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Development of Denoising Methodologies for Enhancement of Sensitivity in Radiographic Images

M.Aarthi[1] L.K. Hema[2]

PG Scholar, Aarupadai Veedu Institute of Technology, OMR, Paiyanoor, India[1]

Faculty, Aarupadai Veedu Institute of Technology, OMR, Paiyanoor, India[2]

Abstract- In digital industrial radiography, image quality is a measure of the effectiveness with which non-destructive examination may be made. It is usually evaluated on the basis of three measures of imaging performance, namely: spatial resolution, contrast, and noise. Other factors considered are the effect of amount of radiation on the image quality, as well as the occurrence of artifacts. Since the introduction of digital technology to radiography has many benefits but the one which is probably the most important is the ability to image processing. Image processing gives Computed Radiography (CR) a considerable advantage over film-screen systems. The role of image processing is crucial in improving the visual quality of the CR image in terms of spatial resolution, sharpness, contrast resolution, dynamic range, SNR. Image processing efforts maximizes the information extraction from the images. In this paper, it is proposed to acquire the computed radiographic images and evaluate the image quality of the images. It is proposed to carry out a systematic study on the various image processing tools that can be applied for improving the image quality of radiographic images. It also being planned to develop a set of image processing tools, which would be appropriate to extract information and features from the given radiographic images.

Keywords- Weld defects, Computed Radiography, Image processing, Denoising, Edge enhancement.

I.INTRODUCTION

Radiography image is created on the principle that, when X-ray or γ-ray passes through an object, it gets attenuated, depending on the absorbency of the metal. The intensity profiles of the defective region will be having a different pattern of gray level intensity with majority of black intensity. Interpretation of radiographic images by human with naked eyes is error prone and unreliable, since the image will be noising and edges will be obscure. Computer-aided process of weld-defect detection is a very effective and useful technique. Image processing technique is widely used nowadays for the identification of weld defects in rail roads, gas pipes etc. Various research work and projects were conducted in image enhancement and segmentation methods for weld detection. Image enhancement is the process of making the image more visible and at the same time to make it easy to understand the abstruse image contents. Segmentation of image is to partition the image into various objects and recognition is the process of labeling the segmented image based on some features extracted. Several researchers have carried out various works on the recognition of weld defect using FBPN neural network, SVM, k-means clustering etc. All the works are impressive and effective, but they have its own drawbacks. In this paper we propose a method for finding weld defects, with good efficiency and less complexity.

In 2001 R R da Silva, M H S Siqueire et al proposed linear classifiers for recognition of weld defect, in which a hierarchical classifier algorithm and non-hierarchical classifier algorithm are compared where hierarchical classifier is giving better performance. In 2004 T.W.Liao developed a Fuzzy based inspection method for weld-defect recognition where fuzzy rule is constructed by using fuzzy c-means. The performance of fuzzy system was compared with MLP neural network. In 2009, Abdelhak Mahmoudi and Fakhita Regragui developed a segmentation method for weld defects. Detection which is fast and efficient. The result showed that, the algorithm is faster, effective and practical, which is a necessary step before characterizing defects. In 2010, Xin Wang, Brian et al. developed a Support Vector Machine Classifier based methodology for identification of weld defects in radiographic images. This methodology was tested by 25 radiographic weld images, where 96.98% of the existing weld defects are detected, with 14.07% of false alarm. In this proposed method, we first

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use denoising methods and edge enhancement methods in image processing technique. Second, we partitioned the image into objects of defective areas.

Horizontal and Vertical Projection profile of the segmented image is performed for the different pattern of segmented defects. Cluster porosity weld defect occurs due to the presence of moisture, which turns into gas, which will be further trapped in the weld when heated. The Cluster Porosity as the name indicates are usually present as cluster or group which appears like regular porosity. Burn-Through is a weld defect which arises due to overheating, which makes the weld metal to penetrate the weld zone. Burn-Through appears to be a dark spot, surrounded by whitish grayscale intensities. Lack of Penetration defect happens when the weld metal fails to penetrate the joints. It usually appears as a dark straight line of medium width. Slag Inclusion defect occurs due to the presence of non-metallic element in weld metal.

