved with the original image to calculate approximations of the derivatives-one for horizontal changes, and another for vertical [2]. The differences are calculated at the centre pixel of the mask. Change in the gray value or variation in the gray value also effects in edge detection.

- **Prewitt Edge Detection**

Prewitt operator edge detection masks are the one of the best understood methods of detecting edges in images. It is also based on the first derivative. There are two masks, one for detecting image derivatives in X direction and another for detecting image derivative in Y direction. A user convolves an image with both masks producing two derivative images (dx and dy) to fond edges [2].The Prewitt edge detector is a good way to estimate the magnitude and orientation of an edge. The maximum response is carried out when the Prewitt edge detection obtains the orientation directly from the kernel [2].

- **Laplacian of Gaussian**

LOG is the Second-order differential algorithm which uses pre-smoothing with Gaussian low-pass filter on the image first. In which do not have to look for edge in X and Y direction or diagonal because it takes into account output you get whenever the edges are located or placed. It highlights the edges and highlights the noise also. So, that Gaussian operator is used for smoothing the image. It could filter the noise and also smooth the edge [2]. The operator normally takes a single gray level image as input and produces another gray level image as output. The Laplacian L(x,y) of an image with pixel intensity values I(x,y) is given by:

$$\mathcal{L}(x,y) = \frac{\partial^2 I}{\partial x^2} + \frac{\partial^2 I}{\partial y^2} \quad (4)$$

[2]Since the input image is represented as a set of discrete pixels, because every pixel have some location and value.

- **Canny Edge Detection Algorithm**

It is used to detect wide range of edges in the image .Canny operator [14] is based on three criteria. The basic idea uses a Gaussian function to smooth image firstly because it is based on the second derivative; it highlights the edges and highlights the noise also. Threshold are used to detect the strong and weak edges, strong edge (more change in gray value) and weak edge(less or slightly change in gray value. This algorithm is good in detecting edges however, the operators are sensitive to noise and the edge determined is discontinuous It detects more edges than any other operators.

3. HISTOGRAM EQUALIZATION

The Histogram Equalization method [15] usually increases the contrast of images and Histogram indicates to measure the quality of the picture and it is basically a distribution of a gray level. Histogram equalization effectively spreading out the most frequent intensity values to transform the gray levels of the image so that the histogram of the resulting image is equalized to become a constant:

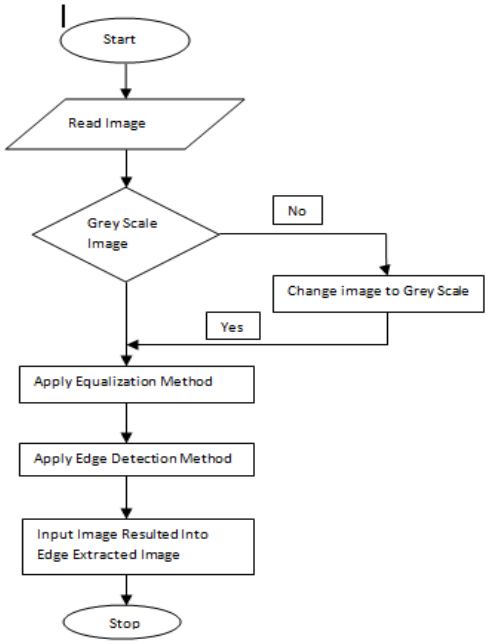
$$h[i] = constant, \quad 0 \le i < L \quad (5)$$

And to normalize a histogram by dividing each its value by total no of pixel in the image.

The purposes:

- To make equally use of all available gray levels in the dynamic range.
- For further histogram specification

4. FLOW CHART



5. EXPERIMENTAL ANALYSIS

In this paper image of different types of fish images (binary image) in different categories are taken. They are then formed into a histogram then apply equalization method on every images of different Category for enhancement of image and then form histogram of Equalized image. It has been observed that equalized image is better than original image, we can see the histogram to differentiate. After that all methods or techniques of edge detection apply on Equalized or improved image of different categories of fishes.

