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Insulator Crack Detection Using Soft Computing Techniques

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Abstract:
The edge extraction technique in image processing was used to identify and classify micro-cracks on the composite insulator material in order to extract the shed's micro-cracks. The composite insulator has a significant impact on the operation and even power lines, so faults in the composite insulator must be identified. From the standpoint of image processing, the proposed approach for this project includes an image of a composite insulator, including micro-cracks. To extract the micro-crack on the insulator, first preprocess the image to extract the insulators after graying and edge- detecting. Image analysis refers to the process of altering the features of an image by executing various adjustments or alterations utilizing various functions. The Sobel operator, the Canny operator, the Prewitt operator, and the Laplace operator are all edge extraction operators that use this concept.
Finally, images of composite insulators were extracted using different methodologies and compared, and the images wereassessed using composite insulator features.

Keyword: composite insulator, micro cracks, different edgeextraction operators, edge detection.

1. INTRODUCTION

The insulator is an important factor of a transmission line that is frequently used to support the conductor. Because of their lower weight, composite insulators are commonly used well developed technology and high-quality product, and hydro phobicity is the best. The hydro phobicity is also utilized to ensure that they operate safety. The detection approach is utilized to provide a more precise result while avoiding the disadvantages. The process of extracting useful information from images, such as detecting structures, counting objects, recognizing colour, or measuring object properties, is known as image analysis.

This is the most basic method for identifying the required objects in an image and effective. The pixels in a picture are separated based on intensity of each pixel to a threshold value. When objects in the image are expected to have more intensity than the background (and undesirable components) of the image, the threshold technique is advantageous. However, for images that are not bimodal, the image histogram contains numerous peaks, or one of the classes (peak) present has a significant variance, this is a disadvantage.

Otsu's Binarization, on the other hand, is frequently utilized in document, pattern recognition, and other applications. We need an adaptable method that can alter the threshold for different image components. In this case, the algorithm breaks the image into smaller sections and calculates the threshold for each of

them. As result, photos with illumination produce superior results. The threshold value can be the mean of the neighbourhood area or the weighted sum of neighbourhood values using Gaussian window weights (a window function to define region).

II. PREPROCESSING OF IMAGES

To begin, a clear image of a composite insulator shed with micro-cracks must be obtained. The visible spectrum is a frequency range that may be sensed by human eyes and other micro organisms and consists of an extremely limited range of wave length.

A. Graying Image

The composite insulators original image is a color image. An RGB image is one in which the colors red, green, blue are all present, and the color is a gray shade. Because smaller data allows developers to do more complex operations in less time, Gray scaled images are the most widely used in image processing.

Gray level = 0.299 *r + 0.587 *g + 0.114 *bGray scale = ($\frac{R+G+B}{3}$)

B. Image in Binary format

A binary picture is a monochromatic image made up of pixels that can only have one of two colours: black and white. The distance transform is an important feature. The distance transform can be calculated quickly. It enables fast computation of voronoi diagrams, which assign each pixel in an image to the nearest of a collection of points. It also
enables capturing and storing, which differs from thinning in that it allows the original image to be recovered. In image recognition, the distance transform is also important for finding the objects centre and matching

g (x, y) = { 1 if f(x , y) ≥ T
0 otherwise

Here g(x ,y) represents threshold image pixel at (x , y) andf(x , y) represents grayscale image pixel at (x ,y).

C. Edge detection

Edge detection is a technique for segmentation an image into discontinuous parts. It is a common approach in image processing, such as the image brightness varies sharply.
Edge detection allows user to look for a substantial shift in the gray level in an images features. This texture indicates the end of one picture section and the start of another. There are two types of edge detection operators: Sobel, and Prewitt operators are gradient-based operators that compute first-order derivations in a digital image. Canny edge detectors and Laplacian of Gaussian are examples of Gaussian-basedoperators that compute second-order derivations in a image.

