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Edge Detection with Theory and Soft Reviews

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Abstract - image processing idea is a manipulation of pixel information for better visualization or hiding information has many ways to execute in computer vision. Edge detection is effective method in the image processing and it is the basic step for image segmentation. Edges are detected for the purpose of creating a contour or boundary between an object and the background or various parts of the particular image. To detect the edge includes different mathematical operations that are used with the motive of finding very sharp discontinuities in a digital image. Edge detection is the basic concept for segmentation used in machine learning, computer vision, and image processing, and also for face recognition, identification of thumb, iris recognisation, and especially satellite images. This paper presents to give a review of the edge detection process, theoretically, practically by using MAT Lab codes in a proper way to make understand very quickly with basic, advanced methods to fill the gaps exist.

Key Words: **Edge, dot, line, Edge Detection, segmentation, Sobel, Prewitt, LoG, Canny etc**.

1. INTRODUCTION

Manipulation of pixel information for better vision or hiding the information called image processing has many procedures or techniques to execute the aim. Among many image segmentation is one to identify the boundaries or edges.

The boundary/edge detection has basically four steps to complete the process. The smoothing or filtering is the first step is used to remove or suppress the noise as much as possible. The noises are of many kinds. Here considered general kind among all types of noises which are Sault & pepper, impulsive, guasian noises. Many detectors are available which works very good for the quality high digital images, butt which is not well enough for these kind noisy images and these are unable to detect the edges for various reasons. Hence the second step is filtering follows the sharpening. This process concerned with quality improvement of the image process mainly focuses on the changes in local intensity of the Pixels. The main point is the enhancement has to produce a more suitable image than the noisy original for a specific application. Hence Third step is the detection process it has to work on the pixels for which it is to be considered as noise and which is to be retained. It indicates that all the points are possible to become the edge points are extracted in this step. It is the important step in the processing of an image in case of the edge detection for getting a clear data of the object boundaries. The final step is *localization* that deals with the exact location and orientation of the edges where the necessity of localization being the edge thinning and linking. Thinning is a morphological operation that is used to remove selected foreground pixels from binary images and is related to the hit-and-miss transform. Linking is the way of grouping the edge points to form edges by considering each point's relationship to neighboring edge points.

Now we can also say Sub dividing the image in to equal parts to interact information for identifying the edges called segmentation. Level of sub division can vary based on the application. It's not easy, most difficult task, very much Useful for autonomous applications and much more like cancer Identification of humans. Identification of roads of satellite images, boundaries of water channels on the earth, boundaries of a satellite images.

Classication of image segmentation is of many types which are shown below table1.

Table -1.0: Classification of segmentations

S.No	Segmentation Classification based on	Types of segmentation
1	Locality	i)Local segmentation ii)Global segmentation
2	region	i) region approach ii) boundary approach iii) edge approach,

3	thresholding	i) Adaptive thresholding ii) Global thresholding iii) Histogram
4	continuity	i) discontinuities ii) Similarities.

Among these classifications here considered continuity based classification shown below fig-1.

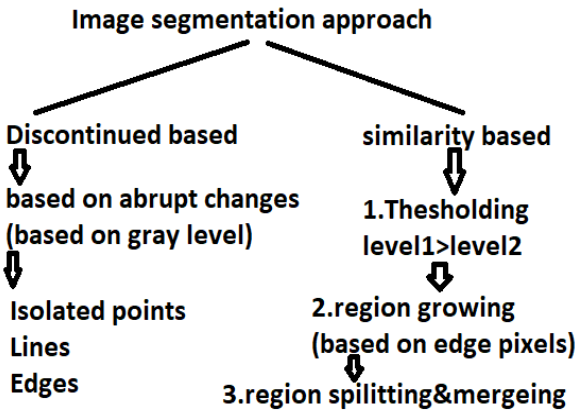


Fig-1.1: segmentation classification based on continuity approach.

Discontinue approach means abrupt changes in the gray level or missing data between the two points cannot identify the point or line or edge is called discontinued approach.similariy based approach means cannot identify the boarder level between any two points or lines. Point can identify if gray level more than the threshold value. group of points gives line having same class of gray levels and line can be identify similar points can differ with another similar pixels and edge can form by adding similar lines and also edge can form by finding the difference between object and background. They are two types of edges which are ideal, noisy edges.