Every Category has three (3) fish image with family name:-

There are following Categories of Fish:

a) Freshwater Fishes b) Saltwater Fishes

c) Poisonous Fishes d) Dangerous Fishes

5.1. Fish Categories

- **Fresh Water Fishes:**

Table 1: Three Fresh Water Fishes with fish family

Fresh water Fishes		
S.No.	**Fish Name**	**Fish Family**
1	Synodontis Petricola	Mochokidal
2	Firemouth Cichlidal	Cichlidal
3	Porthole Catfish	Callichthyidal

- **Salt Water Fishes:**

Table 2: Three Salt Water Fishes with fish family

Salt Water Fishes		
S.No	**Fish Name**	**Fish Family**
1	Pinecone	Monocentridal
2	Old Wife	Enoplosidal
3	Two Band Clown	Pomacentridae

- **Poisonous Fishes**

Table 3: Three Poisonous Fishes with fish family

Poisonous Fish		
S.no	**Fish Name**	**Fish Family**
1	Red Snapper	Lutjanidae
2	Trigger	Balistidae
3	Spotted Puffer	Tetradontidae

- **Dangerous Fishes:**

Table 4: Three Dangerous Fishes with fish family

Dangerous Fishes		
S.no	**Fish Name**	**Fish Family**
1	Candiru	Trichomycteridal
2	Tiger	Characidae
3	Atlantic Manta	Mobulidal

5.1.1. Edge Detection used in Fresh water Fishes with Different Methods

Experiments were carried out over several 360 X 360 sizes of standard images of different categories of different fish families .Edge detection methods like Prewitt, Roberts, LoG, Zerrocross, Canny have been implemented on some standard test images using MATLAB 12.0.

- Fish Name :-Porthole Catfish
- Fish Family:-Callichthyidal

Test Image -1 (Porthole Catfish)

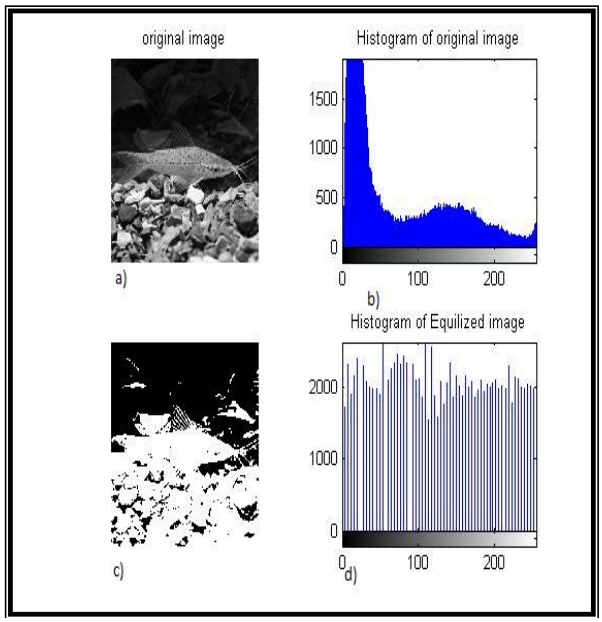


Figure 2 a) Original Image in Black and White b)Histogram of original image c)Equalized Image d) Histogram of Equalized Image