I. EXTRACTION FROM THE INSULATOR SHED

Feature extraction is a step in the dimensionality reduction process, Which divides and reduce a large set of raw data into smaller groupings. As a result, processing will be simpler. The fact that these enormous data sets have a large number of variables is the most crucial feature. As a result, feature extraction aids

in the extraction of the best feature from large data sets by selecting and combining variables into features are simple to use while still accurately and uniquely describing the real data set. The suggested study introduces the concept of multiple texture feature extraction approaches, including structural, statistical model, and transform methods.

The techniques of segmenting a picture into parts with various texture containing comparable groups of pixel is known as texture segmentation. Then extract the texture feature extraction

$$\frac{\partial f}{\partial x} = f(x+1, y) - (x-1, y)$$

$$\frac{\partial f}{\partial y} = f(x, y+1) - (x, y-1)$$

Where ∂f/∂x and ∂f/∂y are partial differentials in the x and y directions, Gx and Gy are combined at each pixel in theimage to give the gradient magnitude, using :

$$G = \sqrt{(G_x^2 + G_y^2)}$$

The gradient's direction is determined by

$$\Theta = \arctan\left(\frac{Gx}{Gy}\right)$$

A. Sobel operator

It is also a derivate mask that's utilized to detect edges. This is one of the most basic ways of detecting in Image processing/ Machine learning. It is a precursor to picture identification and is commonly implemented as an activation layer in a covolutional network. The sobel operator is defined as follows:

$$G = \sqrt{(G_x + G_y)}$$

The gradients direction is

$$\Theta = \arctan\left(\frac{Gx}{Gy}\right)$$

B. Canny operator

The canny operator is the margins of an image carry the majority of the information. A collection of pixels around which the gray-level values show a step change is usually referred to as an image edge. Many analytical methods in disciplines including image segmentation, pattern recognition, machine vision, and regional from extraction are based on edge detection, which is an important part of image processing.

$$G(x, y) = \frac{1}{2\pi\sigma^2} \exp\left(-\frac{x^2+y^2}{2\sigma^2}\right) \quad \text{(or)}$$

$$H_{ij} = \frac{1}{2\pi\sigma^2} \exp\left(-\frac{(i-(k+))^2+j-(k+1))^2}{2\pi\sigma^2}\right); \; 1 \leq i, j \leq (2k+1)$$

Canny operator creates an orientation at each point with easy, which can be highly beneficial for image post-processing. The canny edge detector improves on the Sobel edge operator by a factor of two canny and sobel edge detection techniques are more efficient than other algorithms.

C. Prewitt operator

It is a gradient-based operator, as the name implies. It is one of the most effective methods for determining an images direction and magnitude. For image edge detection, it computes the gradient approximation of the function. One of the early gradient transform edge detection method was the Prewitt operator. It is a well-liked analysis software.

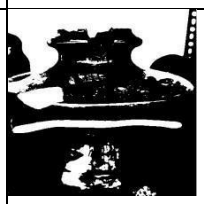
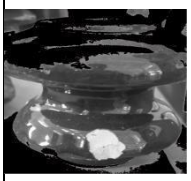
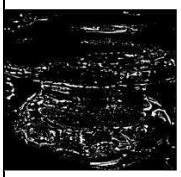
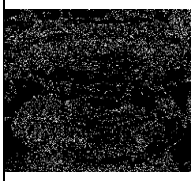
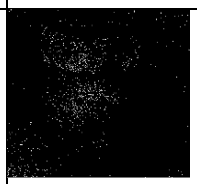
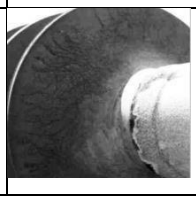
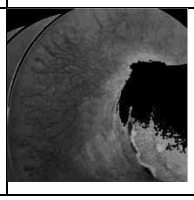
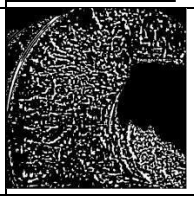
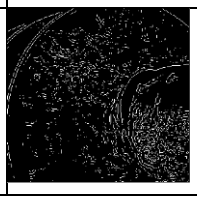
$G = \sqrt{(G^2 + G^2)}$

