# Comparitive Study of Edge Detection using Multi Structural Elements with different parameters

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**Abstract**— The important step of image processing is edge detection .Conventionally, the method of edge detection only provides the information regarding edges from certain aspects. In this paper, detection of edges is done using multi structural elements with the help of morphological operations and then analyses the results with the help of different parameters. By simulation and comparing the images with the traditional methods i.e. sobel edge detector, canny edge detector,perwitt edge detector, laplician of Gaussian edge detector, the proposed method gives the better result of edge detection.

**Index Terms**— Mathematical Morophology, structuring element, sobel edge detector, canny edge detector,perwitt edge detector, laplician of Gaussian edge detector ,Peak Signal to Noise Ratio,(PSNR),Root Mean Square Error(RMSE) and Correlation Coefficient(CoC).

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## 1 INTRODUCTION

IN Image analysis, the most common method is used for object detection is edge detection techniques.The discontinuities in gray level image is defined by an edge . It can be also say that the difference between background and an object is known as edge. Some classical traditional methods like Sobel, Perwitt ,Canny and Roberts are used for edge detection in image processing.These are based on the image gradient which are calculated by the use of first order derivation.In many cases , these methods are not gives the suitable results of edge detection of image in image processing. Moreover , the hidden objects are also not well detected by using these traditional methods.In this paper, the different multi structural elements are used i.e. 3*3,5*5 and 7*7 with morophological operators so that the edge of image is properly detected and gives the better results of edge detection in image processing.These results can also be compared with different parameters like RMSE ,PSNR and CoC.

## 2 TRADITTIONAL METHOD OF EDGE DETECTION

### 2.1Sobel Edge Detector

In digital images, the approximate partial derivation in gradient is computed by the Sobel operator.In terms of computations, the edge is based on the edge convolving with the integer,separable and small valued filter in vertical and horizontal directions .Mathematically, the approximations of the derivative can be calculated by using two 3*3 kernals which are convolved with the original image.

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### 2.2 Canny Edge Detection

John F.Canny was developed Canny Edge operator in 1986. In this technique, multistage algorithms are used for the edge detection in image .This technique or detector helps in the detection of wide range of edges in image for the better results of edge detecton .The noise can be reduced and suppression can be minimum are the stages of canny algorithms which are used in images.

### 2.3Perwitt Edge Detection

The maximum response which are directly from the kernel are obtained by the use of Perwitt Edge Detector.The perwitt edge operator or detector are used for the measurement of two components i.e. horizontal edge components and vertical edge components.These two components (vertical and horizontal ) are used different kernals.

### 2.4Robert Edge Detection Method

This technique are used to perform 2D spatial gradient measurement of an image.This operator or detector is simple to use and easy to compute.In this technique, mostly used the gray scale image for input and output operations.The points at input image which are having absolute magnitude of the spatial gradient represents the absolute magnitude of pixel value at that point in output image.

### 2.5Laplacian of Gaussian edge Detector

The Marr and Hilder thin was invented Laplacian of Gaussian Edge d\detector in 1980 . This method is used for detection the correct edge places of an image . This method or detector is also used for the testing of wider area around the pixel in an image.Thiss techniques or method are not able to give the suitable result for the edge orientationbecause in this techniques the laplacian filters are used.

## 3 MATHEMATICAL MORPHOLOGY

The theory which is developed from Set Theory is known as mathematical Morophology.This theory was introduced by Matheron[5]. These techniques are used for geologic samples and geometric structures of metallic samples. The image analysis are extended by Serra.Mathematical morophology is a very important theory ,the operations which are used in MMare defined by the basic idea of certain form of structural i.e. arithmetic operator.This arithmetic operator are used to certain measure and extract the corresponding shape of image.It is also used to recognition purposesand achieve the right image analysis.

Main Morphological Operators are as follows:

The basic mathematical morphology has four basic morphological operators: dilation, erosion, opening and closing operator.