The ideal edges don't contain any sort of noise, which are of four types. One among are step edge, the intensity changes suddenly from a particular value on one side to different value on the side and second is ramp edges are the edge changes continuous over a finite distance. Third is line edges, the intensity value changes abruptly and then returns back to the starting point within a short distance and forth is roof edges are the one in which the changes occur for a finite distance but is not abrupt. Ideal edges are shown below fig 2.and the noisy edges, as name says, those are the disturbances in the ideal edges and distorts original information as shown in fig 3. Hence in edge detection process the first step is the removal of this kind of noise.

The edge detection methods can be classified in to three types which are Gradient methods, Zero crossing methods, and optimal edge detection methods.

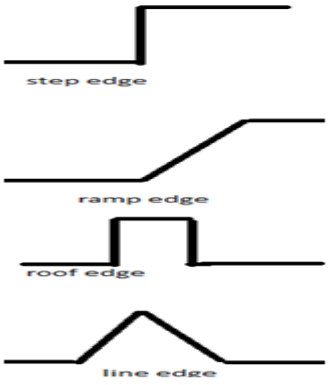


Fig 1.2: ideal edges

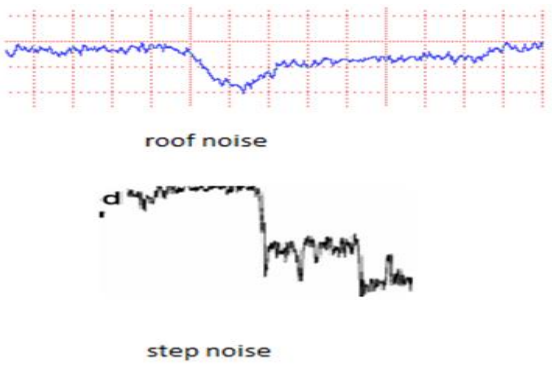


fig 1.3: noisy edges

The gradient methods are the first order derivatives which include Sobel, Roberts, and Prewitt operators. Zero crossing methods are the second order derivatives that use the approaches Laplacian of Gaussian and Difference of Gaussian, and the optimal edge detection methods are the canny edge detector.

III. LITERATURE SURVEY

Himanshu Rana. [1] This paper concluded the study of edge detection process and a comparison between various edge detection methods of techniques. The gradient array can further be reduced using the hysteresis, where hysteresis mainly uses two different threshold values. If the magnitude of a pixel is below the first threshold, the value is marked as zero and if the magnitude is above second threshold, then it is marked as an edge.

Firas A. Jassim. [2] The author has proposed a method that combines median filter and simple standard deviation both in order to make edge detection process more superior in image processing. In this method, initially noise is removed from the gray scale image using a median filter in order to make the image smooth and remove the noisy pixels. After this, simple statistical standard deviation could be computed for specified window size and then if the value of standard deviation inside the window size is greater than the given threshold, the upper left pixel in the window represents an edge. The proposed method has been tested with various binary images. The results have been compared with the Sobel and Canny's edge detector, and the results give a clear significance that the proposed method gives satisfying results for various gray level digital images. The proposed algorithm gives even better.

Poonam Dhankhar, Neha Sahu.[3] the author has presented the overview of edge detection techniques in accordance with image segmentation. The edge detection can be referred to as a part of image segmentation that states the presence of line or edge in a digital image. The main motive of detecting edges is to minimize the data processing amount by simplifying the image data. The segmentation basically is a process of differentiating the image objects from the background. The image can be segmented mainly using four techniques: threshold techniques, edge detection techniques, region-based techniques, and connectivity preserving relaxation methods. Among all these methods the one most commonly and widely used is the "edge detection" that results in successful segmentation of an image. The segmentation involves a series of steps as initially an input image is given whose gray scale image is taken; further the noise reduction is done followed by the masking process; after that non maxima suppression is carried and finally the edges are detected. Detection of edges also has various techniques to carry out this work such as Sobel, Prewitt, Roberts, Canny and Laplacian of Gaussian (LoG). All these techniques can be used for detecting edges successfully but the most accurate and clear results are given by the canny method.

Sonam Saluja, Aradhana Kumari Singh, Sonu Agrawal.[3] The author explains the comparison of different edge detection methods, where all different approaches can be used for the purpose of edge detection according to the need of segmentation. Author concluded the gradient based approaches are most sensitive towards noise and the canny operator is comparatively less sensitive towards the noise.