II.MAKING OF RADIOGRAPHIC IMAGES

A radiograph is a photographic record produced by the passage of x-rays or gamma-rays through an object onto a film. When film is exposed to x-rays, gamma-rays or light, an invisible change called a latent image is produced in the film emulsion. The areas so exposed become dark when the film is immersed in a developing solution, the degree of darkening depending on the amount of exposure. After development, the film is rinsed, preferably in a special bath, to stop development. The film is next put into a fixing bath, which dissolves the undarkened portions of the sensitive salt. It is then washed to remove the fixer and dried so that it may be handled, interpreted, and filed. The developing, fixing, and washing of the exposed film may be done either manually or in automated processing equipment.

III.PROPOSED SYSTEM FOR WELD DEFECT DETECTION

The proposed system has the following phases,

3.1 Spatial resolution:

Spatial resolution is the ability to distinguish small objects at high contrast. It is affected by sampling and limited by the pixel size.

3.2 Sharpening:

Sharpening brings out detail and gives an image presence, but not all images should be sharpened the same and even areas within an image often need a specific sharpening treatment. When it comes to sharpening, there are many factors that need to be considered.

3.3 Contrast resolution:

Contrast (grayscale) resolution is the ability of a system to distinguish between objects of different signal intensity. It is affected by quantization and limited by bit depth.

3.4 Dynamic range:

The difference in signal intensity, or frequency, between the largest and smallest signals a system can process or display. The optical density is the difference between the lightest and darkest useful regions of the image. Increasing the number of bits per pixel in a digital image increases the dynamic range of the image.

3.5 SNR (Signal to noise ratio):

The ability to detect an object in a radiograph is related to the ratio of the differential intensity to the ambient noise level. This ratio is called the image signal to noise ratio. Systems are designed to minimize electronic noise, so we focus on the quantum noise effects here.

3.6 Denoising

The radiographic images are basically low in contrast, dark and noisy. Image enhancement is an inevitable part in automatic defect detection, since the defects are unidentifiable directly, due to noises and low image contrast. In this method, a special and transform domain filtering is used to remove the noise. Various denoising techniques have been proposed so far and their application depends upon the type of image and noise present in the image

IV.DENOISING

Image denoising is classified in two categories:

4.1. Spatial domain filtering

This is the traditional way to remove the noise from the digital images to employ the spatial filters. Spatial domain filtering is further classified into linear filters and non-linear filters.

4.1.1 Linear Filters

A mean filter is the optimal linear for Gaussian noise in the sense of mean square error. Linear filters tend to blur sharp edges, destroy lines and other fine details of image. It includes Mean filter and Wiener filter.

a. Mean Filter

This filter acts on an image by smoothing it. It reduces the intensity variations between the adjacent pixels. Mean filter is nothing just a simple sliding window spatial filter that replaces the centre value of the window with the average values of its all neighboring pixels values including itself. It is implemented with the convolution mask, which provides the results that is weighted sum of vales of a pixel and its neighbors.It is also called linear filter. The mask or kernel is square. Often 3×3 mask is used. If the coefficient of the mask sum is up to one, then the average brightness of the image is not changed. If the coefficient sum to zero, average brightness is lost, and it returns a dark image.

b. Weiner Filter

Weiner filtering method requires the information about the spectra of noise and original signal and it works well only if the underlying signal is smooth. Weiner method implements the spatial smoothing and its model complexity control corresponds to the choosing the window size. H(u, v) is the degradation function and H(u, v)* is its conjugate complex. G(u, v) is the degraded image. Functions Sf(u, v) and Sn(u, v) are power spectra of original image and the noise. Wiener Filter assumes noise and power spectra of object a priori.

$$F(u,v) = [\ H(u,v)/\ H(u,v)^2 + [\ Sn(u,v)/Sf(u,v)\ ]\ ]\ G(u,v)$$

4.1.2 Non- Linear

With the non-linear filter, noise is removed without any attempts to explicitly identify it. Spatial filters employ a low pass filtering on the group of pixels with the assumption that noise occupies the higher region of frequency spectrum. Generally spatial filters remove the noise to reasonable extent but at the cost of blurring the images which in turn makes the edges in the picture invisible.

a. Median Filter

Median filter follows the moving window principle and uses 3×3, 5×5 or 7×7 window. The median of window is calculated and the center pixel value of the window is replaced with that value.