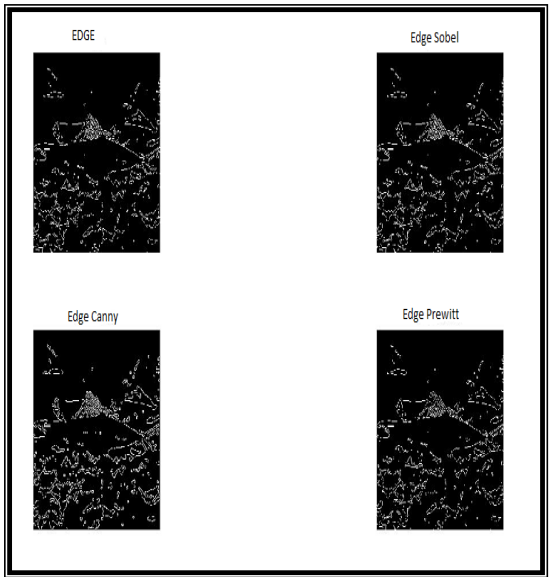


Figure 3: a)Edge b) Sobel Method c) Canny Method d)Prewitt Method

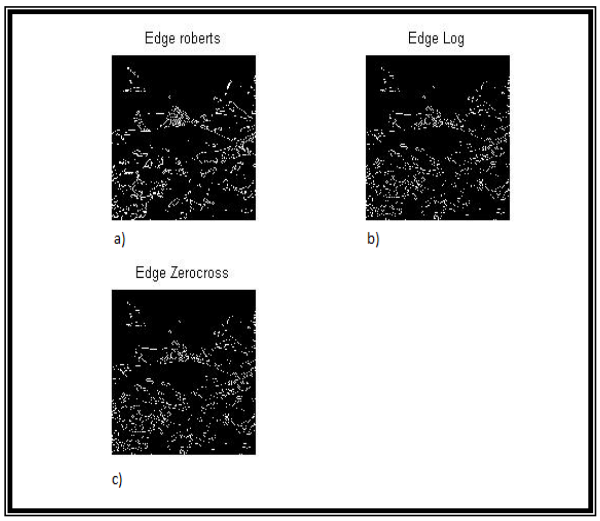


Figure 4: a) Roberts Method b)LOG Method c)Zerocross Method

The result clearly shows that the canny method has a better performance after the equalization of fish image was done in the form of Black and White image. It has better outline of edge and good detection effect on the tail and fin part. Log and Zerocross also give good detection effect than Sobel Robert's and Prewitt methods.

5.1.2. 5.1.2 Edge Detection used in Saltwater Fish with Different Methods:-

- Fish Name :-Pinecone
- Family Name:- Monocentridal

Test Image –II (Pinecone)

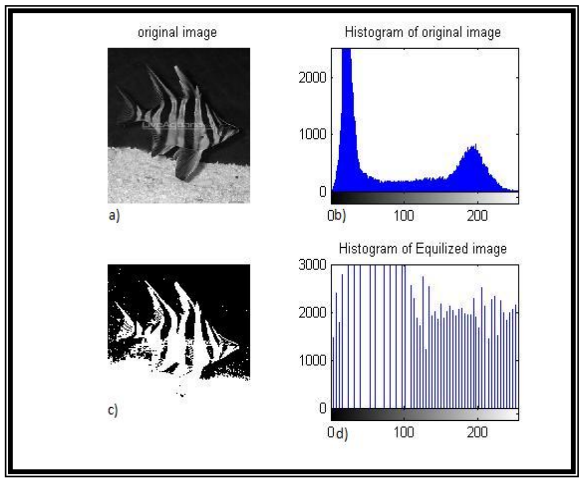


Figure 4` a) Original Image in Black and White b)Histogram of original image c)Equalized Image d) Histogram of Equalized Image

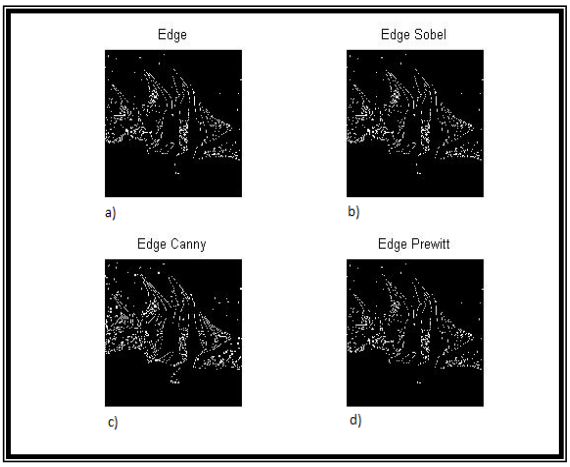


Figure 5: a)Edge b) Sobel Method c) Canny Method d)Prewitt Method

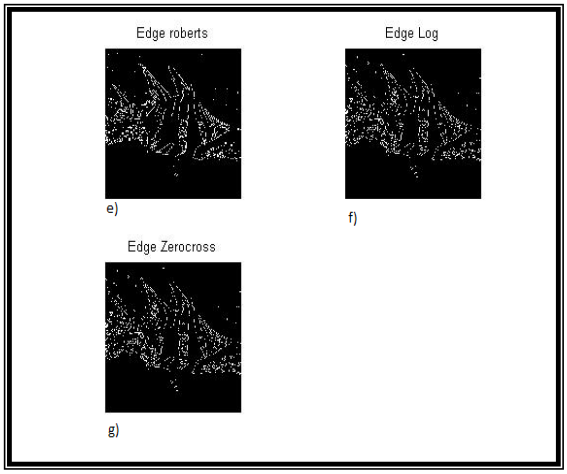


Figure 6: e)Roberts Method f)LOG Method g)Zerocross Method

The result clearly showed that the canny method has a better performance after the equalization of fish image which was in

the form of Black and White. It has better outline of edge and good detection effect on the tail and fin part. Log and Zerocross also give good detection effect than Sobel, Roberts and Prewitt.

