

# Image Processing Method on Radiographic Image of Piping using MATLAB: Enhancement and Detection Process



Puteri Zirwatul Nadila M. Z, Norfadhlin Khalid, Roszaiman Abd Khalid, M. K. Puteri Zarina

**Abstract:** Image enhancement is a pre-processing process to enhance the quality and information content of original data. This paper investigates two methods of image augmentation that is deployed to remove noise and improve radiographic images. The first method is image filtering, which consists of smoothing, sharpening and edge enhancement (Sobel & Prewitt) operations. The filtering method emphasizes certain characteristics or eliminates other details. While the second method is morphological technique that utilizes the opening and closing operation, which employed to removed distorted noise and imperfection on the processed images. Each method and operation applied to the image is evaluated subjectively based on the enhance image quality. The image quality measured using MSE (Mean Square Error) and PSNR (Peak Signal to Noise Ratio) which is a full reference metrics. The image quality results are compared to give a wide picture on the performance of the enhanced images. The image processing operations accomplished by using MATLAB image processing toolbox.

**Keywords:** digital radiography; image enhancement; image detection; image quality

## I. INTRODUCTION

Radiography is one of the Non-Destructive Testing (NDT) techniques to find out internal incoherence existing in the material or component. This method has a lot of advantages over the conventional radiographic film which includes the ability to digitally transfer image, immediate image preview, cost reduce due to film processing steps and time efficiency. Ekinci S and Ron PINCU [1][2] reviewed the use of digital radiography in the evaluation of defects in welds. However, there are some problems in digital radiography system must have a problem which effect the imaging quality. Chen and Lu [3] reviewed the problems occurred in the digital radiographic system. Most of the digital radiography image is in poor quality.

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Suitable technique is important to improve image quality for better inspection. Image processing method has a technique such as noise elimination, intensity adjustment, edge recognition and other means. The main goal of these approaches is to extract particulars of image or to enlarge the contrast in a low contrast image and it can be done by adjusting the concentration of the pixel of the input image [4]. The image processing method reviewed by many authors to improve the radiography image and shows better interpretation of weld defect [5][6][7]. Image augmentation and image segmentation is selected to enhance the digital radiography image contains three defects in piping. Figure 1 exhibits the process flow chart of image processing via image processing toolbox in MATLAB. Image enhancement allow removing of noise, sharpening, or adjusting an image's contrast. Meanwhile for detection process, methods such as thresholding and edge detection is selected to detect object boundaries within pictures.

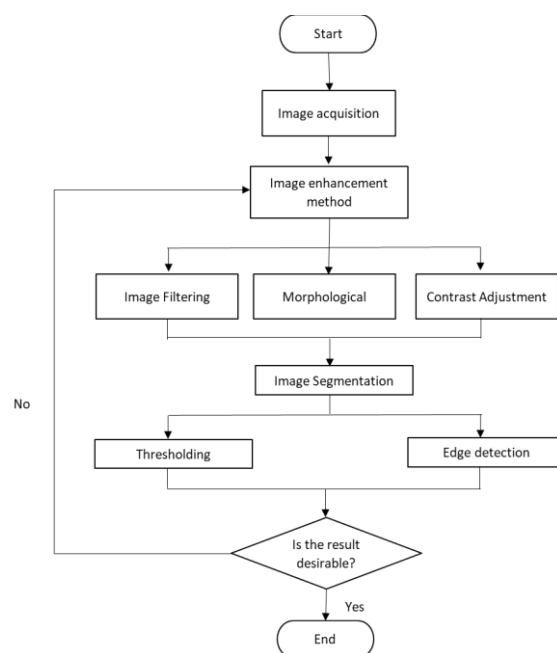
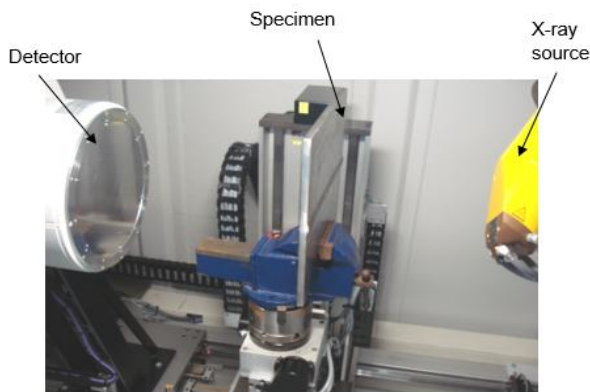