Jaspreet Kaur, Anand Sharma.[4] The author states that the edge detection process gives a significant information of an image while reducing the amount of data and unwanted information without disturbing and manipulating the originality of that image. Various edge detection techniques are discussed in this paper, as they can be used in different conditions. The sobel operator has simple operation but high signal to noise ratio whereas in case of Robert's cross edge operators detects edges and their orientation effectively but is inaccurate and more sensitive to noise. Laplacian of Gaussian finds right places of edges and area around pixel but it does not give any directional information about the edge whereas the canny edge detector gives more efficient texture based images and have good signal to noise ratio but it is time consuming and have greater computationally complexity.

Mamta Juneja, Parvinder Singh Sandhu.[5] The paper basically discusses the comparison between various approaches used for the edge detection with the help of various experimental results, statistical evaluation and performance analysis. Author describes edge detection as the means of detecting an object or various objects in a digital image where the separation of image objects from its background is an important task in the digital image processing. . Generally, an edge can be defined as a means of creating differentiation between two separate regions in an image with the help of changing image amplitude attributes like different tristimulus values and constant luminance values in an image. The paper mainly describes the behavioural analysis of the zero crossing operators and gradient operator in accordance with their capability of detecting the edges in an image. While doing all this no specifications such as texture or shape are provided, the methods or operators are applied to the complete image. The results shown in the paper gives clearly idea that Sobel, Prewitt and Roberts results to low quality edge maps comparative to others. The Laplacian of Gaussian and Canny produces better as well as clear representations of the image, where the canny method has better capacity to detect both strong and weak edges being even superior to the Laplacian of Gaussian.

Dr.S.Vijayarani, Mrs.M.Vinupriya.[6] This research paper presents the process of edge detection as a way of catching sharp discontinuities in a digital image. Edge detection plays a crucial role in analyzing images and acts as a key for solving various complex problems. The paper has also introduced the concept of face recognition that is basically stated as the process of identifying and verifying a person from a digital image automatically. Edge detection plays a key role in the face recognition. There are several edge detection mechanisms that have been developed in past few years, though no particular algorithm is there to suit all types of applications. In this particular paper the author has compared mainly the results of sobel and canny edge detector, where the results are calculated and compared in the form of accuracy and time. The results show that the sobel edge detector has the accuracy 75% whereas canny edge detector has the accuracy 87.5% and the time consumed by sobel edge detector was 34.9(seconds) whereas the time consumed by the canny edge detector was 34.7(seconds). Finally according to the conducted tests of comparisons the canny edge detector was found to be more efficient and reliable.

Muthukrishnan.R and M.Radha. [7] The effective visualization of image content is considered to be as a matter of great importance in computer vision and more specifically in image processing. For efficient interpretation of image, segmentation is a crucial step that is supposed to make the object and the background separate. The image segmentation basically assorts an image into constituent objects and makes them separate from background for the purpose of properly identifying the image content. Edge detection is the profound tool for segmentation. Edge detection refers to the process of sorting out and determining sharp discontinuities in an image where the discontinuities are the sudden changes in the concentration of pixels that makes the boundaries of objects distinct in a picture. Several popular edge detection techniques are discussed throughout the paper specifying their usage in accordance with different conditional requirements. Through the experimental results it is observed that Marr-Hildreth, Laplacian of Gaussian and Canny edge detectors virtually produces the similar edge maps but the results produced by canny better when compared to a number of selected images as different algorithms work better according to different conditions.

S.Lakshmi and Dr.V.Sankaranarayanan. [8] The paper gives a brief introduction to the different techniques of edge detection used for the purpose of segmentation computing. An edge is the basic feature of an image where edge detection is a process of distinguishing and locating sharp discontinuities in the image. The segmentation mainly is a way of separating an image into different regions or its component objects and this is a decisive step in the interpretation of a particular image. The image segmentation and extraction process has to deal with a lot of challenging things like the noise volume having a significant impact on shaping the edge, changes in lighting conditions, dynamic nature of the background, detection of a false edge, shifting in the actual position of the detected edge and the luminance features of the image. Edge detection is classified in three major categories. First are the gradient methods that include the Robert, Sobel and Prewitt edge detection techniques. Second are the zero crossing referred to as the second order derivatives using two basic approaches, Laplacian of Gaussian and Difference of Gaussian. And the third one is optimal edge detection having canny edge detection as its pillar technique. Various approaches for computing segmentation are also described including fuzzy based approach, wavelet approach, genetic algorithms, neural networks and morphology. The purpose of this paper basically is to present the theoretical study of various edge detection techniques that has proved to be of great use with varying requirements, along with the different computing approaches of segmentation.