*Dilation and Erosion*
The dark details can be eliminate and the bright regions can be used to enhanced by the use of dilation operator.and for the weakens the less bright region of edges to eliminate the detail of by the brightness of the use of operator i.e. erosion,

*Opening and Closing*
Both operations i.e. opening and closing are mutually dual operations .Opening operators are used to break the narrow gap and smoothes the counter of an image .While closing operator eliminates small holes fills gaps in contours and fuse narrow breaks

## 4 DIFFERENT PARAMETERS

***Root Mean Square Error***
An estimator is to quantify the difference between an estimator and the true value of the quantity being estimated is called Mean square error
The mean square error is the squared error averaged over the M × N array.

$$MSE=1/MN \sum_{i=1}^{M}\sum_{j=1}^{N} (f1(i,j)- f2(i,j))2 \quad (1)$$

where f1 is output image and f2 is input image. Its value must be less.

$$RMSE=\sqrt{MSE} \quad (2)$$

***Peak Signal to Noise Ratio***
The rario between the maximum possible power to the power of corrupting noise is know as Peak Signal to Noise Ratio. It affects the fidelity of its representation .It can be also said that it is the logarithmic function of peak value of image and mean square error.

$$PSNR=10 LOG(2552/MSE) \quad (3)$$

where MSE is the mean square error **.** Its value must be high

***Correlation Coefficient***

The correlation coefficient a concept from statistics is a measure of how whl trends in the predicted values follow trends in past actual values. It is a measure of how well the predicted values from a forecast model "fit" with the real-life data. The correlation coefficient is a number between 0 and 1. If there is no relationship between the predicted values and the actual values the correlation coefficient is 0 or very (the predicted values are no better than random numbers). As the strength of the relationship between the predicted values and actual values increases so does the correlation coefficient. A perfect fit gives a coefficient of 1.0. Thus the higher the correlation coefficient the better.

$$\text{Correlation}(r) = N\Sigma XY - (\Sigma X)(\Sigma Y) / \text{Sqrt}([N\Sigma X_2 - (\Sigma X)_2][N\Sigma Y_2 - (\Sigma Y)_2])$$

where
N= Number of pixels of image
X= input image
Y =output image
ΣXY = Sum of the product of input and output image
ΣX = Sum of pixels of input image
ΣY = Sum of pixels of ouput image
$\Sigma X_2$ = Sum of square of pixel of input image
$\Sigma Y_2$ = Sum of square of pixels of output image

## 5 IMPLEMENTATION OF METHOD

1) Intially, take an image .
2) Use the different structuring elements one by one for image which are mentioned below:

**1st method:**

Se1= 1 1 1
0 0 0
1 1 1
**(180 degree)**

Se2=1 0 1
1 0 1
1 0 1
**(90 degree)**

Se3=0 1 1
1 0 1
1 1 0
**(135 degree)**

Se4= 1 1 0
1 0 1
0 1 1
**(45 degree)**

**2nd method:**

Se1=1 1 1 1 1
1 1 1 1 1
0 0 0 0 0
1 1 1 1 1
1 1 1 1 1
**(180 degree)**

Se2= 1 1 0 1 1
1 1 0 1 1
1 1 0 1 1
1 1 0 1 1
1 1 0 1 1
**(90 degree)**

Se3= 0 1 1 1 1
1 0 1 1 1
1 1 0 1 1
1 1 1 0 1
1 1 1 1 0
**(135 degree)**

Se4=1 1 1 10
1 1 1 0 1
1 1 0 1 1
1 0 1 1 1
0 1 1 1 1
**(45 degree)**

**3rd method**

Se1=0 0 0 0 0
0 0 0 0 0
1 1 1 1 1
0 0 0 0 0

Se2=0 0 1 0 0
0 0 1 0 0
0 0 1 0 0
0 0 1 0 0

0 0 0 0 0
**(180 degree)**
Se3= 1 0 0 0 0
0 1 0 0 0
0 0 1 0 0
0 0 01 0
0 0 0 0 1
**(135 degree)**

**4th method:**
Se1=0 0 0 0 0
0 0 0 0 0
1 1 1 1 1
0 0 0 0 0
0 0 0 0 0
**(180 degree)**
Se3= 1 0 0 0 0
0 1 0 0 0
0 0 1 0 0
0 0 01 0
0 0 0 0 1
**(135 degree)**
Se5= 0 1 0 0 0
0 0 0 0 0
0 0 1 0 0
0 0 0 0 0
0 0 0 0 1
**(112.5 degree)**
Se7= 0 0 0 1 0
0 0 0 0 0
0 0 1 0 0
0 0 0 0 0
0 1 0 0 0
**(67.5 degree)**

