Research on Fault Detection System of Power Equipment Based on UV and Infrared Image

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Abstract. UV corona on power system can reflect the location of the fault and the severity of the fault, the traditional UV and infrared detection equipment can only use the band and the visible light band image of the power system fault detection. In this paper, a power system fault detection system based on ultraviolet and infrared dual-band images is designed. The principle of UV imaging detection and image fusion are introduced respectively. The software of the host computer is written by MFC. The software can acquire both ultraviolet and infrared, the two images are fused using the image fusion algorithm based on edge detection and cross correlation and the highest point temperature is plotted. Experiments show that the system can detect the failure of power equipment in time, and has a certain practical value, which puts forward a new idea for fault detection of power equipment.

1. Introduction

Power equipment in the long-term outdoor high temperature, high pressure and full load, it is prone to failure, and even the formation of accidents, so the need for power equipment to determine the status of fixed-point. Early maintenance of the power equipment is a fault after the maintenance, in this way the sudden failure will often cause huge losses. The daily preventive maintenance of electrical equipment has become a system of power sector, can effectively reduce and prevent the occurrence of electrical equipment accidents. The traditional preventive maintenance must be in the case of power failure to be detected, the state after the device is often off and the run time is not the same, affecting the detection accuracy and accuracy. Therefore, the uninterrupted power equipment, real-time online monitoring system to reflect its superiority[1].

The spectral range of the ultraviolet band is 10~400nm. The sunlight also contains spectral information of the ultraviolet band, where the following spectra are almost completely absorbed by the atmosphere and are therefore referred to as the solar blind zone. When the power equipment is exposed to operation in the atmospheric environment, the intensity of the partial discharge of the insulator on the surface of the device is proportional to the fifth power of its voltage, and the redistribution of the voltage due to the presence of the zero potential insulator will result in severe partial discharge Increase. Partial discharge can emit ultraviolet light in the blind area of the solar day, so that the discharge of the electrical equipment can be detected by detecting the spectrum of the Japanese blind ultraviolet band[2].

Infrared imaging detection means is a remote sensing diagnosis technology, the basic principle is to detect the object's infrared radiation signal, access to the object's thermal status characteristics, and according to the characteristics and related criteria to determine the state of the object. As the infrared imaging testing technology is not contact, real-time, fast and conducive to judgments and other characteristics, it is widely used in power equipment on-line monitoring and fault diagnosis[3].
In this paper, a power failure detection system based on ultraviolet and infrared images is designed, which can collect the ultraviolet and infrared images of fault points in real time, and use the image registration algorithm to fuse the image. This technique can provide a new detection method for the detection of power failure.

2. System principle

2.1 UV imaging detection module system principle

![Figure 1: ICCD structure diagram](image)

The ICCD is mainly composed of a photocathode, a microchannel plate (MCP) amplifier, a phosphor screen, a fiber optic cone and a visible light CCD camera. The ICCD is composed of an ultraviolet sensor module (Intronified CCD, ICCD) The ultraviolet signal emitted by the light source is photoelectrically converted to the photocathode which is sensitive to the ultraviolet signal after passing through the filter. The generated photoelectron is accelerated by the high voltage electric field and then multiplied by the MCP through the MCP. After the multiplication of the electronically bombarded the phosphor screen, Photon conversion, the photon passes through the fiber optic cone to reach the visible CCD camera, thereby obtaining the UV image of the fault target. UV ICCD camera structure diagram shown in Figure 1[4].

By adjusting the gain of ICCD can change the detection sensitivity, get the best detection effect, in a certain range, the gain and the detection accuracy of a linear relationship, by adjusting the ICCD gain can improve the detection sensitivity[5].

2.2 Image Fusion Technology Based on Geometric Relation

The system uses both ultraviolet and infrared cameras to obtain two bands of images. The viewing angle of the UV camera is 8°*6°, the angle of view of the infrared camera is 25°*18°, the camera's field of view is different, the geometry of a single pixel is also different, so the two band images need to be a single pixel registration and integration in order to properly display the information of the point of failure. The system uses two image registration algorithms based on feature point location and edge region detection to register two images[6]. As the UV camera field angle is smaller than the infrared camera, so get a single UV image smaller than the infrared image. We define the edge position of the UV image in the infrared image by geometric relationship, and superimpose the ultraviolet image on the infrared image.

