Visualization based on HDR Image Processing for X-ray Inspection of Power Transmission Cable Joints

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ABSTRACT

In inspection of the power transmission cable joints, X-ray film often becomes low contrast since internal structure is encapsulated by a copper tube. Because the x-ray image has various edges with very different intensities, it is difficult for conventional methods to enhance the faint features of the target effectively. HDR image processing can achieve both suppression for clear edges and enhancement for poor edges simultaneously. We propose visualization system which enhances aimed features by contrast adjustment using multi-scale processing.

KEYWORDS

HDR image processing, Visualization, X-ray inspection, Power transmission cable joints

INTRODUCTION

In order to retain the reliability of the power transmission cable the inspection of the joints is sometimes performed on site. As the internal structure including insulation system is encapsulated by a copper tube, the inspection mostly relies upon X-ray or γ-ray imaging. However, as the absorption by the copper tube and conductor is very significant the contrast of the image in terms of the insulation layer that is the most important is very poor. It is often claimed that the inspection is very hard even for the experienced expert. We propose a visualization based on the high dynamic range (HDR) image processing for faint features in an X-ray image.

The HDR image processing that enhances local contrast by maintaining the dynamic range of the original image has been proposed [1] - [7]. Our method visualizes the faint features in X-ray images by using HDR image processing with a multi-scale contrast adjustment (MSCA) shown in [8]. It separates the X-ray image into Laplacian pyramid, and subsequently adjust the contrast of each level of the pyramid. Since each level of Laplacian pyramid has own spatial frequency band, our method can enhance the only frequency bands constituting the target features. Therefore, we can enhance only the poor edges excluding the strong edges (e.g. the boundary on the copper conductor), and visualizes the all of the features; the details, texture and boundaries.

In the underground power transmission cable joints which are our inspection target, they have interfaces between different materials and deformation in such interfaces may occur due to deteriorations during its field operation. Presently the inspection is being performed by skilled experts, by simply looking at the X-ray images. Enhancing only the faint contrast of the target interface, our method can support experts to detect this deformation.

RELATED WORKS

Existing Enhancement Algorithms

Many effective contrast enhancement methods have been proposed. This paper introduces some effective methods for this problem and compares with our method.

Contrast limited adaptive histogram equalization (CLAHE) [6] is a contrast enhancement method which overcomes limitations of standard histogram equalization. It performs histogram equalization in each local area, and reduces noise by partially reducing the local histogram equalization effect. Block noise is reduced by bilinear interpolation. Although this method is effective and very often used for inspection system, interpolation processing may cause pseudo contours for the image that has HDR.

In HDR image processing field, many dynamic range compression algorithms have been proposed, where it can compress the dynamic range while preserve poor edges. Compressing and companding HDR images with subband architectures [7] is one of them. Li's method [7] uses a symmetrical analysis-synthesis filter bank, and apply local gain control to the subbands. Although this method can enhance the contrast while suppressing the halo effect, the enhancement effect for poor edges is not enough.

Digitalization of X-ray Film

For applying visualization based on HDR image processing, it is necessary to digitize the X-ray films. We use a digital still camera to capture the transmitted light of X-ray films as shown in Fig. 1. LEDs are used for the backlight for avoiding flickers. Box and black felts can reduce the influence of ambient lights.

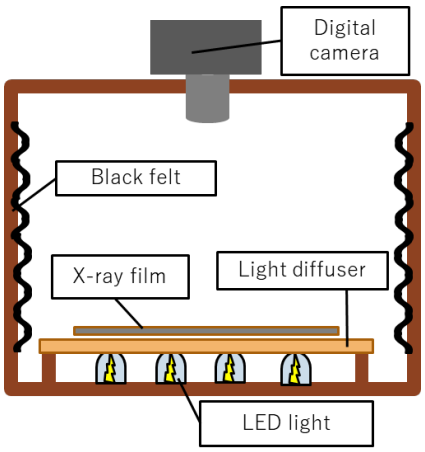

Fig. 1: Digitalization system for X-ray films