



The Recognition and Detection Technology of Ice-covered Insulators under Complex Environment

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Abstract

In order to avoid the impacts of outer factors on the ice-covered insulators recognition, such as weather, seasons, outside illumination changes, acquisition time, image background and image contrast, a general algorithm which can recognize and detect the ice-covered insulator accurately in a complex environment is put forward in this paper. With the video monitoring device, the image information of insulators with or without covered ice can be acquired. The ice-covered insulator images under complex environment are regarded as the research objects.



Abstract

Morphological closing operation is conducted on the ice-covered insulator images firstly. Then the high frequencies in the image are removed by the Wavelet Domain. A kind of invariant background quotient image can be acquired by dividing the processed images and the original images, then after the camera calibration on the quotient images, the edge contours of insulators can be extracted using the wavelet edge detection method, and the icing thickness of insulator can be obtained by using template matching algorithm and geometric model.



Abstract

The method is verified in an artificial climate chamber, the results show that this method can eliminate the interference of the complex background weather, accurately identify icing insulators and calculate the insulator icing thickness. This method can be applied to recognition and detection of ice-covered insulators under complex environment.



(a) Icing laboratory internal graph



(b) Wire icing graph



(c) Insulator icing graph



(d) Wire icing measurement graph

Fig.1 Artificial climate icing laboratory



Algorithm implementation process

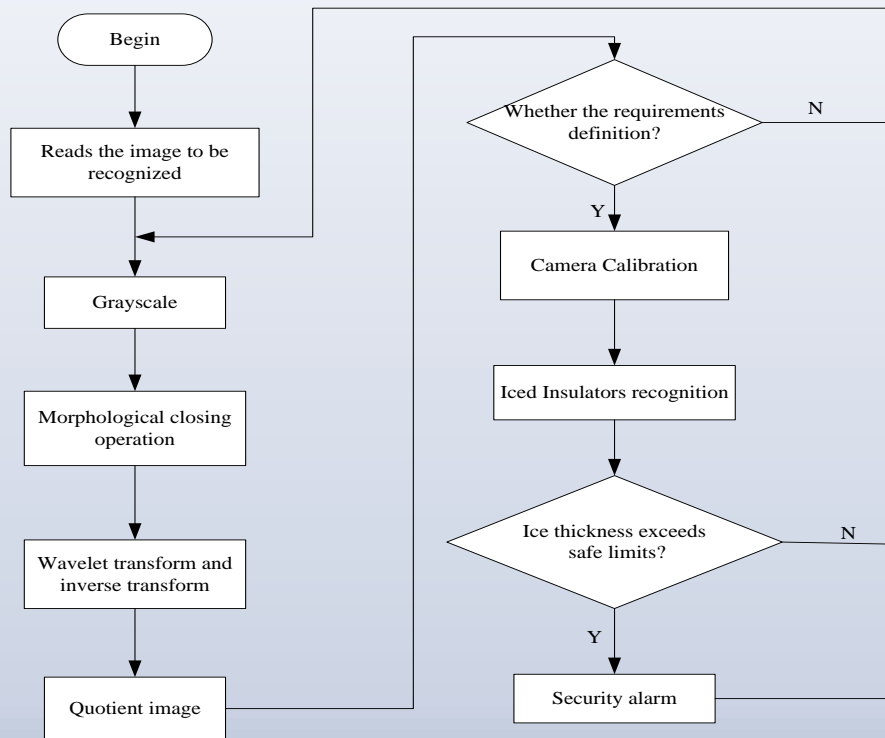
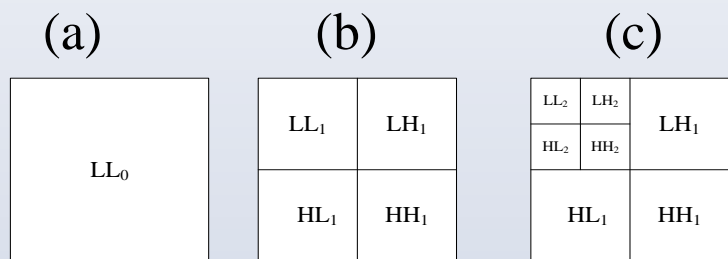