Saloni Lamba, Paru Raj[9].this paper a review of Edge Detection and its Techniques in Digital Image Processing authors has given quick review of the edge detection process and the edge detection techniques. After studying concluded that, need to write the clear difference between various edge detectors theoretically, practically to give the clarity about edge detection techniques.

III. PROPOSED METHOD

To visualize the various differences between edges, need to see the various windows shown below. Here considered only 3x3 templates only.

Two Dimensional Masks:

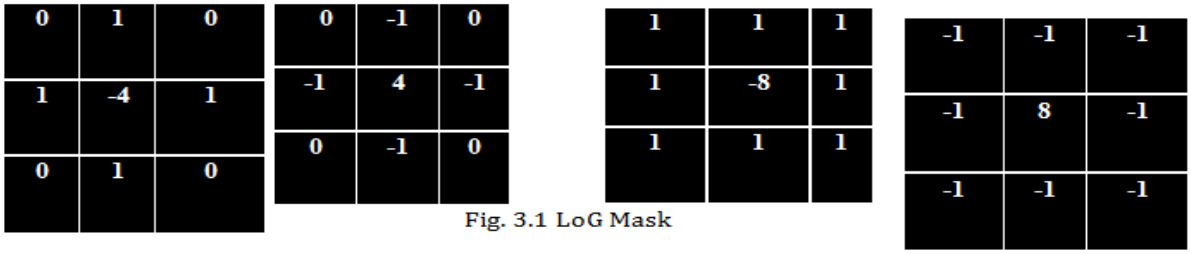


Fig. 3.1 LoG Mask

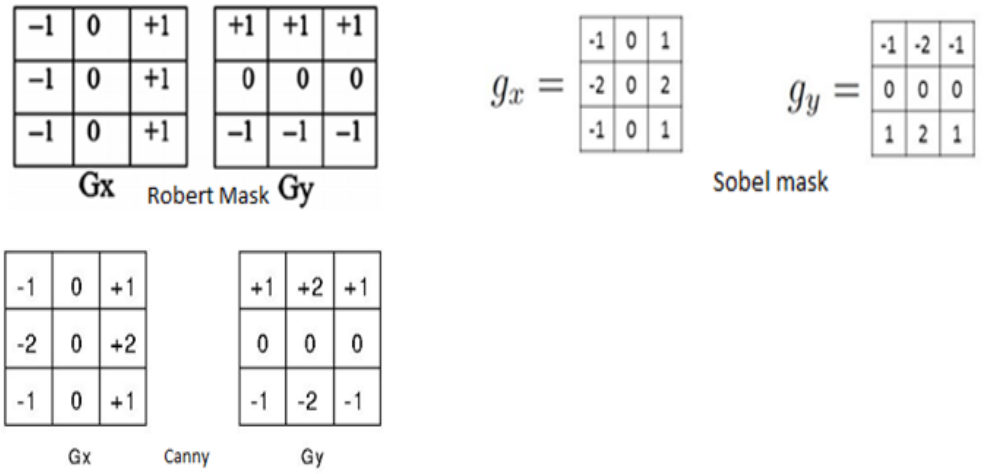


Fig 3.2 Robert, sobel, canny 3x3 Masks

The proposed Mat lab code proposed one will give full clarity about every edge detection by filling every object with color and its MAT Code shown below.

IV.1 MAT LAB CODE FOR VARIOUS EDGES

%% Edge detection for various operator windows

%% 1). Sobel ... 2). Prewitt ... 3). Log ... 4). Canny.

