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Vacuum Switches Arc Images Pre–processing Based on MATLAB

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Abstract. In order to filter out the noise effects of Vacuum Switches Arc(VSA)images, enhance the characteristic details of the VSA images, and improve the visual effects of VSA images, in this paper, the VSA images were implemented pre-processing such as noise removal, edge detection, processing of image's pseudo color and false color, and morphological processing by MATLAB software. Furthermore, the morphological characteristics of the VSA images were extracted, including isopleths of the gray value, arc area and perimeter.

1 Introduction

Vacuum switch has already the absolute advantage in the field of medium voltage, and is developing to the high-voltage large-capacity, low overvoltage and size miniaturization. Arc of the vacuum arcing chamber is a kind of the low-temperature plasma, it is formed by free metal vapor, which is evaporated when contact electrodes disconnect. The formation, development and final extinction of arc have an important influence on turn-off circuit. The research of VSA shape and the diagnosis of plasma characteristics have very good guidance for the further study of the arcing chamber performance [1–3].

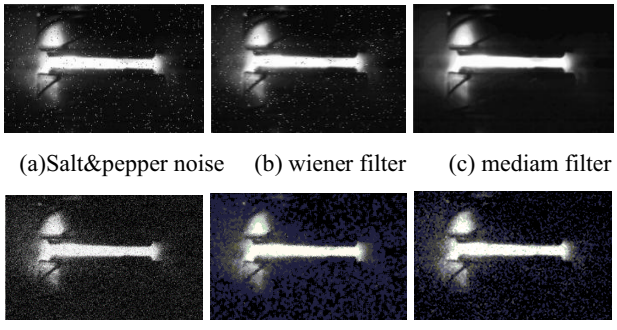
Arc's characteristics, such as outline form, brightness, and radiation distribution, have an important meaning for the breaking process of vacuum switch. But in the process of the VSA images acquired using CCD, these characteristics of VSA are weakened due to a variety of reasons . In order to retain these characteristics, some technical measures to highlight the weakened characteristics of VSA images have to be used. Image preprocessing is image processing using some technology to get better visual effect, a clearer image. It can help us to extract more accurate image analysis and image feature.

The process of VSA images pre-processing includes:1.noise processing;2.edge detection;3.processing of image's pseudo color and false color;4.morphological processing. After the VSA images preprocessing, morphological characteristics of VSA images are extracted using MATLAB ,including isopleths of the gray value and arc parameters such as area and perimeter. It lay the foundation for the study of the VSA shape and the diagnosis of plasma characteristics [4].

2 VSA images pre-processing

2.1 Noise removal

In the process of VSA images acquisition and transmission, all kinds of noise is likely to appear. So it is necessary for the arc images to filter the noise out. In order to compare the different denoising effect of different ways, in this article, imnoise function in MATLAB image processing toolbox is used to add two different types of noise to the VSA images respectively, including salt and pepper noise and Gaussian noise. And then two methods of filter are used respectively to process the VSA images, including adaptive filter and median filter[5]. As shown in figure 1, the filter effect of median filter to the salt and pepper noise is more helpful than adaptive filter, and the filter effect of adaptive filter to Gaussian noise is better.



(a)Salt&pepper noise (b) wiener filter (c) mediam filter

(d)Gaussian noise (e) wiener filter (f) mediam filter

Fig.1 Comparision of VSA images quality before and after filter

2.2 Edge detection

Edge detection is an important component of image preprocessing, it plays a key role in distinguishing the target object from the background. In an image, internal

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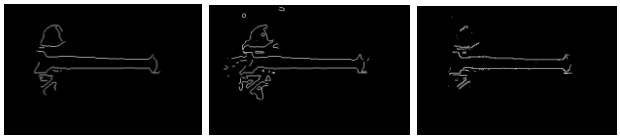
features tend to vary, such as gray scale, color and texture features. Edge is the border of two different characteristic areas. In order to detect VSA images' outline information and filter out irrelevant information, it is essential to detect the edge of VSA images. The commonly used edge detection operators include three kinds of methods, such as Canny operator, Log operator, and Robers operator[6]. As shown in Fig. 2, edge detection effect of Canny operator is the best. Log operator may smooth out the original sharpened edges at the time of restraining noise, which, causes the sharpened edge cannot be detected. Robers operator's ability to restrain the noise is relatively poor.



(a) Canny Operator (b)Log Operator (d)RobersOperator

Fig.2 Comparision of three Operators for extraction edge

2.3 Image pseudo color and false color processing

In order to improve visual effects and strengthen feature details of the VSA images, two practical image processing technologies are adopted, which are pseudo-color and false-color image processing. The so-called pseudo-color processing technology is about converting each level of the gray-scale images into different colors in the light of linear or nonlinear function. The more finer of the segmentations the more detailed of the colors, so as to capture more information and strengthen the effect of image enhancement. False color processing is designed for color images which is about color coordinate transformation from the three primary colors of originals into new ones, it enhances the identification of images, people's eyes are sensitive to the blue most, detailed VSA images can be displayed in different shades of the blue in the light of different degree of pixels, thereby enhancing visual effects [7], as shown in Fig. 3.