Fig. 1 Flowchart of image processing

## II. IMAGE ACQUISITION

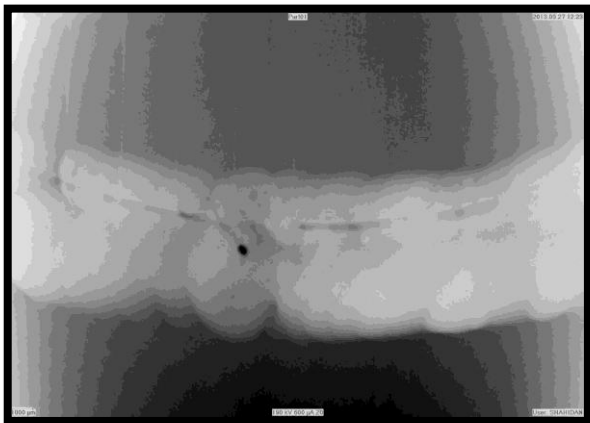
In this research, image is taken using NDT Analyzer Model: m 225D from GE Phoenix X-ray equipped with digital image chain for improved contrast and greater resolution. The  $\mu$ -focused digital radiography has 9" triple-, 6" dual- and 6" single-field image intensifier for full digital imaging.

The piping is captured by using microfocused digital radiography. The current is 500  $\mu$ A and voltage is 190 kV. Exposure time to acquire the image is 200  $\mu$ s. The sampling is placed in the  $\mu$ -focused digital radiography machine as displayed in Figure 2 below.



**Fig. 2 The arrangements in the micro focus x-ray machine**

The image in Figure 3 below shows radiographic image of piping obtained by exposure technique of single wall single image (SWSI). The weld defects are blow hole, porosity and lack of blending. Lack of root fusion or incomplete root fusion in Figure 4 happens when the weld metal does not produce a solid bond with the base metal or when the weld metal fails to cover the base metal to the desired depth, which causes inadequate throat thickness. Porosity and blow hole are voids or apertures caused by gas and non-metallic material entrapment in molten metal during solidification.



**Fig. 3 Original radiographic image**

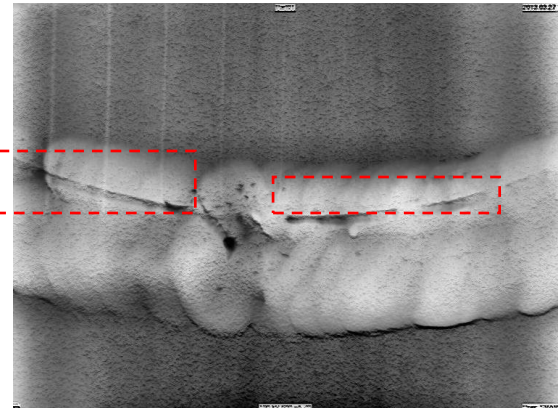


**Fig. 4 Incomplete root fusion**

### III. ENHANCEMENT PROCESS

Image enhancement processes in MATLAB provide variable procedures that seek to enhance the visual outlook of an image or to alter the image to a form that suits the human analyst to run the analysis or used for other computerized

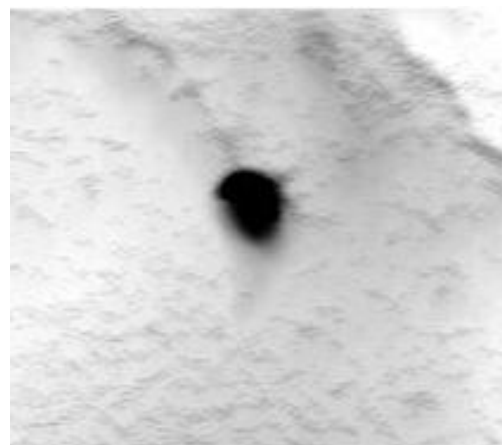
image processing procedures. The image improvement process comprises three categories: filtering, morphology, and adjustment of contrast. Figure 5, Figure 7 and Figure 9 indicate the outcome after augmentation method and three weld defects obviously displayed in the image.