**5th method:**
Se1=1 1 1 1 1
1 1 1 1 1
0 0 0 0 0
1 1 1 1 1
1 1 1 1 1
**(180 degree)**
Se3 = 0 1 1 1 1
1 0 1 1 1
1 1 0 1 1
1 1 1 0 1
1 1 1 1 0
**(135 degree)**
Se5= 1 0 1 1 1
1 1 1 1 1
1 1 0 1 1
1 1 1 1 1
1 1 1 0 1
**(112.5 degree)**
Se7=1 1 1 0 1
1 1 1 1 1
1 1 0 1 1
1 1 1 1 1
1 0 1 1 1
**(67.5 degree)**

0 0 1 0 0
**(90 degree)**
Se4=0 0 0 0 1
0 0 0 1 0
0 0 1 0 0
0 1 0 0 0
1 0 0 0 0
**(45 degree)**

Se2=0 0 1 0 0
0 0 1 0 0
0 0 1 0 0
0 0 1 0 0
0 0 1 0 0
**(90 degree)**
Se4=0 0 0 0 1
0 0 0 1 0
0 0 1 0 0
0 1 0 0 0
1 0 0 0 0
**(45 degree)**
Se6== 0 0 0 0 0
0 0 0 0 1
0 0 1 0 0
1 0 0 0 0
0 0 0 0 0
**(22.5 degree)**
Se8=0 0 0 0 0
1 0 0 0 0
0 0 1 0 0
0 0 0 0 1
0 0 0 0 0
**(157.5 degree)**

Se2=1 1 0 1 1
1 1 0 1 1
1 1 0 1 1
1 1 0 1 1
1 1 0 1 1
**(90 degree)**
Se4=1 1 1 1 0
1 1 1 0 1
1 1 0 1 1
1 0 1 1 1
0 1 1 1 1
**(45 degree)**
Se6= 1 1 1 1 1
1 1 1 1 0
1 1 0 1 1
0 1 1 1 1
1 1 1 1 1
**(22.5 degree)**
Se8=1 1 1 1 1
0 1 1 1 1
1 1 0 1 1
1 1 1 1 0
1 1 1 1 1
**(157.5 degree)**

**6th method**
Se1=1 1 1 1 1 1 1
1 1 1 1 1 1 1
1 1 1 1 1 1 1
0 0 0 0 0 0 0
1 1 1 1 1 1 1
1 1 1 1 1 1 1
1 1 1 1 1 1 1
**(180 degree)**
Se3=0 1 1 1 1 1 1
1 0 1 1 1 1 1
1 1 0 1 1 1 1
1 1 1 0 1 1 1
1 1 1 1 0 1 1
1 1 1 1 1 0 1
1 1 1 1 1 1 0
**(135 degree)**
**7th method**
Se1=0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
1 1 1 1 1 1 1
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
**(180 degree)**
se3=0 0 0 0 0 0 1
0 0 0 0 0 1 0
0 0 0 0 1 0 0
0 0 0 1 0 0 0
0 0 1 0 0 0 0
0 1 0 0 0 0 0
1 0 0 0 0 0 0
**(45 degree)**

**8th method**
Se1=0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
1 1 1 1 1 1 1
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
**(180 degree)**
Se3=1 0 0 0 0 0 0
0 1 0 0 0 0 0
0 0 1 0 0 0 0
0 0 0 1 0 0 0
0 0 0 0 1 0 0
0 0 0 0 0 1 0
0 0 0 0 0 0 1
**(135 degree)**
Se5=0 0 0 0 0 0 0
0 0 1 0 0 0 0
0 0 0 0 0 0 0
0 0 0 1 0 0 0
0 0 0 0 0 0 0
0 0 0 0 1 0 0
0 0 0 0 0 0 0
**(112.5 degree)**