Fig.2 Algorithm flowchart

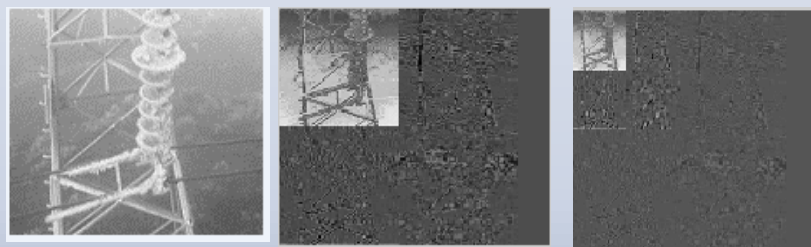


(a) Fog day
(b) Cloudy day
(c) Sunny day

Fig3. The original color image



(a) Original image
(b) A decomposition
(c) Two decomposition



(d) Original greyscale image
(e) A decomposition image
(f) Two decomposition image

Fig.4 Wavelet transfer decomposition



The background estimation images and the original image after processing the 2D image dividing, and a higher resolution target image is obtained by the method of synthesis.



(a) Fog day quotient image

(b) Cloudy day quotient image

(c) Sunny day quotient image

Fig5. Image processing effects



Recognition Algorithm

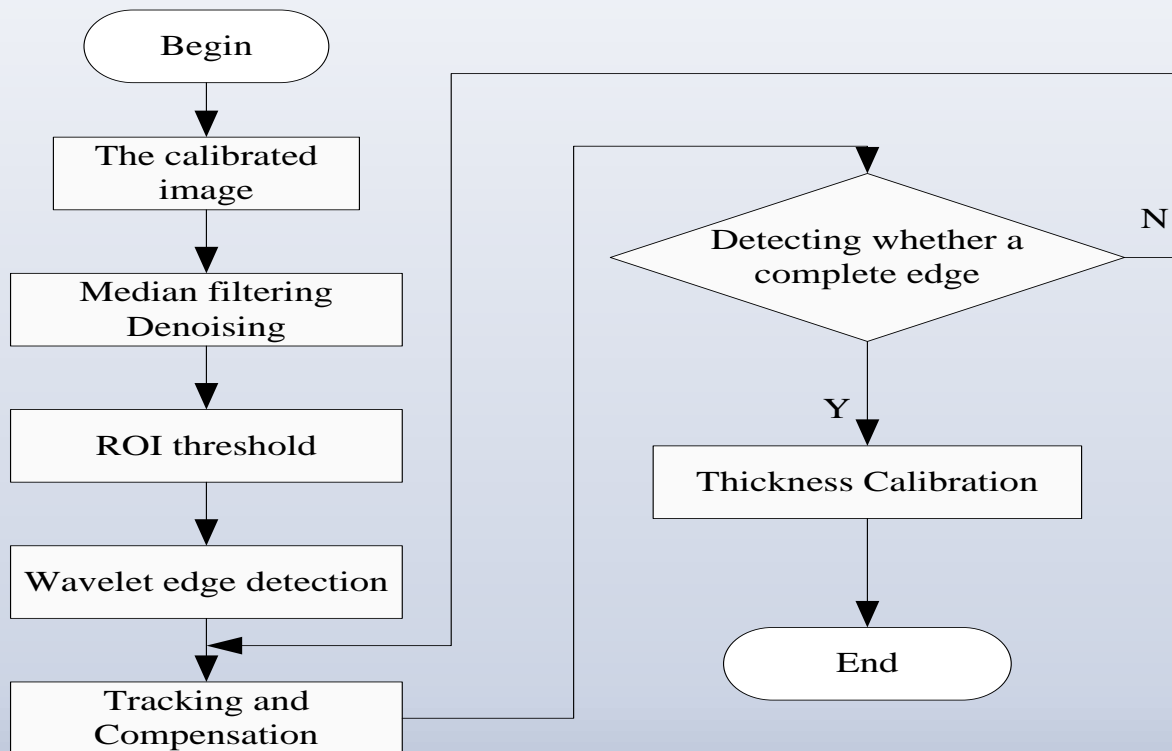
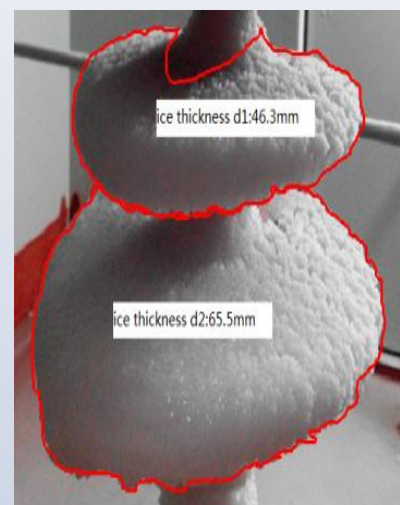


