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Combination of Thresholding and Log Edge Detection Technique in Thermal Image Analysis

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Abstract*: Accuracy itself a complete statement to describe a final destination. Now days, we have so many image processing tools available. By using that, it is very easy to extract the information or details of background of an Image taken from thermal imaging camera. Without any special function or a tool it is a very cumbersome task to be carried out for any researcher. Normally, thresholding technique is applied to separate out different objects from the background present in an image. To get an accurate result and enhancement in analysis and measurement of any object of thermal image, it is required to apply essential steps in an algorithm used in addition with thresholding. In this paper, thermal image of an electrical system is used. To protect the circuit, it is necessary to distinguish area of an acquired thermal image by high heated area and normally heated area. Now to protect circuit, it is necessary to measure high heated area accurately where normally heated area is ignored. In this paper I have used LoG (Laplacian of Gaussian), an optimal edge detection technique in addition with thresholding, and achieved high accuracy in a result identified. The result or measured area is in terms of pixel for simplicity.
***Keywords*: Thermal imaging, Overheat Area, Thresholding, LoG Optimal Edge Detection, Circuit Protection**

I. INTRODUCTION

In [1] Jibu Vargese et al., used thermal image analysis technique to find out loading condition of PCB based on thermal camera image. In [2] TANG Qingju et al., compared and analyzed ant colony algorithm and canny operator to extract required parameter from infrared thermal images. In [3] TANG Qingju et al., discussed about fusion of morphology and canny algorithm in Infrared image edge detection. In [4] Aleksandra Pavlović et al., discussed about fusion of visual and thermal image to find area of interest from thermal images. In [5] S. Harishkumar et al., has worked on hot spot occurs due to transformer heating.

The overcurrent from the any electrical circuit will increase the temperature and ultimately the heat. In [9] author have used an infrared thermal image of an electrical system. The author used to find high heated and normally heated area from an image to protect the circuit from over current. This is almost same case as we are differentiating or separating object from the background. Thresholding technique is normally used to differentiate the object from the background in image processing. By using thresholding technique user may get result but that may not be accurate. So, to get accurate result it is necessary to change or modification is required in algorithm. Inspired from this, I have applied LoG, an optimal edge detection technique in addition with thresholding to achieve accurate result.

II. PROBLEM DEFINITION

Figure-1 shows small part of an image cropped from a normal image. Figure-2 shows almost same image but it is an infrared thermal image acquired by thermal imaging camera. Figure-1 shows an electrical circuit system image. The current will flow from the wire shown in Figure-1. As we know, any current passing through a wire or a circuit will rise temperature of a wire. Figure-2 shows infrared thermal image of the same wire which carries current. It seems that, it is better to go for an infrared thermal image than normal image to detect temperature of a part of an image.

So to decide, whether current passing through the circuit or wire is over or normal, one has to separate high heated and normal heated area of an image. So many image processing techniques are available to separate out an object from the background. Normally used technique for task defined above is Thresholding only. In majority cases, this is true for normal and an infrared thermal image taken from thermal imaging camera. By using only thresholding technique, we can easily distinguished high heated and normally heated area. But, to get better result, I have applied LoG, an optimal edge detection technique with thresholding, to detect different areas accurately available in an infrared thermal image.

III. INFRARED THERMAL IMAGING

Thermal imaging is a method of improving visibility of objects in a dark environment by detecting the objects' infrared radiation and creating an image based on that information. Night vision technologies that are most commonly used are near-infrared illumination,

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low-light imaging and thermal imaging. Thermal imaging works in environments without any ambient light. Fog, haze and smoke can be penetrated by thermal imaging just like near-infrared illumination [1]. All objects emit infrared energy as a function of their temperature. Heat signature is the infrared energy produced by an object. More radiation is been emitted as the object becomes hotter. Tiny differences in temperature can be detected using a heat sensor called as thermal camera. Infrared radiation is collected by the device from objects in the scene and creates an electronic image based on temperature differences information. Thermal camera can detect each object distinctly and can give a distinctive image as the objects that are closer very rarely have precisely same temperature. Grayscale images are obtained using a thermal camera. Cold and hot objects look black and white respectively whereas variation between two is indicated by depth of gray. Different temperatures are indicated by different colours in some thermal cameras [1].

Fig-1. Normal image.

(Coutesy:http://www.cheyenneelectric.com/thermographic-scanning-service)

Fig-2. Infrared thermal image.

(Coutesy:http://www.cheyenneelectric.com/thermographic-scanning-service)

IV. THRESHOLDING TECHNIQUE

If background lighting uniform, then segmentation can be achieved simply by thresholding the image at a particular intensity level [6]. The basic result being that the initial gray-scale image is converted into a binary image also called black and white image in which objects appear as black figures on a white background or as white figures on a black background. Thresholding is the simplest method used for image segmentation. From a grayscale image, thresholding can be used to create black and white or binary images. The key parameter in the thresholding process is to choose an optimum threshold value. Several different methods for choosing a threshold exist; users can manually choose a threshold value by trial and error method, or a thresholding algorithm available, can also compute a value automatically, which is known as automatic thresholding. In a noiseless image with uniform background and object values, the mean it is also called average value or median will work as an optimum threshold.