In the actual image fusion, the steps are as follows:

1) the two optical path of the camera fixed on the same optical axis, 5m outside the four low-pressure mercury lamps were placed in the four corner of the UV image, the UV camera and infrared cameras were used for characterization of the first calibration of the UV Image and first infrared image. The edges of the first ultraviolet image and the first infrared image are superimposed on the same coordinate system. The first ultraviolet image in the four low-pressure mercury lamp spot center line to form a first rectangle, the rectangular center coordinates recorded as P1, the area recorded as S1. The center point of the rectangular spot is denoted as P2, the area is denoted as S2, and the area of S1 is divided by the area of S2 to obtain the image of the ultraviolet image and the infrared image Zoom ratio.
(2) the first ultraviolet image is centered at the center of the image as the zoom center and enlarged according to the image fusion zoom ratio to obtain the second ultraviolet image. The second ultraviolet image includes four spots, and the four spot sizes are different from those in the first infrared image Spot size equal;
(3) connecting the center point of the four spots in the second ultraviolet image to form a third rectangle and obtaining the third rectangular central point coordinate P3 to translate the second ultraviolet image so that the third rectangular center point moves to the center point The two rectangular center points coincide with the alignment; the translational amount is calculated from the center point coordinates P1 and the center point coordinates P3, and the translational amount is used as the image fusion translation amount.

Using this algorithm, the ultraviolet image is fused into the infrared image.

3. System development

3.1 Hardware implementation
The project uses the infrared camera for self research products, the detection band is 8~14um, through the Camera Link interface will be collected to the infrared image transmission to the host computer, the host computer through the RS232 interface to the infrared camera to send control commands, used to achieve image contrast adjustment, brightness adjustment and integration time control. The upper computer receives the infrared image and processes the image. The infrared image is subjected to pseudo color processing according to the pre-calibrated temperature value, and the highest point of the temperature is identified.

![Figure 2: System hardware block diagram](image)

![Figure 3: System physical map](image)

The angle of view of the UV camera is smaller than that of the infrared camera, the detection band is 240~280nm, through the Camera Link interface with the host computer for image transmission. If there is an ultraviolet corona image, the host computer receives the original image for the black white
spot signal. When the system is designed, the optical path of the two cameras is strictly fixed on the same optical axis so that the image fusion algorithm can fuse the image through feature point localization and edge area detection.

Figure 2 for the system hardware to achieve the overall system program, Figure 3 for the system physical map.

3.2 Software implementation
The host computer software is written in MFC, and the ultraviolet and infrared images are read at the same time through the Camera Link interface. After the fusion, the interface is displayed and saved in the specified position.

4. Field test results
After the completion of the equipment development, a substation in Fengxian District, Shanghai, conducted a field test, in the detection of an insulator found that the B phase occurred lap, the emergence of UV discharge images, the infrared band image as shown in Figure 5, after calibration the highest temperature of the location and temperature. Figure 6 for the UV image fusion to the infrared image after the infrared infrared dual-band fusion image, the green box in the region for the UV camera to obtain the image, the green point for the UV discharge position, we can see the location of the UV discharge, the temperature was significantly higher the temperature at the non-fault location.

Figure 4: B phase UV band original image
Figure 5: B phase infrared band pseudo color image

Figure 6: B-phase UV-infrared dual-band fusion image

Figure 7, Figure 8 and Figure 9 for the A-phase and C-phase non-faulty location UV band image, infrared band image and UV infrared melt diagram. There is no fault point in this area, the temperature field distribution is very uniform.
5. Conclusion
In this paper, a fault detection device based on ultraviolet and infrared images is designed to obtain the ultraviolet and infrared images of the discharge point of the power system at the same time. The two-band images are carried out by combining the edge region and the cross-correlation image registration algorithm. The experimental results show that the system can work normally, which can provide a new way for the local discharge point detection of electric power field.

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