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The Detecting of Damage Conductor with Guided Image filter

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The Detecting of Damage Conductor with Guided Image filter

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Abstract. The Damage of electrical conductor of high voltage transmission system is very common. This problem effected the distribution of electrical power from the sources into the costumer place. The main cause of this problem if come from the damage of electrical conductor. There were many ways to detect damage conductor so far. The most common is through compute the impedance of transmission line. This method is accurate, but it needs to switch of the line for a while. This disruption contribute losses for the costumers and energy provider. In order to handle this problem, our proposed method is to detect the damage conductor with Guided Image Filter. The input image is a visible image and the reference image is invisible image. The processing is very simple. The result obtained has high accuracy. The accuracy is shown on the detecting map.

1. Introduction

In the usage of conductor devices that were commonly made from silver, aluminum and other metal compounds. As time passing by, this conductor fall onto damaged or corrosion gradually as shown in **Figure 1**[1]. It needs very long time to happen. The corrosion on the electrical conductor will causes the rise of temperature around the damaged regions. Finally, the conductivity of conductor fall down[2][3]. Furthermore, the rise of temperature of the conductor also makes the increase of resistive characteristic of electrical conductor [4]. Since the rise of resistive factor and heat of the conductors, they effect the efficiency of electrical energy distribution, secondly they have also possibility to produce disaster such as fire and etc.

Figure 1. The damaged conductor

Since, there are many negative impacts from the existence of damaged region on the electrical conductor, so that it is needed many efforts to prevent the problem occur. One of the method is computing the impedance of the electrical distribution network. This method has high accuracy.

Otherwise, the network has to be shut down for a while[5][[6]]. This procedure left the disadvantages for the costumer and company side. The losses of supplying energy for a period of time means loses economically and credibility. In order to handle this situation, the authors propose a new method to detect the damaged regions on the conductor through Guided Image Filter with Invisible Image as Reference Image. The invisible image of the damaged region is as shown in Figure 2. The use of visible and invisible image will no need to shut down power system at all[7]. The data of damaged region on the electrical conductor is obtained based on visible and invisible image.

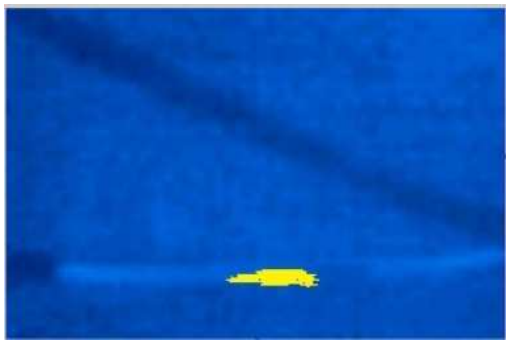

Figure 2. Invisible image of damaged region

2. Methodology

The pair of input images were taken from Thermal Camera FLIR TG167 and Canon EOS 700D. The first one produces invisible image and the other visible image. Both have the same size, format and registered images.

2.1 Guided Image Filter

The proposed method is based on usage of Guided Image Filter with more complete data type. This filter is very common used in visible image processing only. Guided image filter is a linear translation-variant filter that wraps together a guidance image *R*, filter input *t* and an output image *S*. The filtering process according to the following equation,

$$S_i = \sum_j K_{ij} (R)_{t_j} \quad (1)$$

The filtering output at pixel is according to Equ. 1. There *i* and *j* are pixel indexes. $\boldsymbol{K}_{ij}$ is a window kernel as a function of guidance image and independent image. The characteristic of this filter is linear with respect to ***t*** [8][9].

2.2 Morphological Filter

Mathematical Morphology is a kind of methodology based on object formation generally used for identifying object boundary accurately[10]. It can make a simplification operation based on formation in image data. It makes connection the related and removes the unrelated parts [10].

Dilation

The dilation operator is concerning with the pixel formation modification. In the image processing, the pixel formation modification is implemented in the binary (0, 1) or gray scale (0-1) image. The operation of pixel formation is in the binary level image [10]. The dilation operation is a builds addition dimension of pixel forms. It works to merge two pixel formations using vector addition of

each element. **X** and **Y** are pixel formation. The dilation of X and Y symbolized as $\mathbf{X} \oplus \mathbf{Y}$ [19]. $\mathbf{x} \in \mathbf{X}$ is x subset X. And formulated by

$$(X \oplus Y)\, \mathrm{X} = \bigcup_{x \in X} X_y \tag{2}$$

$\mathbf{X_y}$ is a translation of X by y. Since dilation is an operation of pixel formation modification, and it performs a lowest level image, this operation generally used to modify the shape structure image. It can be used to smooth, segment image and so on.

Erosion

Erosion process works at pixel level image, in binary or gray image. It does as a decrement operation. If X and Y is the erosion operation X by Y symbolized as $\mathbf{X} \ominus \mathbf{Y}$ [14]. y ϵ Y is y subset Y. $\mathbf{X_y}$ is translation erosion X by y. Mathematically, it formulated by following equation:

$$(X \ominus Y) = \bigcap_{y \in Y} X_{-y} \tag{3}$$

The erosion operation presents the discrepancy between two pixels form modification.

