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Comparative Performance Study and Analysis on Different Edge based Image Segmentation Techniques of Thermal Images

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***Abstract*—**In this work, authors have been tried to analyse the edge-based approach for thermal image segmentation. Here, author's have used different thermal images for the edge based analysis of image segmentation. Author's have given studies regarding different edge operators like Prewitt, Sobel, LoG, and Canny edge detection operators for segmentation purposes and analyze their performance. This paper compares each of these operators by the manner of checking Peak signal to Noise Ratio (PSNR) and Mean Squared Error (MSE) of resultant image. It evaluates the performance of each algorithm using image quality analysis. This paper presents a comparative analysis of different edge based thermal image segmentation techniques.

Keywords*-Edge, Image Segmentation, PSNR, MSE, SSIM, Entropy, Sobel, Canny, Log, Prewitt*.

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I. INTRODUCTION*(HEADING 1)*

Image segmentation is the process of separating an image into a number of segments. The goal of Segmentation is to facilitating and/or changing the representation of an image into a more meaningful and simple to evaluate the illustration. Image segmentation process is generally used for locating the objects and perimeters of images. In that image segmentation process, a label is allotted to every pixel in an image so that the same label pixels, share the certain visual nature or characteristics of the image. Image segmentation results in a set of sections that conjointly cover the full image.Image Edge detection significantly reducesthe amount of data and filters out useless information, whilepreserving the important structural properties in an image . These detectors are like as filters which are used to filter out the useless information and stores the useful information in the image.[10] Edge detection is used forimage segmentation based on huge amount of changes in the intensity value. Edgeis the boundary between two regions, with relatively distinct gray-levelproperties.Edge detection is a terminology is related to image processing and computer vision , mainly related in the field of feature detection and feature extraction that plays major role in segmentation of an image for identification of objects effectively.[9,10]

II. IMAGE SEGMENTATION

Image Segmentation is the technique of partitioning a digital image into different regions or sets of pixels. Essentially, in image partitions are different objects which have the same texture or colour. The image segmentation results are a set of regions that cover the entire image togetherand a set of contours extracted from the image. All of the pixels in a region are similar withrespect to some characteristics such as colour, intensity, or texture. Adjacent regions areconsiderably different with respect to the same individuality. The different approaches are (i)by finding boundaries between regions based on discontinuities in intensity levels, (ii)thresholds based on the distribution of pixel properties, such as intensity values, and (iii) basedon finding the regions directly.[13] So the choice of image segmentation technique is depends onthe type of problem being considered. Segmentation Methods based on finding the regions directly find for abrupt changes inthe intensity value. These techniques are considered as Edge or Boundary based techniques. Edge detection techniques are basically used for finding discontinuities in gray level images. To detectconsequential discontinuities in the gray level image is the important common approach in edgedetection. Image segmentation basically use for detecting discontinuities are boundary basedmethods.[13]

III. SEGMENTATION USING EDGE DETECTION

We have used different edge based algorithm for our experimental purposes. These are given below:-

A. Sobel edge detector

In Sobel edge detector, the task of edge detection is fulfilled by performing a 2D spatial gradient convolution operation on an image. The sobel edge detector computes the gradient by using the discrete differences between rows and columns of a 3X3 neighborhood. The sobel operator is based on convolving the image with a small, separable, and integer valued filter. In below a sobel edge detection mask is given which is used to compute the gradient in the x (vertical) and y (horizontal) directions. This is given in below:-

-1	0	+1
-2	0	+2
-1	0	+1

+1	+2	+1
0	0	0
-1	-2	-1

Figure1: Masks for the Sobel gradient edge detector

B. Prewitt's operator

The Prewitt's edge detector also uses the three by three convolution mask, which is little different from that Sobel edge detector. Prewitt edge detection masks are the one of the oldest and best understandable techniques of detecting edges in images. This detector always uses the following mask to approximate digitally the first derivatives Gx and Gy. The following is a prewitt mask used to compute the gradient in the x (vertical) and y (horizontal) directions. This is given in figure below:-