Se2=1 1 1 0 1 1 1
1 1 1 0 1 1 1
1 1 1 0 1 1 1
1 1 1 0 1 1 1
1 1 1 0 1 1 1
1 1 1 0 1 1 1
1 1 1 0 1 1 1
**(90 degree)**
Se4=1 1 1 1 1 1 0
1 1 1 1 1 0 1
1 1 1 1 0 1 1
1 1 1 0 1 1 1
1 1 0 1 1 1 1
1 0 1 1 1 1 1
0 1 1 1 1 1 1
**(45 degree)**

se2=0 0 0 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 0 0 0
**(90 degree )**
se4= 1 0 0 0 0 0 0
0 1 0 0 0 0 0
0 0 1 0 0 0 0
0 0 0 1 0 0 0
0 0 0 0 1 0 0
0 0 0 0 0 1 0
0 0 0 0 0 0 1
**(135 degree)**

se2= 0 0 0 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 0 0 0
**(90 degree)**
se4= 0 0 0 0 0 0 1
0 0 0 0 0 1 0
0 0 0 0 1 0 0
0 0 0 10 0 0
0 0 1 0 0 0 0
0 1 0 0 0 0 0
1 0 0 0 0 0 0
**(45 degree)**
se6= 0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 1 0
0 0 0 1 0 0 0
0 1 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
**(22.5 degree)**

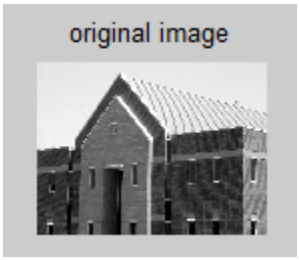
Se7=0 0 0 0 0 0 0
0 0 0 0 1 0 0
0 0 0 0 0 0 0
0 0 0 1 0 0 0
0 0 0 0 0 0 0
0 0 1 0 0 0 0
0 0 0 00 0 0
**(67.5 degree)**

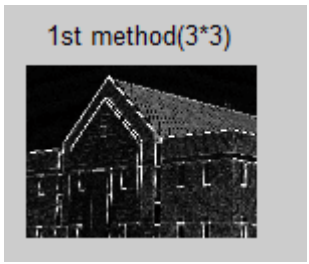
se8= 0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 1 0 0 0 0 0
0 0 0 1 0 0 0
0 0 0 0 0 1 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
**(157.5 degree)**

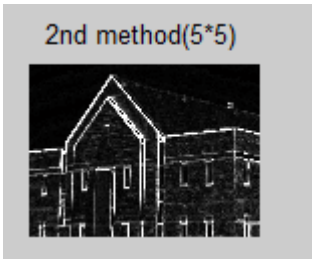
3) All the structuring element, is implemented one by one
4) After that, use morphological operators i.e. dilation and erosion for better results
5) Then take the difference between dilated and eroded image (in all directions) for the detection of edge
6) Then further take the average of all the resultant images i.e. in case of 1st method Se1 + Se2 +Se3 +Se4 / 4
7)Again for better results, find the edges for all the methods of an image.
6) if there is any line spacing between the image edges., then again use the morphological operator i.e. dilation
7) According the need, Increase the intensity of the image
8) Then results is to be displayed
9) At last, compare the result with the traditional techniques of edge detection.
10) Again compare these results according to different parameters