$x \qquad\qquad x$

The gradients direction,

$\theta = atan2(Gx , Gy)$

Table 1 Different Edge Extraction Figures

OPERATORS	GRAY SCALEIMAGE	OTSU METHOD IMAGE	ROI IMAGE	MEDIAN BASED OTSU METHOD IMAGE	EDGE DETECTION IMAGE
SOBEL OPERATOR					
CANNY OPERATOR					
PREWITT OPERATOR					
LoG OPERATOR					

D. LoG (Laplace of Gaussian) operator

Laplace filters are derivatives filters that are employed in image to discover areas of fast change (edges). The LoG operatorwill respond most strongly in the middle of blob-like shapes in photos (same size as the LoG kernel) The Log operator can identify lines by looking for inflection points rather than high magnitudes in the image. This approach takes for less arithmetic operations. The Gaussian filter can be calculated using a formula.

$$L(x,y) = \nabla^2 f(x,y) = \frac{\partial^2 f(x,y)}{\partial_x^2} + \frac{\partial^2 f(x,y)}{\partial_y^2}$$

IV.Results

Four images of an insulator sample that have undergone the process of insulator shed area extraction are chosen fortestingafter the application of various edge extraction operators.

Micro-cracks by several operators, Feature extraction is a technique for extracting the visual content of photographs sothat they may be indexed and retrieved.

For a given image, GLCM calculate the gray level different method probability density functions. The statistical texture features of a digital mammogography are frequently extracted using this method. To characterize region in a picture, several of the aforementioned feature extraction and description approaches can be employed. Texture analysis can be done using this characterization. Texture depicts pattern that have not established analytical describe texture. The most basic strategy is to generate the Fourier transform of a picture and then group the transform data in some way to create a collectionof measurements. The co-occurrence matrix(GLCM) approach is a technique for obtaining second- order statistical texture information.

The use of a gray level co-occurrence matrix (GLCM) to extract second order statistical texture information for image motion estimation is presented in this research. Correlation is a function that calculate the chance of the provided pixel pairings occurring together. As a result, it acted as proxy for the concept of information contained in a message, as opposed to the portion of the message that is rigidly determined (and sopredictable) by intrinsic structures.

$$H(x) = -\sum_{i=1}^{n} p(xi) \log 2\, p(xi)$$

Where n is the image's gray value range, and p(xi) denotes the probability of the pixel gray value n.

Table 2 Features of an Different Edge Extraction Operators:

Indicators	Sobel	Canny	Prewitt	LoG
Contrast	0.461156	0.617647	0.756315	0.282361
Homogeneity	0.895675	0.895733	0.813846	0.880566
Correlation	0.906124	0.901661	0.901786	0.940852
Energy	0.157399	0.160518	0.301196	0.212938
Entropy	6.253092	5.814002	4.097728	6.165834

RESULT & EVALUATION

Feature extraction is a step in the dimensionality reduction process, which divides and reduces a large set of raw data into smaller groupings. As a result, processing will be simpler. The fact that these enormous data sets have a large number of variables is the most crucial feature. So, by selecting and merging variables into features, feature extraction aids in extracting the best feature from those large data set, effectively lowering the amount of data. These features are simple to use while still accurately and uniquely describing the real data set. One of the best and most interesting domains is image processing. In this area, you will essentially begin to interact with your photographs in order to comprehend them. To

process a digital image or video, we use a variety of techniques, including feature extraction and algorithms, to detect features such as shapes, edges, and motion.

When it comes to processing gray gradients, the Sobel operator is sensitive to noise and has a simple and fast computation when it comes to handling grey gradients. In image processing, the Prewitt operator is one of the most effective method for determining an images direction and magnitude. Because of its differential and smoothing characteristics, the Laplace of Gaussian basically functions as a band pass filter.

The previous analysis was confirmed by the calculation of four example images. Table 2 shows that the calculation outcomes of micro cracks on insulator pictures extracted by different operators vary for the same sample.

CONCLUSION

In this study, we looked at an image of a composite insulator with a micro-crack from the standpoint of image processing. To obtain the insulator, first preprocess the image. The composite insulator is then extracted using a different edge extraction operator and evaluated using features of an composite insulators. We extract the composite insulator, which is critical for characterizing it and studying its ageing.

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