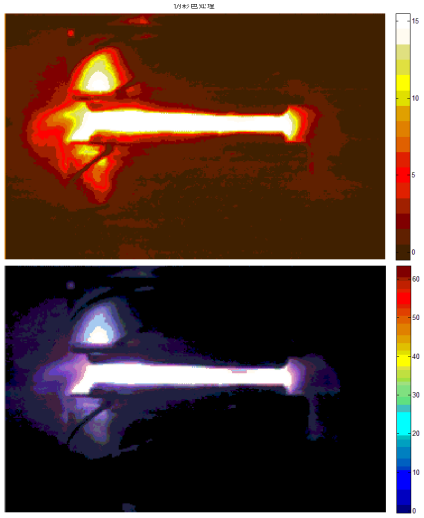
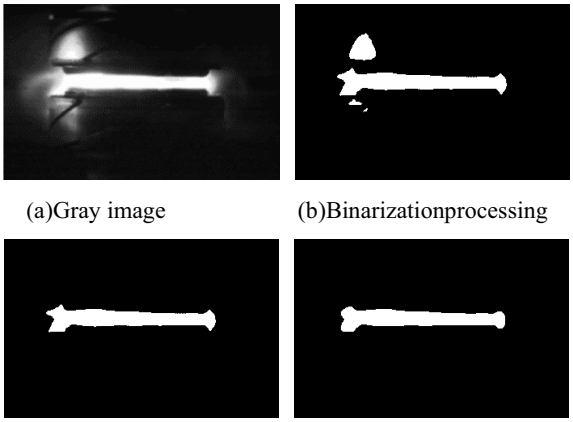


Fig. 3 Pseudo–color and false –color processing

2.4 Morphology processing

Because of the uneven gray scale distribution of the VSA images, the gray-scale value is particularly high and bright in the arc section, while the rest is opposite and changes with arc burning forms, dramatically in the same pixel interframe, droplets will splash in the arc burning process and arc images will occur in contact image region, consequently morphological characteristics of the arc can't be extracted from the grey value separately. Therefore, the VSA images need to be processed morphologically and go through opening and closing operation selectively after binarization processing which can eliminate some unexpected and scattered points, unrelated areas and raised parts in the margins of the VSA images, then better qualities of images are obtained, which offers a good foundation for the extraction of vacuum arc morphological features. As shown in Fig. 4 with three steps included, binarization processing, unrelated areas removing and Opening Operation to show the complete process of binarization optimization.



(a)Gray image (b)Binarizationprocessing

(c)Remove the irrelevant area (d) Opening Operation

Fig. 4 Morphological processing results

3 The VSA images feature extraction

Arc feature extraction is the core part of the VSA images processing, based on the content of digital images pre-processing, with principles of mathematical morphology as supplement, which constitutes the entire system of the VSA images processing. Arc burning process can be qualitatively divided into three parts which are initial gathering, middle proliferation and final extinguishing[8], the arc images will layer and change morphologically during the development.

3.1 Image stratification

The Isotherm is a line which threads each equal temperature point of the object at the same time its density reflects the relative temperature gradient directly in different regions of the VSA images. In the research of VSA temperature, the chromaticity of the VSA images is much less enough, therefore, it is an intuitive temperature display to adopt different isothermal regions,which

further establishes the corresponding relationship between the image color and temperature.

Temperature distribution of the vacuum switch arc is uneven. The spatial distribution of pixels of different gray scale is a reflection of the stratification of the images , referring to the spectral theory, spectral intensity is closely related to inside temperature,particle concentration and composition of the VSA. Accordingly, isopleths of the gray scale depict the location and the intensity distribution of the arc very well, which play an important role for significant information about further research of the center, the root position, and the temperature field distribution of the arc,as shown in Fig.5.

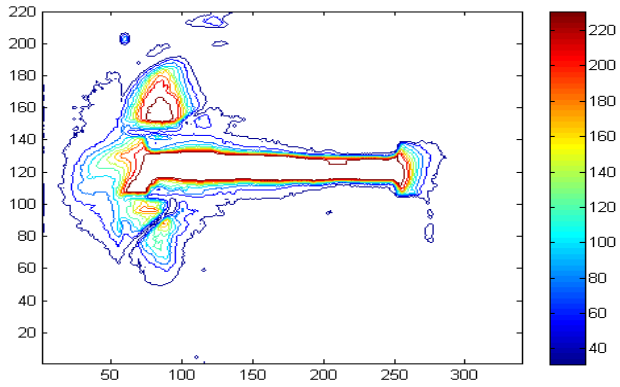


Fig. 5 Isopleths of the gray value

3.2 Image shape change

Binaryzation images of better quality are obtained after a series of pre-processing, areas and perimeters are the most basic morphological characteristics of the binary images. The arc areas are calculated by counting the number of the inside pixels of the arc contour during the processing, while the perimeters are by the sum of the pixels in the boundaries of arc view area. The morphological feature extraction of VSA images in two different stage is shown in Table.1.

Table 1. Area and perimeter of the VSA images

After morphological processing VSA area	After morphological processing arc perimeter	area	perimeter
		3982.625	391.25

4 Conclusion

In this paper, software MATLAB is adopted to process the VSA images which is about noise filtering out, edges detection, image pseudo color and false color processing, morphological processing, and the feature extraction isopleths of the gray value, areas and perimeters of the VSA images. The results are as follow:

1. Median filter is very effective for the salt and pepper noise, while adaptive filter is for the Gaussian noise;
2. The edge detection of the VSA images offers overwhelming foundation for arc morphological feature research;
3. Visual effects are improved and the detailed features are enhanced after image pseudo color and false color processing;
4. Unrelated regions and disturbance points are eliminated in the images and better binary images are obtained through arc image morphological processing;
5. Based on the VSA images preprocessing, gray scale isopleths, the areas and the perimeters after binaryzation are obtained by extracting the features of the Arc images, which build a foundation for researches and inside particle parameters diagnoses.

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