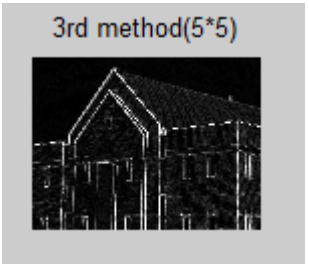
## 5. RESULTS

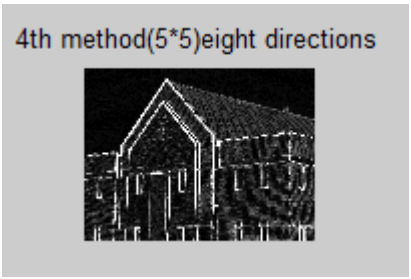
**First Image- Building**

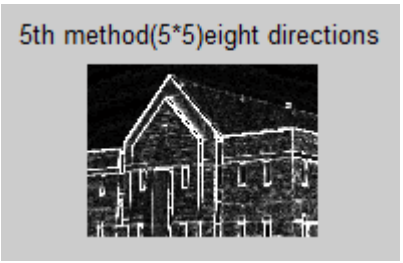


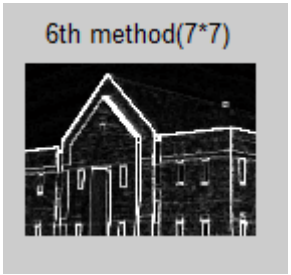



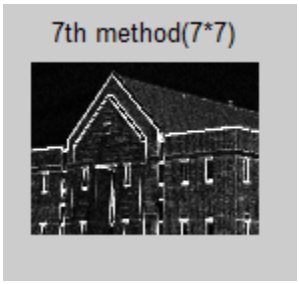



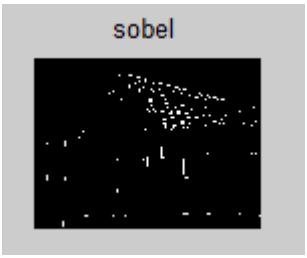



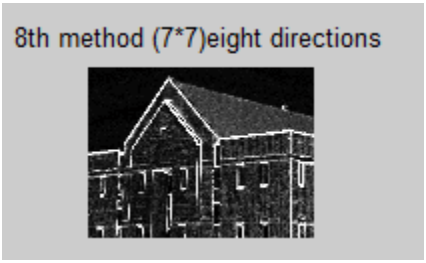



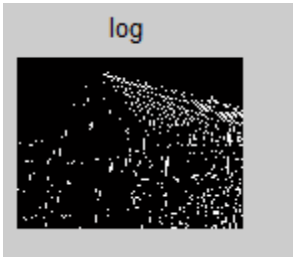



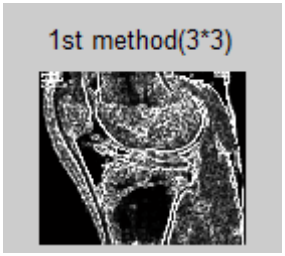


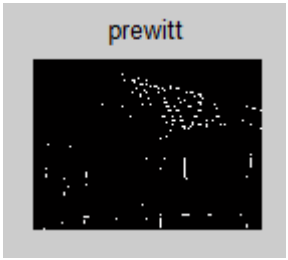



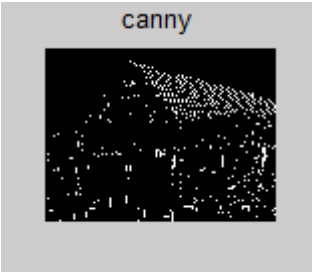

**Seccond-Medical Image**

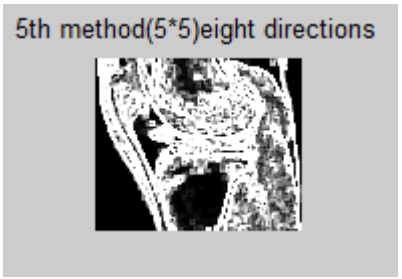



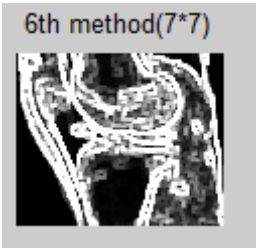


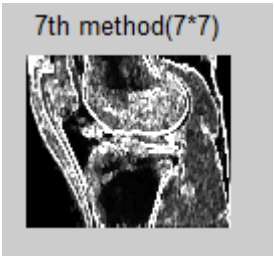


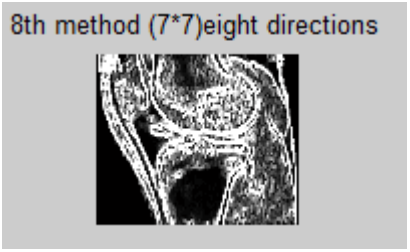


4th method(5*5)eight directions


5th method(5*5)eight directions

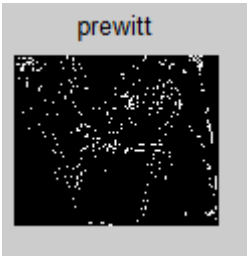

6th method(7*7)


7th method(7*7)


