The Study on Evaluation for Digital Radiography Image of Weldments

Sang-Ki Park*, Yeon-Shik Ahn and Doo-Song Gil

1 Non Destructive Evaluation Center, Korea Electric Power Corporation Research Institute(KEPCO Research Institute), 65 Munji-Ro, Yuseong-Gu, Daejeon, 305-760, South Korea

* Corresponding author: email skpak@kepri.re.kr , TEL 82-42-865-5557,82-42-865-5564

KEYWORDS : Radiographic Image, Digital Radiography, Weld Inspection, Digital Image

This paper presents a novel methodology for segmenting specific region from digital radiographs. The proposed methodology uses a line gray scale leveling scheme to manage the search for suitable boundaries between regions that best defines functional matching in iteratively selected line pixels's set, with critical point. The search scheme is verified in a classification process line by line to extract a specific region, namely weld joint. If necessary conditions considered in line gray scale level approach are satisfied, it is not necessary to apply pre or post-processing to remove noises generated due to radiographic system and to connect discontinuous boundary due to misclassification. To investigate the proposed algorithm, radiographs from boiler tube welded joints of thermal power plant are used. Weld regions on digital radiographs is a type of ellipse. The test result show that the detected weld region is correctly segmented from the original image and made available to be inspected through others methods for classification

Manuscript received: January XX, 2011 / Accepted: January XX, 2011

NOMENCLATURE

h1 = Background gray scale level
h2 = Tube external gray scale level
h3= Tube thickness part gray scale level

1. Introduction (Times New Roman 10pt)

Non-destructive testing such as radiography, ultrasonic and magnetic particle inspection have been the most widely used to detect internal defects in welded structures [1). Radiographs are produced as type of photographic films or digital radiography sensors by exposure the radiation source to penetrate the object being inspected. The image quality is a key factor for detecting flaws at radiographs. The information content of a radiograph depends on the absorption characteristics of the object exposed at selected energy level, which are determined by the density, thickness, material properties of the object and detecting system mechanism, such as source to film distance, exposure time. Radiographs of detected image are characterized by local variation in material density. It manifests a local variation in image intensity. Although it is impossible to observe that region by visual inspection, the image is globally vague, low contrast, and dark biased intensity, due to radiography system itself including noises. Until now, in order to the reliability and visual accuracy of welding inspection, many efforts have been developed towards the design and construction of computer based vision systems because human visual inspections are often subjective, labor intensive, inconsistent and sometimes biased. Due to the development in digital signal processing and computer vision, visual inspection is being extensively applied, aiming at supporting the radiographs interpretation and therefore enhancing contrast, details and feature extraction of the inspected digital radiography images. The preferentially considerable step in weld radiographs interpretation is to segment the welds from the background. The successive procedures are the detection of welding flaws in the weld region and classification of the type [2, 3)]. This is especially true if image data are digitalized from digital radiography system. Digitalized radiographic images not only enable more efficient management of inspection data, but also make automatic inspection of welds and feedback control possible [4, 5)]. Since only items within a weld are of interest, region based weld feature has to be extracted from each image before applying flaw detection algorithms. It is thus desirable to develop some forms of computer aided image processing algorithms to assist the human visual inspection in evaluating the quality of welded region. It is desirable to extract weld first before applying flaw identifying procedure, where one image contain one weld. This article is on evaluation digital radiography image based on gray scale level method. We used radiographs of welds of power plant boiler tube. The gray scale method is to manage the search for suitable boundaries between regions that best defines functional matching in iteratively selected pixel. The search scheme is verified in a classification process line by line to extract a specific region. If necessary conditions considered in the gray scale level approach are satisfied, it is possible to find critical edge point without applying pre post processing to remove noises. Gray scale level is two directions, vertical and horizontal because weld regions on digital radiographs is a type is ellipse.

2. Problem Description

Radiographic images, which have to be taken from the boiler tube of power plant, are formed and ready for the direction of welded joints. After the X-ray or r-ray exposed, each phosphor plate is read by a scanner device and converted into digital images. The encountered problems that exist in digitalized radiographic images are the measure precision and its repeatability caused by the effect of geometric projection and diffusing radiation. The detector is not closely plated on the object.