4.2 Transform domain filtering

The transform domain filtering can be subdivided into data adaptive and non-adaptive filters. Transform domain mainly includes wavelet based filtering techniques.

4.2.1 Wavelet Transform

Wavelet transform is a mathematical function that analyzes the data according to scale or resolution. Noise reduction using wavelets is performed by first decomposing the noisy image into wavelet coefficients i.e. approximation and detail coefficients. Then, by selecting a proper thresholding value the detail coefficients are modified based on the thresholding function. Finally, the reconstructed image is obtained by applying the inverse wavelet transform on modified coefficients.

There are two thresholding functions frequently used i.e. Hard Threshold, Pan, Soft threshold. Hard-Thresholding function keeps the input if it is larger than the threshold; otherwise, it is set to zero. Soft-thresholding function takes the argument and shrinks it toward zero by the threshold. Soft-thresholding rule is chosen over hard-thresholding, for the soft-thresholding method yields more visually pleasant images over hard thresholding. A result may still be noisy. Large threshold alternatively, produces signal with large number of zero coefficients. This leads to a smooth signal. So much attention must be paid to select optimal threshold.

a. Universal Threshold

Donoho in his work proposed Universal threshold (VISU Shrink) that over-smooth images. Universal threshold, with n equal to size of the image, σ is noise variance. This was determined in an optimal context for soft thresholding with random Gaussian noise. This is easy to implement but provides a threshold level larger than with other decision criteria, resulting in smoother reconstructed data. This estimation does not allow for the content of the data, but only depends on the data size n. Also threshold tends to be high for large values of M, killing many signal coefficients along with the noise. Thus, the threshold does not adapt well to discontinuities in the signal.

b. Stein Unbiased Estimated of Risk (SURE)

The Universal threshold was later improved by Donoho using the SURE threshold. It is sub band adaptive and is derived by minimizing Stein's unbiased risk estimator. Stein's result to get an unbiased estimate of the risk.

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V.EDGE ENHANCEMENT METHODS

There are many ways to perform edge detection. However, the most may be grouped into two categories, gradient and Laplacian. The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. The Laplacian method searches for zero crossings in the second derivative of the image to find edges.

5.1 Canny Edge Detector:

The Canny edge detector is widely considered to be the standard edge detection algorithm in the industry.

The steps in the Canny edge detector are as follows:

1. Smooth the image with a two dimensional Gaussian. In most cases the computation of a two dimensional Gaussian is costly, so it is approximated by two one dimensional Gaussians, one in the x direction and the other in the y direction.

2. Take the gradient of the image. This shows changes in intensity, which indicates the presence of edges. This actually gives two results, the gradient in the x direction and the gradient in the y direction.

3. Non-maximal suppression. Edges will occur at points the where the gradient is at a maximum. Therefore, all points not at a maximum should be suppressed. In order to do this, the magnitude and direction of the gradient is computed at each pixel. Then for each pixel check if the magnitude of the gradient is greater at one pixel's distance away in either the positive or the negative direction perpendicular to the gradient. If the pixel is not greater than both, suppress it.

4. Edge Thresholding. The method of thresholding used by the Canny Edge Detector is referred to as "hysteresis". It makes use of both a high threshold and a low threshold. If a pixel has a value above the high threshold, it is set as an edge pixel. If a pixel has a value above the low threshold and is the neighbor of an edge pixel, it is set as an edge pixel as well. If a pixel has a value above the low threshold but is not the neighbor of an edge pixel, it is not set as an edge pixel. If a pixel has a value below the low threshold, it is never set as an edge pixel.

VI.EXPERIMENTAL RESULTS

In the radiographic input image with weld defects are first passed through denoising and preprocessing stages. Edge enhancement method is used for segmentation which gave a better result than region growing. The output of the radiographic weld images are shown in the Figure.

(a) Image with Lack of Penetration Welding Defect and Output Image.