8th method (7*7)eight directions


sobel


log


prewitt

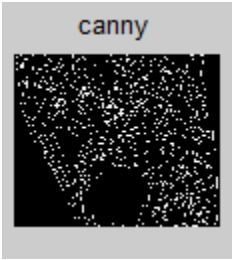

canny

**Table 5.1 Comparison of different edge detection method of building image**

| S.NO. | Method of implementation | MSE | RMSE | PSN | PSNR | CoC |
|---|---|---|---|---|---|---|
| 1 | 1st method | 1.8203e+004 | 134.9200 | 6.8861e+003 | 38.3797 | 0.0174 |
| 2 | 2nd method | 2.0620e+004 | 134.9200 | 6.8861e+003 | 38.3797 | -0.1282 |
| 3 | 3rd method | 2.0494e+004 | 143.1571 | 6.4899e+003 | 38.1224 | -0.0468 |
| 4 | 4th method | 1.9354e+004 | 139.1192 | 6.6783e+003 | 38.2466 | -0.0938 |
| 5 | 5th method | 1.9956e+004 | 141.2659 | 6.5768e+003 | 38.1801 | -0.2301 |
| 6 | 6th method | 2.0683e+004 | 143.8160 | 6.4602e+003 | 38.1024 | -0.1513 |
| 7 | 7th method | 1.9617e+004 | 140.0607 | 6.6334e+003 | 38.2173 | -0.2574 |
| 8 | 8th method | 1.7860e+004 | 133.6398 | 6.9521e+003 | 38.4212 | -0.0902 |
| 9 | 9th method(sobel) | 2.4236e+004 | 155.6782 | 5.9679e+003 | 37.7582 | 0.0608 |
| 10 | 10th method(canny) | 7.1264e+003 | 84.4179 | 1.6135e+003 | 32.0776 | 0.0661 |
| 11 | 11th method(prewitt) | 7.1282e+003 | 84.4285 | 1.6133e+003 | 32.0771 | 0.1885 |
| 12 | 12th method(log) | 7.1252e+003 | 84.4109 | 1.6136e+003 | 32.0780 | 0.1411 |

**Table 5.2 Comparison of different edge detection method of medical image**

| S.NO. | Method of implementation | MSE | RMSE | PSN | PSNR | CoC |
|---|---|---|---|---|---|---|
| 1 | 1st method | 1.6744e+004 | 129.3997 | 1.3853e+003 | 31.4154 | 0.1508 |
| 2 | 2nd method | 1.7847e+004 | 129.3997 | 1.3853e+003 | 31.4154 | 0.0887 |
| 3 | 3rd method | 1.8290e+004 | 135.2409 | 1.3255e+003 | 31.2237 | 0.1319 |
| 4 | 4th method | 1.6785e+004 | 129.5582 | 1.3836e+003 | 31.4101 | 0.1579 |
| 5 | 5th method | 1.7893e+004 | 133.7660 | 1.3401e+003 | 31.2713 | 0.1207 |
| 6 | 6th method | 1.9029e+004 | 137.9446 | 1.2995e+003 | 31.1377 | 0.0409 |
| 7 | 7th method | 2.1621e+004 | 147.0419 | 1.2191e+003 | 30.8603 | -0.1744 |
| 8 | 8th method | 1.6316e+004 | 127.7347 | 1.4033e+003 | 31.4716 | 0.1728 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | 9th method(sobel) | 2.8601e+004 | 169.1192 | 1.0599e+003 | 30.2528 | -0.0057 |
| 10 | 10th method(canny) | 2.8586e+004 | 169.0727 | 1.0602e+003 | 30.2540 | 0.0365 |
| 11 | 11th method(prewitt) | 2.8602e+004 | 169.1211 | 1.0599e+003 | 30.2528 | -0.0093 |
| 12 | 12th method(log) | 2.8575e+004 | 169.0400 | 1.0604e+003 | 30.2548 | 0.1062 |

## Conclusion

It is concluded that detection of edge using mathematical morphology is more efficient than traditional methods .The structuring elements are used in this paper are 3*3, 5*5 and 7*7 with mathematical morphology operator for the better results in edge detection of an image .The main benefits of using mathematical morphology are interpretation, direct geometric, efficiency in hardware implementation and its simplicity .When the result is obtained , then compare the different parameters of image for better results of edge detection among all the methods According to the comparison table ,the minimum RMSE ,maximum PSNR value is to be obtained by using 8th methods among all the methods. But CoC value is not so good which can be improved in future research

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