5.1.3. Edge Detection used in Poisonous Fish with Different Methods

- Fish Name :-Spotted Puffer
- Family Name:-Tetradontidae

Test Image-III (Spotted Puffer)

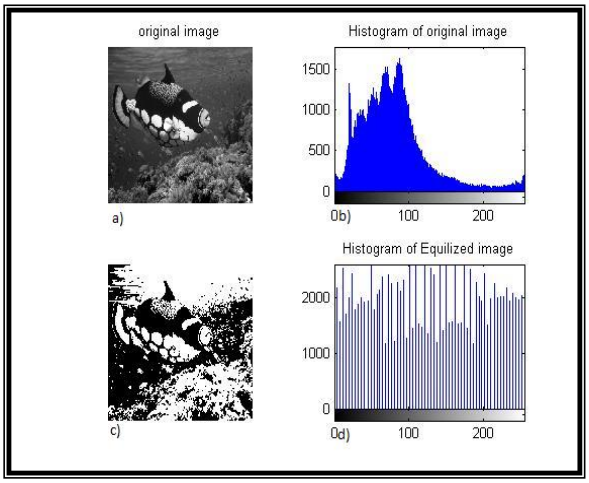


Figure 7 a) Original Image in Black and White b)Histogram of original image c)Equalized Image d) Histogram of Equalized Image

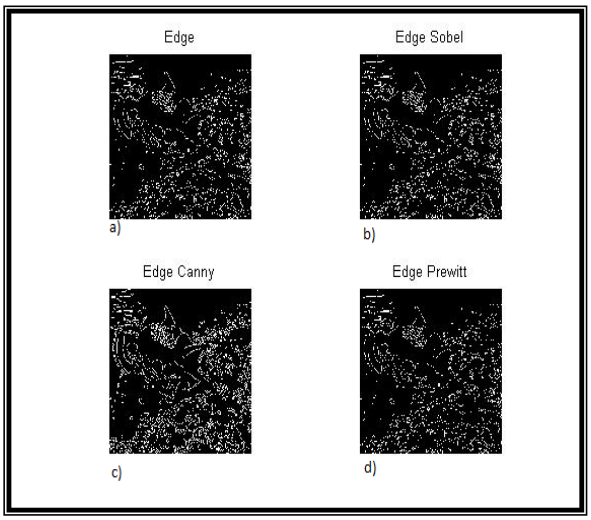


Figure 8: a)Edge b) Sobel Method c) Canny Method d)Prewitt Method

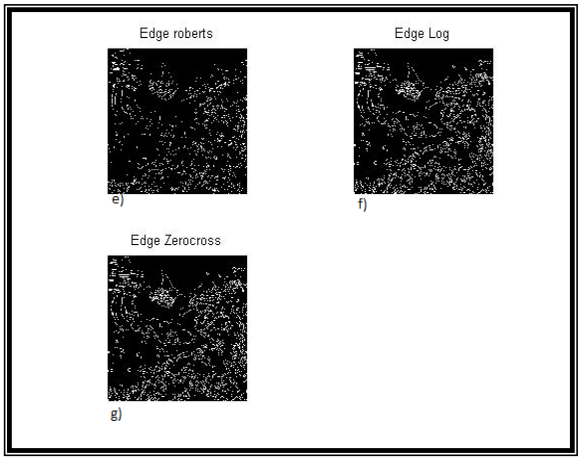


Figure 9: e)Roberts Method f)LOG Method g)Zerocross Method

The result clearly showed that the canny method has a better performance after the equalization of fish image which was in the form of Black and White.It has better outline of edge and good detection effect on the tail and fin part. Log and Zerocross also give good detection effect than Sobel, Roberts and Prewitt.