% different edges of a given image

Clear all;

Close all;

clc;

z=imread ('C:\Users\user\Desktop\stefeen.jpg');

a=rgb2gray (z);

a1=255-a;

a2=imnoise (a, 'salt & pepper', 0.2);

b=edge (a,'roberts');

c=edge (a,'sobel');

d=edge (a,'prewitt');

e=edge (a,'log');

f=edge (a, 'canny');

g=histeq(a);

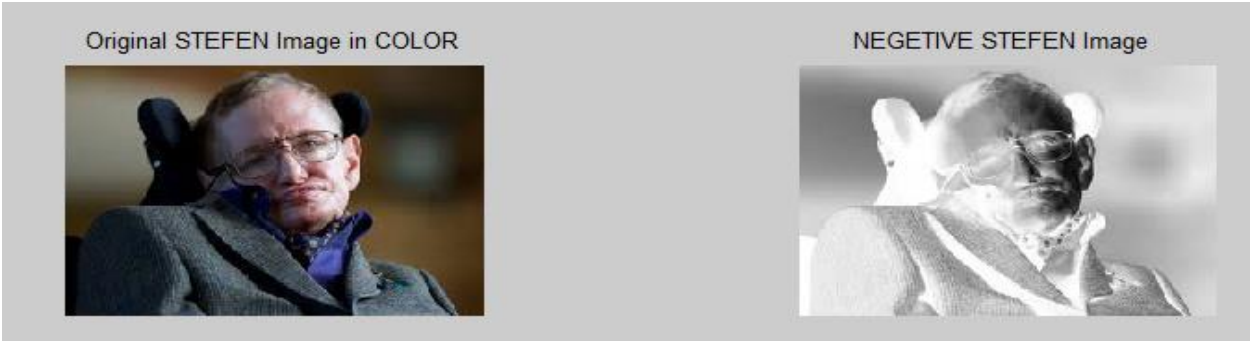
h=watershed (a2,1);

subplot (4,4,1), imshow(z), title('Original STEFEN Image in COLOR')

subplot (4,4,2), imshow(a1), title('NEGETIVE STEFEN Image ')

```
subplot (4,4,3), imshow(a), title(' STEFEN IMAGE IN GRAY')
subplot (4,4,4), imshow(a2), title(' STEFEN IMAGE IN GRAY noise')
subplot (4,4,5), imhist(g), title(' STEFEN GRAY IMAGE WITH HISTOGRAM ')
subplot (4,4,6), imshow(b), title(' STEFEN IMAGE WITH ROBERTS ')
subplot (4,4,7), imshow(c), title(' STEFEN IMAGE WITH SOBEL ')
subplot (4,4,8), imshow(d), title(' STEFEN IMAGE WITH PREWITT  ')
subplot(4,4,9), imshow(e), title(' STEFEN IMAGE WITH LOG ')
subplot (4,4,10), imshow(f), title(' STEFEN IMAGE WITH CANNY ')
subplot (4,4,11), imshow(h), title('watershed of gray STEFEN Image')
```

%% result images from MAT LAB



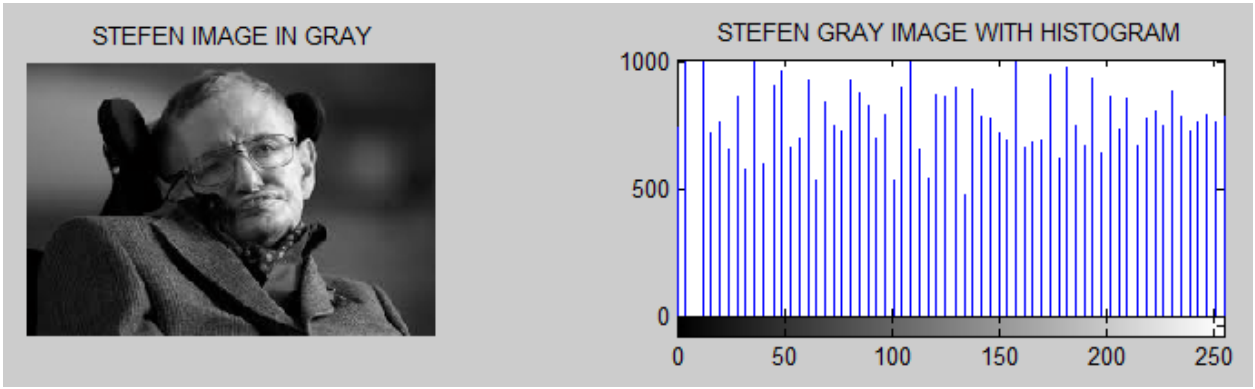
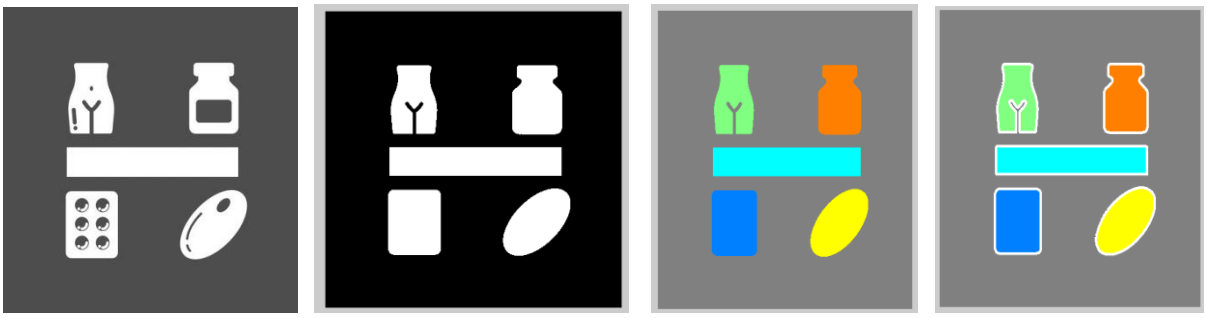