Although direct access which produces the scan over large areas is required, the typical measurement adopts the cross section as depicted in figure 1. Figure 1 shows the radiography test method of boiler tube. The object is exposed vertical to a radiation from source. The transmitted radiation is detected by an imaging plate. Its profile reflects the function of the tangential length in the object. In detected images may be distinguished into three main parts; background, thickness and projections passing through the external and internal tube surfaces. Source to object interaction regarding absorption phenomena result in the partition of regions. The other possible problem is the corruption ascribed to image diffusion. The reasons for it are geometric un sharpness, back scattering, edge effect, detector graininess, blurring , beam hardening, source energetic irregularity, digitization errors, electric control system noise, source point spread function [7] . These effects cause the corruption of image data with respect to the energetic absorption mainly due to the large beam passing length gradients and the sharp edge of the object.

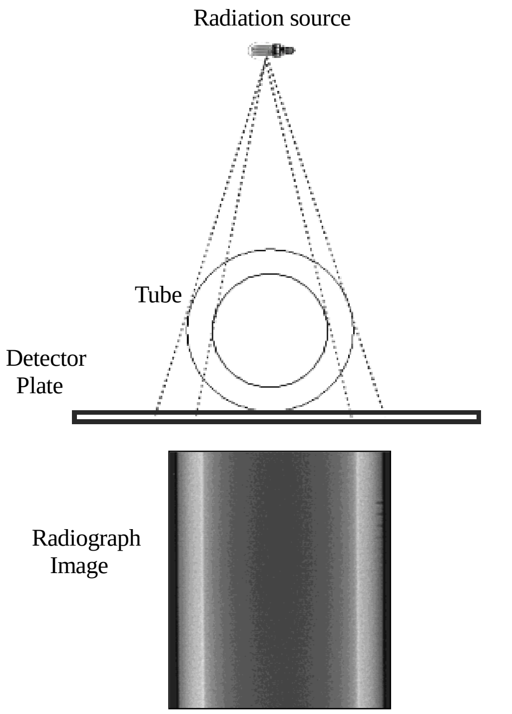


Fig. 1. Boiler tube radiography test method and image

3. Acquisition Scheme of radiographic Image

Radiographic images of welded tubes are produced by double wall double image. This method is based on recording the tangential absorption of the penetrating radiation. The mechanism of this testing allow the adjustment of the radiation direction for inspection of weld area on side wall tube with high sensitivity as depicted figure 2.

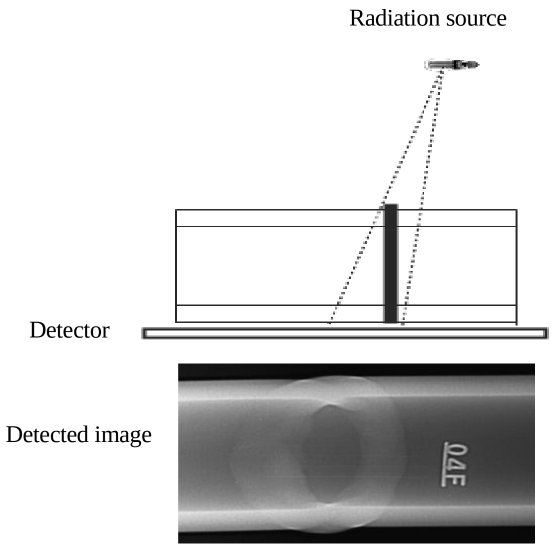


Fig. 2 . Double wall double image method and detected image

As the figure 2 shows, the source is kept at an angle with respect to the weld so as to avoid the overlap of the top and bottom weld. Scanning the weld at an angle provides a slope projection, which improve the probability of detection for latent flaw such as crack, corrosion and lack of fusion. It becomes possible to estimate the weld structure. This varying angle of absorption produces a latent image of the object being examined on a detector. The detector is processed to transform the interest region into shadow image of the internal and external image of boiler tube. The intensity levels graduate from high to low intensity with respect to horizontal direction due to the radiation angle. The intensity in an identical region is not kept uniformity. If the object contains the flaw in weld area, more radiation will pass through weld area than surrounding areas creating a shadow dark region on the image. The produced image could be interpreted and the integrity of intensity could be estimated by signal analysis. Thus for accurate analysis of radiographic images detected by angle double wall double image, it is often necessary to characterize the profiles for the corresponding direction.