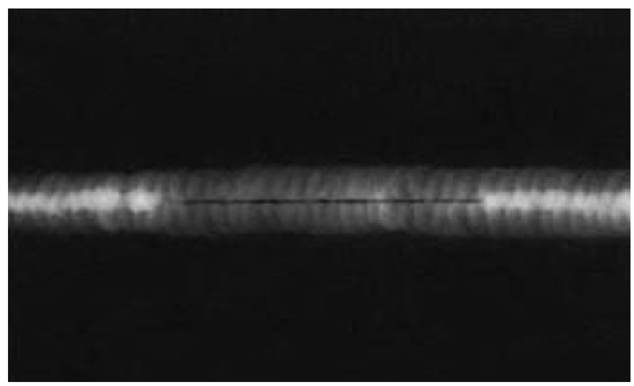

Fig 1: Input Image with Lack of Penetration Welding Defect

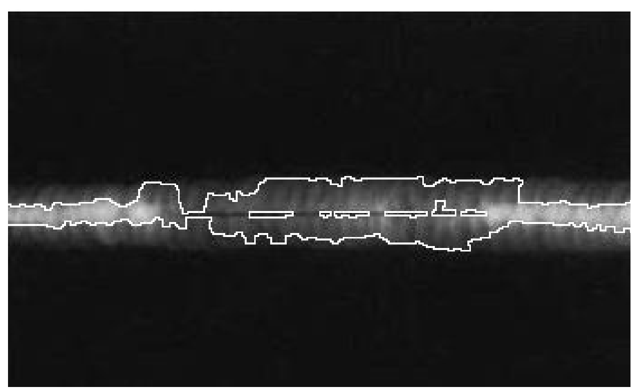

Fig 2: Output Image with Lack of Penetration Welding Defect

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(b) Image with Burn through Welding Defect and Output Image.

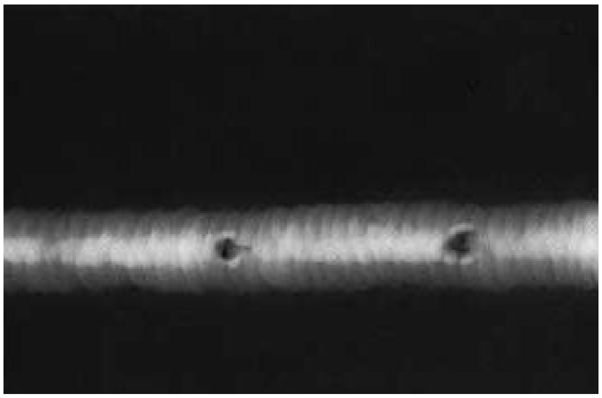

Fig 3: Input Image with Burn through Welding Defect

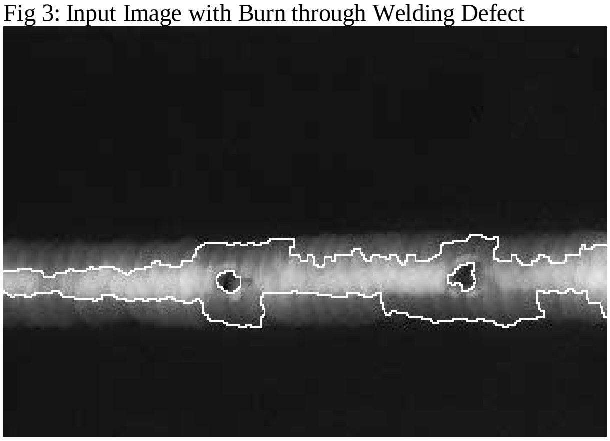

Fig 4: Output Image with Burn through Welding Defect

VII.CONCLUSION

This paper presents the computed radiographic images and the quality of weld defect detection system. The test images have been degraded by various types of noises. The experimental result shows that the proposed method is highly reliable for noisy images in edge enhancement methods. Image processing and enhancement methods performs well for weld defect segmentation and features extracted are very efficient for recognition of weld defects like Cluster Porosity, Slag inclusions, Lack of Penetration (LOP) and Burn-Through. The learning error and the testing error shows the recognition rate of nearly 99% can be achieved through this approach.

REFERENCES

[1] R R da Silva, M H S Siqueira, L P Calôba and J M A Rebello," Radiographics pattern recognition of welding defects using linear classifiers", International Institute of Welding , Vol. 43, No.10, October 2010 , pp. 1-7.