Fig: 4.1.1 result image with various operators

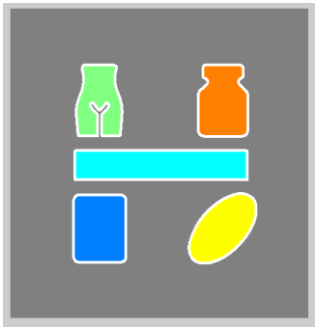
IV.2 TO IDENTIFY THE DIFFERENT SHAPE OBJECTS BY FILLING WITH COLOR

```
%% READ THE DIFFERNET SHAPED OBJECTS IMAGE
C2G = imread ('C:\Users\user\Desktop\pill_icon.jpg');
imshow (C2G)
% Threshold the Image
T = rgb2gray (C2G);
baw = im2bw(T);
imshow(baw)
% Remove the Noise
baw = bwareaopen(baw,30);
```

```
se = strel('disk',2);
baw = imclose(baw,se);
baw = imfill(baw,'holes');
imshow (baw)
% Find the Boundaries
 [B,L] = bwboundaries (bw,'noholes');
imshow (label2rgb (L, @jet, [.5 .5 .5]))
hold on
for k = 1:length(B)
  boundary = B{k};
  plot (boundary(:,2), boundary(:,1), 'w', 'LineWidth', 3)
end
%Determine which Objects are Round
metric = 4*pi*area/perimeter^2.
Stats = region props (L,'Area','Centroid');
threshold = 0.95;
for k = 1:length(B)
  boundary = B{k};
 delta_sq = diff(boundary).^2;
 perimeter = sum(sqrt(sum(delta_sq,2)));
 area = stats(k).Area;
  metric = 4*pi*area/perimeter^2;
  metric_string = sprintf('%2.2f',metric);
  if metric > threshold
    centroid = stats(k).Centroid;
    plot(centroid(1),centroid(2),'ko');
   end
 text(boundary(1,2)-35,boundary(1,1)+12,metric_string,'Color','b', 'FontSize',12,'FontWeight','bold');
 end
```



Original 'pill' image	removed noise from original	color with objects	edge detected objects



Edge shaped after

Fig-2.1: images from actual to clear edge identification

V. CONCLUSIONS

From results observation, it's concluded that, Robert edges are not clear. Canny is the combination of log & original images. Canny detector has given very clear edges, canny edge detection is a best technique to extract useful structural information from different vision objects and reduce the amount of data to be processed. Canny has found that the requirements for the application of edge detection on diverse vision systems are relatively similar. Thus, an edge detection solution to address these requirements can be implemented in a wide range of situations. Detection of edge with low error rate, which means that the detection should accurately catch as many edges shown in the image as possible

1. The edge point detected from the operator should accurately localize on the center of the edge.
2. A given edge in the image should only be marked once, and where possible, image noise should not create false edges.

Sobel edges are clear than Robert operator.prewitt, log will give double edges.

Still they are many problems to identify the edges in clear way. Hence to fill the gap, here proposed another method i.e filling the objects with different colors by mat lab code which is very much useful to identify the objects and edges will give much more clarity in vision.

VI. FUTURE SCOPE.

It's suggested to scholars who are interested in edge detection/segmentation based on nature of pixel growth, can easily identify the image of a human in various stages with the good command in neural networks and image processing.

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IX. BIOGRAPHY

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