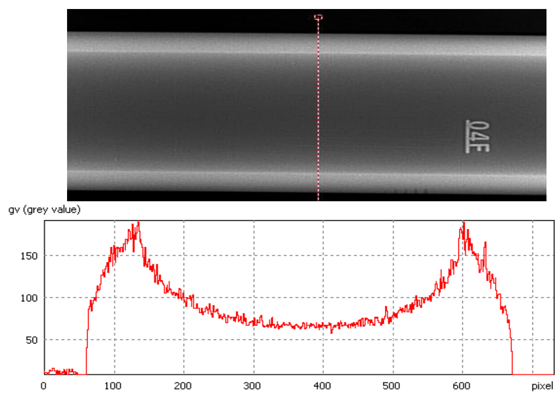
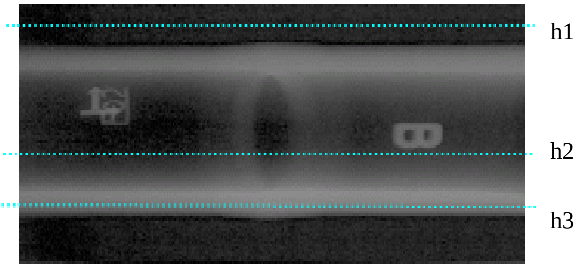
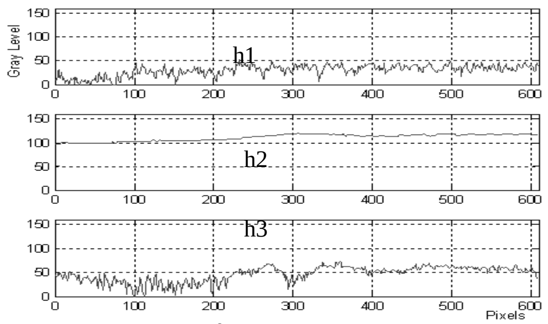


Fig. 3. Measurement profile of one of line data at Y- axis

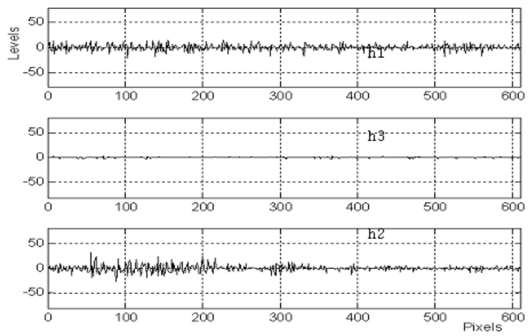
Vertical and horizontal evaluation can be done through the better knowledge of each element of the data. We have built an approach to estimate the mathematical functions and division parameters. Figure 3 shows a measured profile for the corresponding across tube. Y –axis represents the evaluation of profile plots. The background corresponds to scattering noise characteristics. The un-sharpness of the exposure rounds the edges. The two critical points are boundaries between tube and background. Noise level increases in proportion to lower position [6].



(a) Horizontal axis line of object image



(b) Distribution of horizontal gray scale level



(c) Result of differential conversion

Fig. 4. Analysis of gray scale profile to horizontal region

Figure 4 illustrates typical three profiles depicting the absorption variation over the X-axis; background(h1), thickness(h3), and projections passing through the external and internal tube surface(h2). The h2 and h3 horizontal lines separate two classified zones which have different scale along X-axis. The center of the lines corresponds to the specific weld area. The left and right sides correspond to the tube zone.

4. Methodology for region Segment

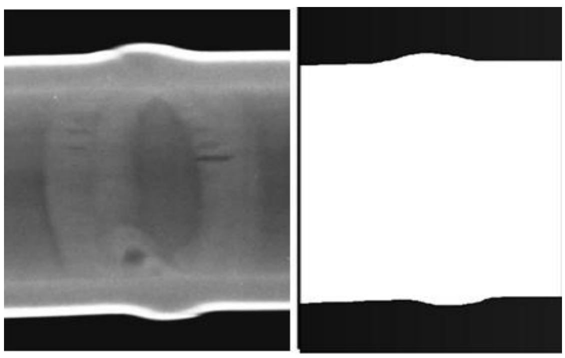
Since the radiographic inspection is based on analysis of the image obtained using r-ray penetration to object, the geometric shapes in radiography are basis on the judgment of the abnormal section. Image features are the most basic characteristic parameters are chosen to describe and distinguish the specific weld. The methodology of this study for extracting welded region consists of three major steps: preprocessing, edge verification, and feature segmentation. Each weld image is processed line by line. Segmental parameters are computed as critical points on each individually selected line image. The segmentations process deal with the specifics to binary image. After segmentation process has been completed, two continuous boundary tracks are marked to identify the contours of weld.

