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Automatic Display Temperature Range Adjustment for Electrical Equipment Infrared Thermal Images

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Abstract

With the important role in detecting electrical equipment defect, infrared thermography is widely used in power industries. With the rapidly increasing data of thermal images, the automatic processing for thermal images is more and more important. This paper presents a new approach to adjust the display temperature range of electrical equipment infrared thermal images. We first take advantage of the temperature distribution of thermal images to find two temperature peaks representing foreground and background respectively, and then find the new display temperature range according to the peaks. In the experiments, we collect 2000 images with improper display temperature ranges to validate the performance of our method. The experiment results show that our approach can effectively improve the image quality of thermal images, which helps the analysis of infrared thermal images.

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Keywords: Infrared Thermography; Electrical Equipment Live Detection; Display temperature; Thermal Image Quality; Temparature Histogram

1. Introduction

Infrared Thermography(IRT) is a key method of electrical equipment live detection, which can monitoring and detecting the thermal status of equipments visually [1,2]. With a thermal infrared imaging camera, infrared energy generated by electrical equipment can be converted into electronic signals, and a thermal distribution matrix with temperature value is calculated.

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Furthermore, with a proper color palette, such as Ironbow, BlueRed, Grayscale and Amber, a pseudo-color image is generated for users. With the pseudo-color image, abnormal over-heated regions can be easily watched, and help users to find the inside defects of electrical equipment. To make the difference between various temperature regions more significant, users should define the display temperature range. With the temperature range defined, the thermal infrared imaging camera will rescale the temperature matrix and the redraw its pseudo-color image. Assuming the calculated temperature matrix is T ,and the display temperature range is $T_r = [t^d_{\min}, t^d_{\max}]$.The rescaled temperature matrix T_d for display is computed with the following equation:

$$T_d(i,j) = \begin{cases} T(i,j) & \text{if } T(i,j) \le t^d_{\max} \text{ and } \mathrm{T}(i,j) \ge t^d_{\min} \\ t^d_{\min} & \text{if } T(i,j) < t^d_{\min} \\ t^d_{\max} & \text{if } T(i,j) > t^d_{\max} \end{cases} \tag{1}$$

Here, *(i,j)* is the coordinate of the matrix.

For example, a thermal image captured by a thermal infrared imaging camera is shown in Fig. 1. Its color palette is Ironbow and the display temperature range $t^d_{\min} = -0.7°\mathrm{C}, t^d_{\max} = 23.2°\mathrm{C}$. Meanwhile, the minimum and maximum value of its original T is -4.9 ℃ and 23.9 ℃. We can see that there is a big difference between the two ranges. The direct negative impact made by this difference is the equipment is not clear enough in contrast to the air. In this case, temperature various inside the equipment region is hardly to be recognized.

Fig. 1. A thermal image generated by a thermal infrared imaging camera

Unfortunately, in real detection process, restricted to the professional knowledge and skills of human users, the display temperature range is often incorrectly defined[3]. Due to these human factors, the boundary between the equipment region and background region is blurred like the example in Fig. 1. As a matter of fact, the display temperature range defined by the users is of most important for preliminary fault judgement, and its can also be an important way to find whether the detection quality of users.

In previous work for infrared thermal images diagnosis for electrical equipment[4-7], people usually focus on proposing different segmentation and detection methods to find the over-heated regions automatically. They suppose that the quality of thermal images is good enough for image segmentation, detection and recognition. Few studies [3, 8] focus on the quality assessment for thermal images with no methods to increase the quality.

In contrast to the related works mentioned above, the main contribution of this paper is: We aim to introduce a visible method to change the display temperature range of thermal images, in this way, the quality of images are increased and diagnosis of thermal images with previous studies would be more effectively.