1	1	1
0	0	0
-1	-1	-1

-1	0	1
-1	0	1
-1	0	1

Figure2: Masks for the Prewitt gradient edge detector

C. Laplacian of Gaussian(LOG)

It was invented by Marr and Hildreth (1980). The Gaussian filtering technique is combined with Laplacian for breaking down the image where the intensity varies to detect the edges effectively. It uses linear interpolation for determining the sub pixel area of the edge. The digital implementation of the Laplacian function is made using the mask given in below figure. The Laplacian is a 2-D isotropic measurement of the 2nd spatial derivative of an image. The Laplacian of an image indicates regions of quick intensity change and is therefore used for edge detection. The Laplacian is often applied to an image that has first been smoothed with something approximating a Gaussian Smoothing filter in order to reduce its sensitivity to noise. The operator normally takes a single gray level image as input and produces gray level image as output image. The Laplacian *L (x, y)* of an image with pixel intensity values *I (x, y)* is given by:

D. Canny's edge detection algorithm

The Canny edge detector have been considered as an optimized edge detection problem, which satisfies all of the three performance criteria. The steps for algorithm are as follows:-

i) The initial step of this detector is to filtering out noise in the image by using a Gaussian smoothing filter.
ii) The second step in this edge detector is to locate the edge strength in the smoothed image by computing the image gradient, which helps to indicate where the actual edge is located.
iii) In final step it is required to thin down the edges by tracking along the edge in the direction of edge and set any pixel that is not at the maximum value to be 0, which is called non-maximum suppression. And finally edges are detected and link using pixel connectivity and double threshold that is, if the edge. If the magnitude is below the low threshold, it is considered as a non-edge. This edge detector has the advantage that maximum edges get detected by using this edge detector.

IV. PROPOSED WORK

Here the proposed technique shows how image quality changes according to different edge based segmentation methods. This is given below:-

Input : Color Thermal Image
Output : Edge Based Segmented Image

Step1. Take RGB color Thermal image and read the image.
Step2. Convert RGB to gray scale image.
Step3. Apply different edge detection operators like Sobel, Prewitt, Log, Canny for edge based image segmentation.
Step4. After applying this method we get edge based segmented image.
Step5. Compare Thermal Image and Edge Based Segmented Image.
Step6. Calculate the PSNR, MSE, SSIM, Entropy in order to check for the image quality of the edge based segmented image by using below mentioned mathematical formula.
Step7. End.

V. SIMULATION RESULTS AND ANALYSIS

In this section we have presented the experimental result and evaluated the performance of the proposed method. The proposed method is implemented in the MATLAB and the operating system used is windows 7.

A. Measure Of Imperceptibility

In the experimental phase we have used the parameter PSNR(Peak Signal to Noise Ratio) for calculating the difference between the cover image and Edge based image. The PSNR for an image of size NxN is given as follows:

PSNR = 10 log10 (255^2 / MSE) (dB)
where MSE=(1/N*N) ΣΣ (xij – x'ij)2 ,

B. Measurement Of Structural Similarity

The structural similarity (SSIM) was suggested by Wang et al. [22]. It is composed of three values: Luminance comparison; Contrast comparison; and Structural comparison. These components are normalized such that they are 1.0 for identical images. The SSIM index is the product of these three components (raised by an exponent, if required). The formula for this measure is given by

$$\mathrm{SSIM}(x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

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where μx , μy , σx, σy , *and* σxy local statistics parameters of the two images x and y and C1 , C2 are constants used to avoid division by zero.

Here the results are shown for different thermal images. These four table compare different edge based techniques for several images. The Canny method shows better performance than other edge detection methods. Canny method gives better PSNR, SSIM, Entropy values than pther edge based segmentation methods.