A more sophisticated approach might be to create a histogram of the image pixel intensities and use the valley point as the threshold. The histogram approach assumes that there is some average value for the background and object pixels, but that the actual pixel values have some variation around these average values [7]. Global (single) thresholding method is also used when there the intensity distribution between the objects of foreground and background are very distinct. When the differences between foreground and background objects are very distinct, a single value of threshold can simply be used to differentiate both objects apart. Thus, in this type of thresholding, the value of threshold T depends solely on the property of the pixel and the grey level value of the image. Some most common used global thresholding methods are Otsu method, entropy based thresholding, etc [7]. Thresholding is the simplest segmentation method [8]. The pixels are partitioned depending on their intensity value. I have used Global thresholding, using an appropriate threshold T given by below equation. In this paper I have applied global threshold to differentiate high heated area from infrared thermal image as shown in Figure 3. Global thresholding is shown in Equation 1.

$$g(x,y) = \begin{cases} 1 & if\ f(x,y) > T \\ 0 & if\ f(x,y) \leq T \end{cases} \quad (1)$$

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Figure 3. Thresholded image

V. LOG (LAPLACIAN OF GAUSIAN) EDGE DETECTION TECHNIQUE

LoG algorithm is outlined in Table-I. For LoG [10], Locality is not especially good, and the edges are not always thin. Still, this edge detector is much better than the previous one in case of low signal to noise ratio. Malfunctioning at corners, curves and where the gray level intensity function varies, not finding the orientation of edge because of using the Laplacian filter. LoG edge detection method operated image is shown in Figure 4. Laplacian filter is susceptible to noise [11]. To decrease the noise effect, Gaussian filter could be used. Thus, in Laplacian of Gaussian (LOG) operator, at first the Gaussian smoothing is applied, then the Laplacian operation is performed. The high frequency noise components could decrease by this combination [11]. The sensibility to noise is decrease by using the combination of Gaussian function and Laplacian mask. The LOG function for convolution is defined by the following Equation 2.

$$LoG(x,y) = \frac{1}{\pi\sigma^4}\left[1 - \frac{x^2+y^2}{2\sigma^2}\right] e^{\frac{x^2+y^2}{2\sigma^2}} \qquad (2)$$

Where x and y are the corresponding row and column of the image, and σ is standard deviation. LOG operator calculates the second spatial derivative of an image. The two-dimensional cross section of the zero-crossing of the Mexican hat is shown in Figure 1.

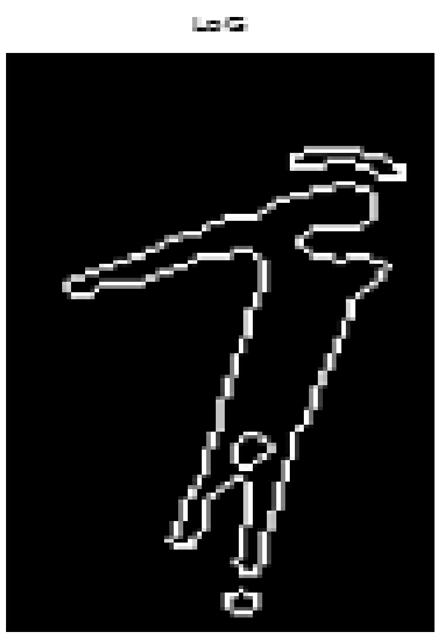

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Fig 4. LoG Operated image

TABLE I
LOG ALGORITHM

No.	STEPS
1	Convolve the image I with a two dimensional Gaussian function.
2	Compute the Laplacian of the convolved image; call this L.
3	Edges pixels are those for which there is a zero crossing in L.

VI. ALGORITHM

Table-II shows an algorithm used to identify high heated area accurately of an infrared thermal image.

TABLE-II
ALGORITHM USED

Steps	Method used
1	Cropped the Acquire Image of an electrical circuit from thermal imaging camera as shown in Figure 2.
2	Apply global thresholding technique to cropped Image with well-defined threshold level. After thresholding, an image will be divided in binary levels or black and white levels as shown in Figure 3.
3	Apply LoG Edge detection Method to Figure 3. Different areas in terms of contours of thermal image will be seen. Resulted image is shown in Figure 4.
4	Now we can find different areas identified as contours which shown in edge detected image. Simple arithmetic conversion is employed to find areas in terms of pixel. Resulted areas are as shown in Table III.

VII.RESULT

To find different areas of an image, first I have applied only thresholding and then I have applied LoG edge detection method along with thresholding shown in Figure 3 and Figure 4 respectively. As we can see in Figure 4, there are total four different areas detected in an infrared thermal image. Whereas in Figure-3, only two areas with some noise are detected. In Figure 4, we have extracted more accurate areas. Table III shows the same detail numbered as 1 with thresholding only and 2 as thresholding and LoG. Table III shows, we are getting three different areas by using thresholding technique only and four different areas with combination of thresholding followed by LoG edge detection method.