Fig.6 Algorithm recognition flowchart

Examples and results analysis

In indoor condition, by simulating the insulator at a humidity of 80% RH and a temperature of -19.4°F under sunny day.



(a) No iced insulator

(b) Iced Insulator

(c) Ice thickness recognition

Fig.7: Recognition of insulator on sunny day



Table : Measurement values and Recognition values of the icing insulators' thickness /mm(20mm)

$$y = \frac{1}{2} \left(\frac{H - D}{D} \right) \cdot d$$

Experimenta l conditions	Insulation sheet (up)			Insulation sheet (down)		
	Measuremen t values	Recognition values	△/%	Measureme nt values	Recognition values	△/%
Sunny Day	45.9	46.3	1.5	64.4	65.5	1.7
Cloudy Day	45.8	47.1	2.8	64.6	66.5	2.9
Fog Day	46.9	48.7	3.8	65.1	67.7	3.9
Snowy Day	47.1	49.2	4.4	65.4	68.6	4.8

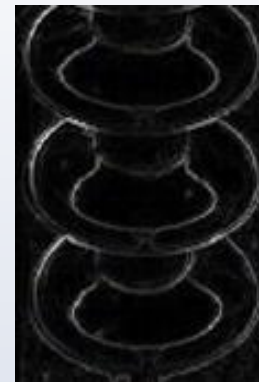
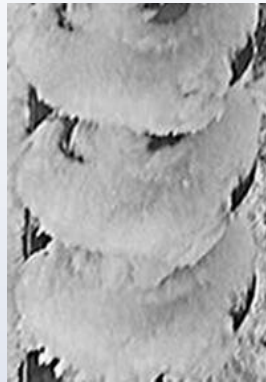
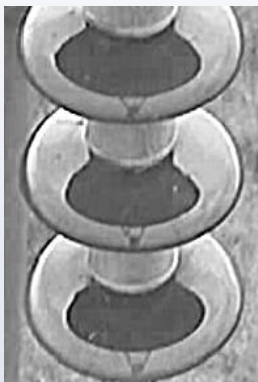
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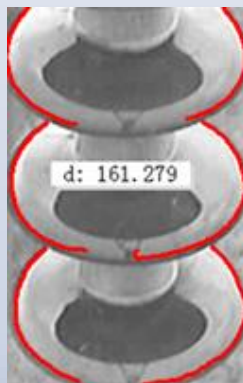
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(a) No icing insulators image preprocessing results (b) Pretreatment results Iced Insulators image (c) No icing image segmentation insulator



(d) Segmentation Iced Insulators image

(e) No icing Insulator diameter

(f) Iced Insulator diameter

Fig.8 Wild Insulators image recognition

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