5.1.4. Edge Detection used in Dangerous Fish with Different Methods

- Fish Name: -Atlantic Manta
- Family Name:-Mobulidal

Test Image –IV (Atlantic Manta)

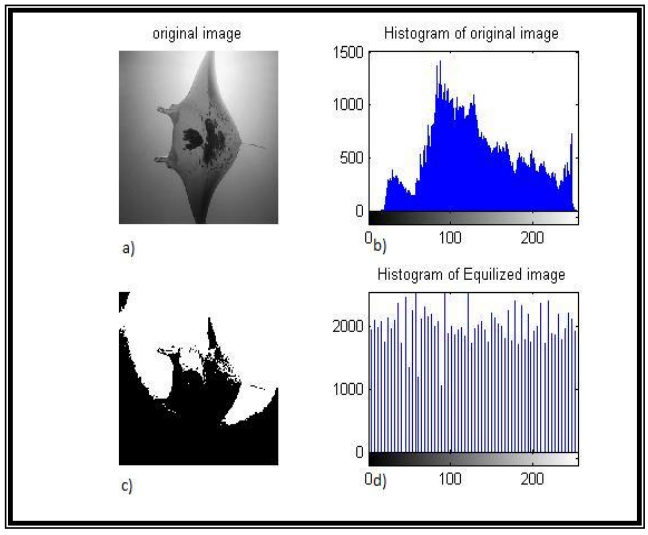


Figure 10 a) Original Image in Black and White b)Histogram of original image c)Equalized Image d) Histogram of Equalized Image

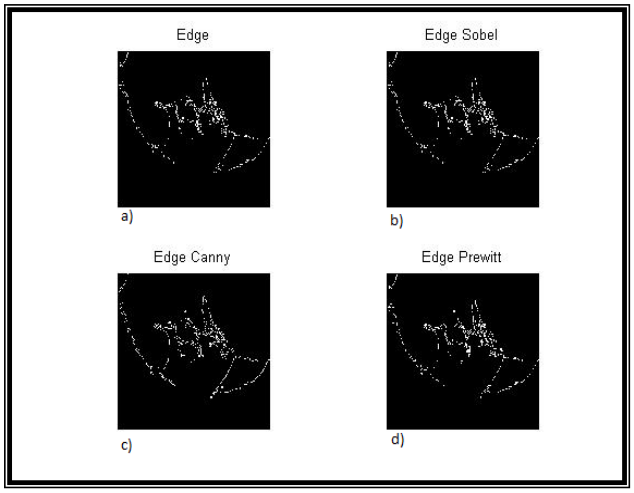


Figure 11: a)Edge b) Sobel Method c) Canny Method d)Prewitt Method

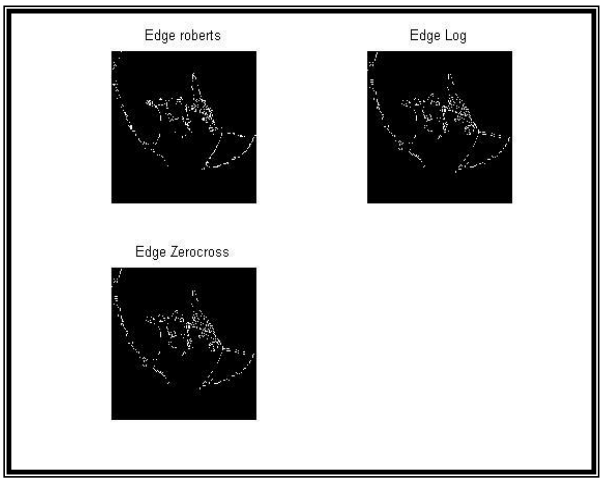


Figure 12: e)Roberts Method f)LOG Method g)Zerocross Method

The result clearly showed that the canny method has a better performance after the equalization of fish image which was in the form of Black and White. It has better outline of edge and good detection effect on the tail and fin part. Log and Zerocross also give good detection effect than Sobel, Roberts and Prewitt.

6. CONCLUSION

Edge detection method or techniques applied on different categories of fishes after the image has been equalized or image has been Enhanced .The edge detection is the primary step in identifying an image object, it is very essential to know the advantages and disadvantages of each edge detection filters. This paper dealt with study of edge detection techniques of Gradient-based and Laplacian based. Edge Detection Techniques applied on different type of fishes of different families. The software was implemented using MATLAB 12.0. The performance of the Canny's method is better in equalized image also as compared to other methods i.e. Sobel, Prewitt, LoG,Zerocross and Robert's. Canny's edge detection algorithm is more costly in comparing to Sobel, Prewitt and Robert's operator. It seems that although Laplacian does the better for some features (i.e. the fins and Tail), it still suffers from mis-mapping some of the lines.

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