TABLE-III
RESULT

Sr. No.	Areas found							Decision	Method Used
	Total Area	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6		
1	1840.8 (In Pixel)	915	1	26	---	---	---	Overheat (High Temp.)	Thresholding Only
	100 (In %)	49.706	0.0543	1.4124	---	---	---		
2	1840.8 (In Pixel)	1014	10	26	18		---	Overheat (High Temp.)	Thresholding + LoG
	100 (In %)	55.0584	0.57	0.8264	2.0234	---	---		

VIII. CONCLUSION

By seeing Figure 3 and Figure 4, we can distinguish them with two different areas with noise and four different areas in terms of contour respectively. That is also shown in Table III. In this paper we are trying to protecting circuit from over current flowing. So, in this context, it is very much necessary to have an accurate result. If any user have an accurate result then it is possible to take right decision about temperature rise in an image which is ultimately over current flowing. If it doesn’t then wrong perception can create major loss, damage or an accident in an industry. So it is always preferable to use LoG edge detection method along with Thresholding.

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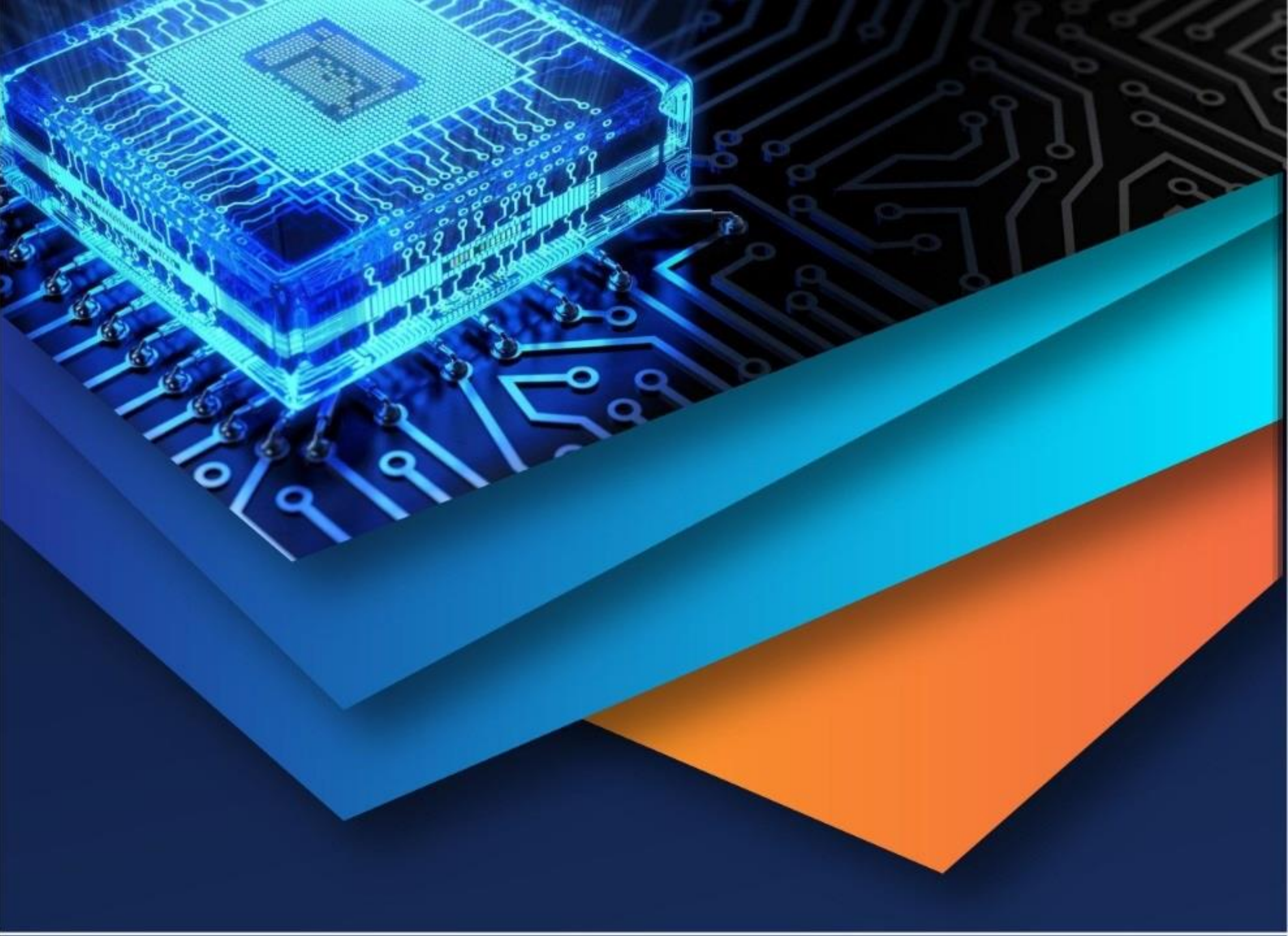

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