4.1 Preprocessing

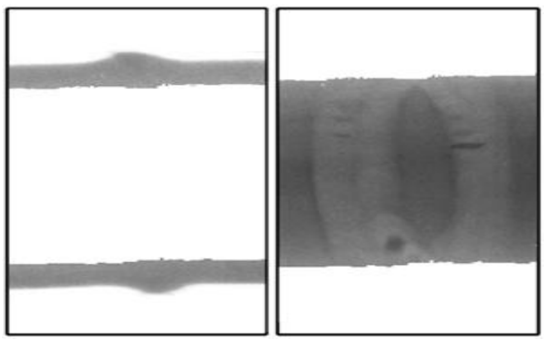
The preprocessing operation is applied to remove noises generated due to detecting procedure and to separate the weld area from the surrounding sign changes on peaks in the slope of the vertical and horizontal line image. As shown in figure 3. Line data at Y-axis includes the two typical peaks which locate on left and right sides. These troughs separate line image vertically into three sections: background, thickness, external and internal tube surface. If peak is encountered the date include in these area are excluded from line image on the basis of peaks, converting the data included in these areas into binary logic. Median filter is applied to remove noise in exclusion image. Figure 5 shows an exclusion/filtered profile for the corresponding across the tube.

4.2 Edge verification and feature segmentation

Once surrounding areas have been eliminated from detected image, local exclusion is carried out only for the selected sub image. For a set of segmented sub image, the algorithm takes sub images sequentially. This is similar to human visual segmental are presented regionally in a sequential manner. Sub selection start from the horizontal line clustering that search the trough, two opposite maximal peaks at X-axis. Similar to vertical exclusion process, the matching point is used to detect the sign changes until the tracking point maximal level of iteration has been reached.



(a) Detected image (b) Background



(c) Thickness region (d) Weld part image

Fig. 5. Each region segment image of weld

5. Conclusions

A methodology for extracting and segmenting weld region from digital radiographic image was implemented and tested. In this approach, a line gray scale level scheme tracks the trough point on line image with boundary edge verification at X-axis and Y-axis. The peaks of weld area in the horizontal and vertical position were tested for sub image extraction. Segmental parameters relevant to maximal troughs were computed as critical points on each individually selected line image. To perform the search for the radiographic image regions most similar to weld characteristic, sequential exclusion process was efficiently used due to a local threshold valve. Our obtained results strongly suggest that this method is feasible for segment specific weld region. By testing images, we showed that the proposed approach is able to detect and segment weld feature, even if the detected image are low contrast, blurred and noise contaminated. However, this method has a limitation. It was segmented the linear type sub image, trough the internal surrounding area is eliminated.

REFERENCES

1. Silva R.R, Caloba L.P, Siqueira M.H.S, Rebello J.M.A: Pattern recognition of weld defects detected by radiographic test, NDT & E Internet Vol 37, no 6, 461-470, 2004
2. T. W. Liao and J. Ni, "An automated radiographic NDT system for weld inspection :part 1-weld extraction," NDT&E, Vol. 29, no. 3 pp. 157-162, 1996
3. Liao T.W, Classification of welding flaw types with fuzzy expert system, with Appl. Vol 25, pp 101-111, 2003
4. Gayer, A, Saya, A and Shiloh, A, :Automatic recognition of welding defect in real time radiography, NDT Intern Vol. 23, no 3 pp 131-136, 1990
5. T. W. Liao and J. Ni, "An automated radiographic NDT system for weld inspection :part 1-weld extraction," NDT&E, Vol. 29, no. 3, pp. 157-162, 1996
6. Park S.K, Hwang J.H, Development of boiler tube inspection technique by computed radiography, pp 292-298, 2010
7. .Lee Y., Fundamentals of Nondestructive Testing Vol. 1 Radiographic Testing, Sejin, 1995