[2] T.W. Liao "Classification of welding flaw types with fuzzy expert systems", An international journal of Expert Systems with Applications 25, 2009 , pp.101–111.

[3] A Mahmoudi and F Regragui, "A Fast Segmentation Method for Defects Detection in Radiographic Images of Welds", Proceedings of the 7th ACS/IEEE International Conference on Computer Systems and Applications (AICCSA) Morocco: IEEE Computer Society, 2009, pp.857-860.

[4] Xin Wang, Brian Stephen Wong and ChingSeong Tan, "Recognition of Welding Defects in Radiographic Images by Using Support Vector Machine Classifier", A Research Journal of Applied Sciences, Engineering and Technology 2(3), 2010, pp. 295-301.

[5] Yuqian Zhao , Jianxin Liu , Huifen Li and Guiyuan Li, "Improved Watershed Algorithm for Dowels Image Segmentation", Proceedings of the 7th World Congress on Intelligent Control and Automation June 25 - 27, Chongqing, China,2011.

[6] N. Nacereddine, and M. Tridi, "Computer-aided shape analysis and classification of weld defects in industrial radiography based invariant attributes and neural networks", Proceedings of the 4th International Symposium on Image and Signal Processing and Analysis, 2010, pp. 88-93.

[7] Juan Zapata , Rafael Vilar and Ramón Ruiz "An automatic system of classification of weld defects in radiographic images", An international journal of NDT&E International 42l, 2012, pp. 467-476.

[8] A Mahmoudi and F Regragui, "Welding Defect Detection by Segmentation of Radiographic Images", Proceedings of the World Congress on Computer Science and Information Engineering: IEEE Computer Society, 2012, pp. 111-115.

[9] Juan Zapata , Rafael Vilar and Ramón Ruiz , "Performance evaluation of an automatic inspection system of weld defects in radiographic images based on neuroclassifiers", An international journal of Expert Systems with Applications 38 , 2012 ,pp.8812–8824.

[10] Rathod, V.R., Anand, R.S. and Alaknanda, "Comparison of Different Segmentation Techniques in Detection of Flaws in Weldments", Proceedings of the 2nd International Conference on Computer and Automation Engineering (ICCAE), Vol. 2, February 26-28 , 2011 , pp. 672-677.

[11] Shaun. W. Lawson and Graham. A. Parker, "Intelligent segmentation of industrial radiographic images using neural networks", Proceeding of the International Conference on Emerging Trends in Electronic and Photonic Devices & Systems, 2011.

[12] Li Cheng, Li Yan and Fan Shangchun, "CCD infrared image segmentation using watershed algorithm", Proceedings of the Third

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[13] Abdelwahab Zaramdini and Rolf Ingold , "Optical font recognition from Projection Profile", Electronic Publishing, Vol6(3), 249-260 September-2010.

[14] Zhang xiao-guang, Xu jian-Jan and Li yu, "The Research of Defect Recognition for Radiographic Weld Image Based on Fuzzy Neural Network", Proceedings of the 5th World Congress on Intelligent and Automation, June 15-19, 2011, Hangzhou, P.R. China , pp. 2661-2665.

[15] Mohamed Rizon, Haniza Yazid, Puteh Saad, Ali Yeon Md Shakaff, Abdul Rahman Saad, Mohd Rozailan Mamat, Sazali Yaacob, Hazri Desa and M. Karthigayan,"Object Detection using geometric Invariant Moment", An American Journal of Applied Sciences, June 2012, pp. 1876-1878..

[16] D.D Wang, and Jinwu Xu "Fault Detection based on evolving LVQ Neural network", 2011 IEEE

[17] H. Kasban , O.Zahran , H.Arafa , M.El-Kordy , S.M.S.Elaraby and F.E.Abd El-Samie , "Welding defect detection from radiography images with a cepstral approach", An international journal of NDT&E International 44, 2012, pp. 226-231.

[18] Chuan-Yu and Shih-YuFu "Image classification using a module RBF Neural Network", Proceedings of the First International Conference on Innovative Computing, Information and Control, 2010 IEEE.