TABLE1. Comparative Results Of PSNR Values

Original Image	Sobel PSNR	Prewitt PSNR	Log PSNR	Canny PSNR
Thermal1.jpg	7.4709	7.4708	7.4751	7.4767
Thermal2.jpg	6.1491	6.1490	6.1647	6.1652
Thermal3.jpg	7.1888	7.1887	7.2917	7.2924

TABLE2. Comparative Results Of MSE Values

Original Image	Sobel MSE	Prewitt MSE	Log MSE	Canny MSE
Thermal1.jpg	1.1640	1.1643	1.1630	1.1626
Thermal2.jpg	1.5782	1.5783	1.5762	1.5760
Thermal3.jpg	1.2422	1.2424	1.2415	1.2404

TABLE3. Comparative Results Of SSIM Values

Original Image	Sobel SSIM	Prewitt SSIM	Log SSIM	Canny SSIM
Thermal1	.03103	.03099	0.03116	0.03122
Thermal2	0.06709	0.06705	0.06727	0.06735
Thermal3	.05843	0.05831	0.0629	0.0647

TABLE4. Comparative Results Of Entropy Values

Original Image	Sobel Entropy	Prewitt Entropy	Log Entropy	Canny Entropy
Thermal1	0.258876	0.257924	0.409084	0.457495
Thermal2	0.264353	0.260301	0.518370	0.585275
Thermal3	.271975	0.270112	0.391832	0.417116

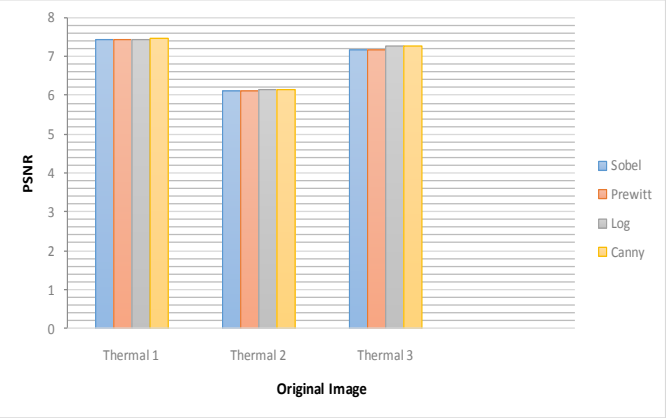

Figure 3: Graphical representation of PSNR values of different segmentation techniques

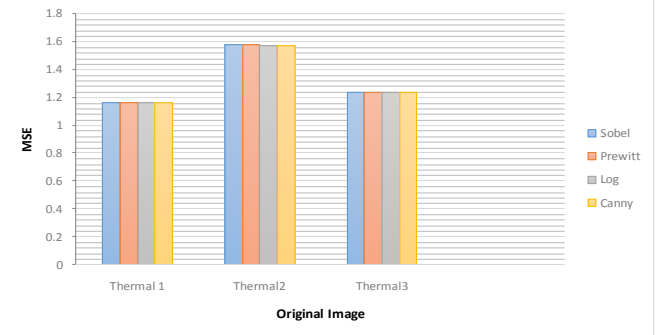

Figure 4: Graphical representation of MSE valuesof different segmentation techniques

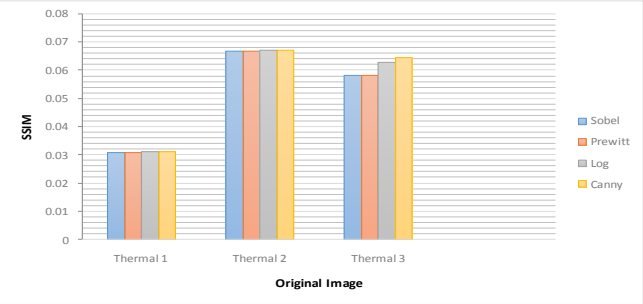

Figure 5: Graphical representation of SSIM valuesof different segmentation techniques

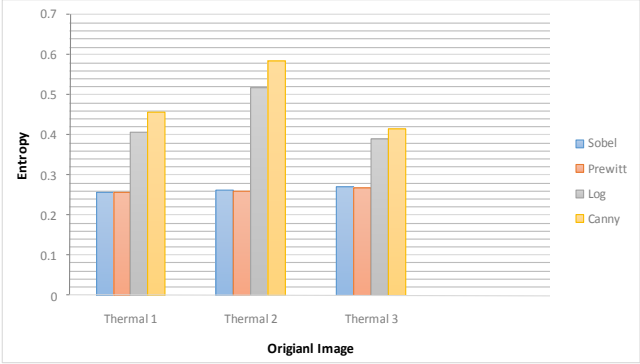

Figure 6: Graphical representation of Entropy valuesof different segmentation techniques

Here the graphical representation is used to analyze the thermal image quality for different edge based segmentation techniques. If we see the graph of entropy that shows the Canny based segmentation gives better entropy value than other techniques.If we see the graph of PSNR, SSIM that shows the Canny based segmentation gives better value than other techniques. Also the Canny method provide less MSE than other methods so error is less for this type of segmentation.