Opening operation

The opening operation is combination operation between erosion and dilation. This operation works starting with erosion and follow by dilation operation. Mathematically formulate as follow:

$$X \circ Y = (X \ominus Y) \oplus Y \tag{4}$$

Where X is an image, Y is structuring element. This equation gives smoothing, breaking uncorrelated and removing small objects. Also it sharpens the binary image.

Closing operation

The closing operation of image or pixel form X by the structuring element Y, it symbolized as X ● Y. The closing operation presented as following equation:

$$(X \bullet Y) = (X \oplus \mathrm{Y}) \ominus \mathrm{Y} \tag{5}$$

The characteristic of closing operation, mainly are removing the small holes and filling the gaps among part pixel form.

2.3 Algorithm

Our method has several stages to complete. Each stage contains a certain process and output. The stages are as follow:

1. Pre-processing phase, the input images (visible and invisible image) must be in the same size, orientation and data type. The process include making image registration. The output of this process is Initial map.
2. Generating Guided Map phase, in this process the map of damaged region on the conductor has beed detected.
3. Optimization phase, the accurate boundary of damaged region on conductor generated. The fusion the Guided map and visibile image form Damaged Region.

The block diagram of the algorithm as shown in the Figure 3.

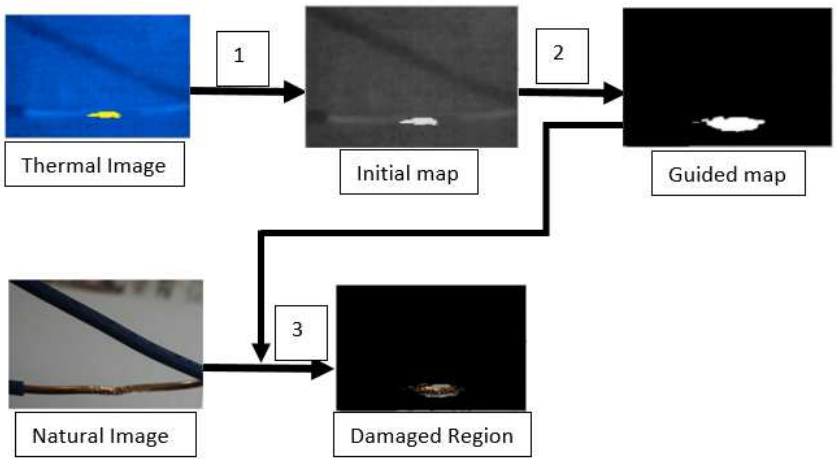

Figure 3. Block diagram of Proposed Method

3. Result and Discussion

Based on our method, the algorithm is able to detect the damage region of electrical conductor accurately. As shown in Figure 4. In Figure 4(a), the input image is a slender surface of conductor. The Figure 4(b), the damaged region detected and Figure 4(c). The detailed of the damaged regions.

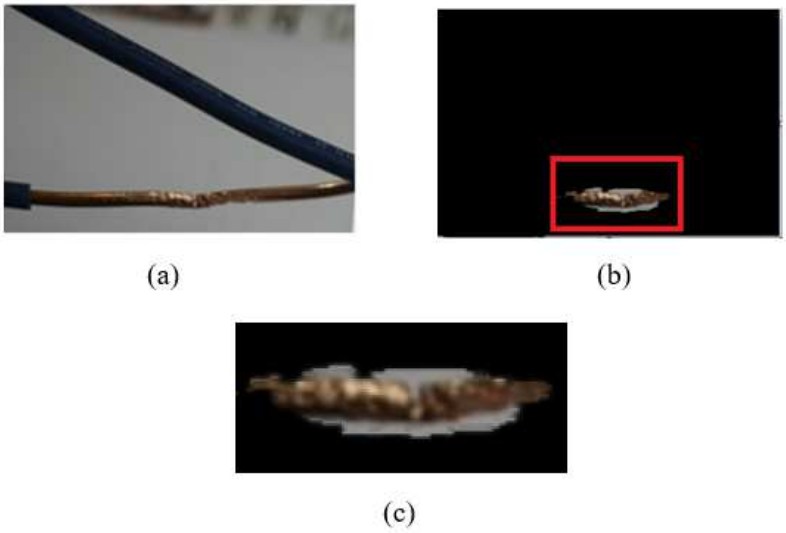

Figure 4. The Result of Proposed method. (a) The input image ; (b) Damaged region detected and (c) The Detail damaged region.

From the Figure 4(c), the method show the accuracy of detecting region. It can generate all damaged region.

4. Conclusion

The Proposed method is a kind of new method to implementing the detection of damaged surface on the conductor. This method can be applied easily. The thermal data shortened the processing of defining region map. It helps simplification of algorithm and computing cost lower.

The proposed method gives easiest way to determining the appropriateness prediction of damaged region of the surface conductor. Since this method is supported by a pair of visible and invisible images.

Finally, the utilization of a pair of visible and invisible images help to handle the problem of detecting damaged conductor in electrical fields, especially the transmission line.

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