To evaluate the performance of the proposed edge based algorithm, we have used 256 x256 gray scale and color images. Simulations were done using MATLAB 8.0. In table 1, we give the results of PSNR obtained from the proposed edge based algorithms. Threeimages have been taken and these methods are applied to obtain results as shown in figure.

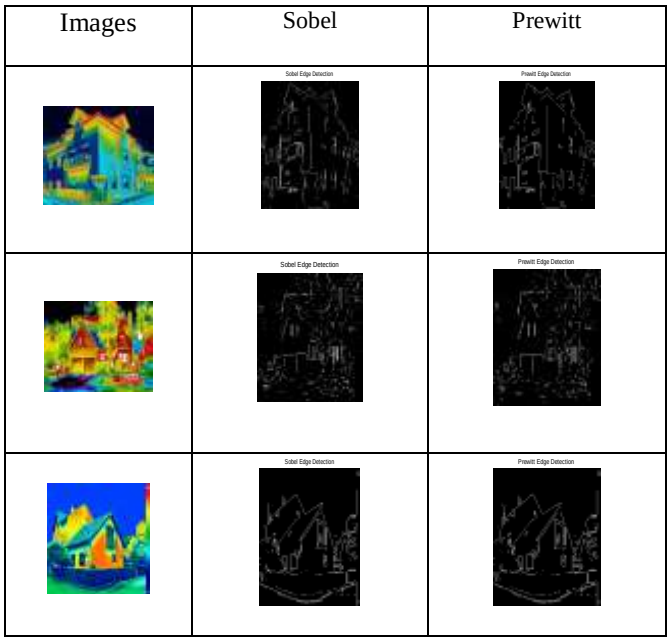

Figure7: Comparison Of Sobel and Prewitt edge Based Segmentation Technique

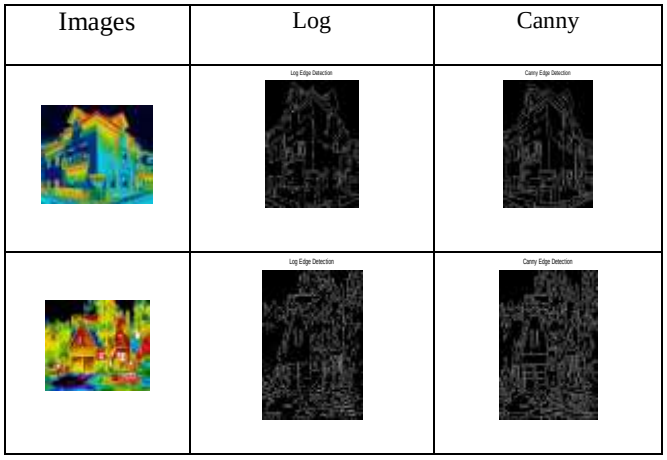

Figure8: Comparison Of Log and Canny edge Based Segmentation Technique

VI. CONCLUSION

In this paper a comparative study of edge detection techniques which are based on discontinuity intensity levels. The performance of various edge detection techniques is carried out with different images by using MATLAB software. It is observed from the results of Sobel. Prewit, LoG and Canny edge detectors produce almost same edge map. Canny result is better one when compared to all for a selected image since different edge detections work better under different conditions. Though LoG gives better visual assessment then laplacian still the edges are spotty and thick. On the other hand the edges in gradient images obtained by sobel and prewitt operator produces much satisfactory results in terms of clearer edges where both produces much accurate results than laplacian and LoG. In this analysis the gradient image determined by canny operator produces highest PSNR,SSIM, Entropy rather than other in terms of image quality. So, the results shows that canny edge detection is less erroneous than other edge detection techniques.

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