**Fig. 5 Processed image after image enhancement and incomplete root fusion weld defect**



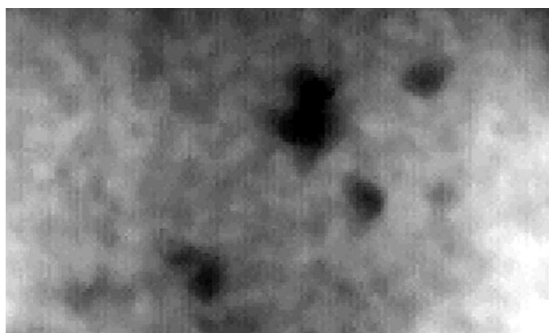
**Fig. 6 Original image before enhancement and blow hole weld defect**



**Fig. 7 Processed image after image enhancement and blow hole weld defect**



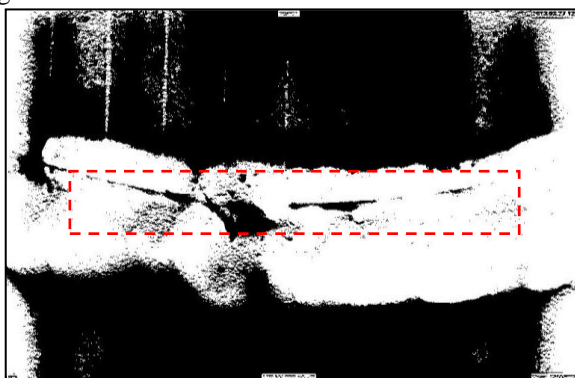
**Fig. 8 Original image before enhancement and porosity weld defect**



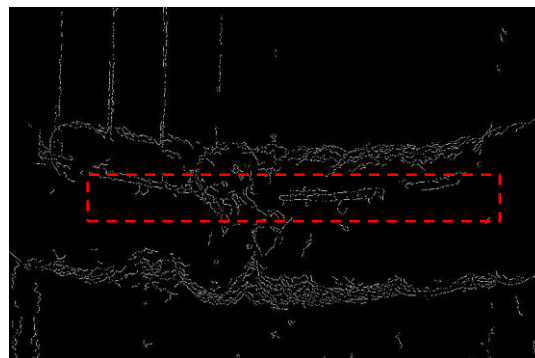
**Fig. 9 Processed image after image enhancement and porosity weld defect**

#### IV. SEGMENTATION PROCESS

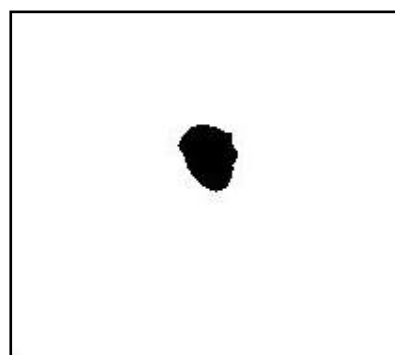
Image segmentation is a method of dividing the center from the background or grouping pixel areas based on color or shape resemblances. The method of image segmentation includes histogram thresholding and edge detection. This method is reviewed by many authors to achieved successful detection of different kinds of image [8][9][10][11][12]. Image detection method implemented after processing and enhancing an image. Image breakdown is one of the digital image processing procedures, which partition of image is analyzed into multiple parts or regions, often based on the facets of the pixels in the image. Image thresholding is shown in Figures 10, 12, and 14. Meanwhile canny edge detection result is shown in Figures 11, 13 and 15. Canny edge detection achieves enhancement and compression without the loss of any important edge with detecting discontinuities in brightness.



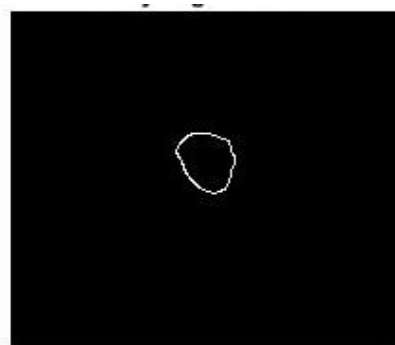
**Fig. 10 Incomplete root fusion segmented by histogram Thresholding**



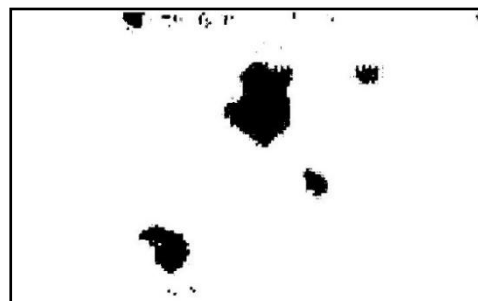
**Fig. 11 Incomplete root fusion segmented by Canny edge detection**



**Fig. 12 Blow hole segmented by histogram Thresholding**



**Fig. 13 Blow hole segmented by Canny edge detection**



**Fig. 14 Porosity segmented by histogram Thresholding**





**Fig. 15 Porosity segmented by Canny edge detection**

## V. RESULT AND DISCUSSION

The result for image enhancement and image detection proved that the weld defect in radiographic image improved compared to original image. The methods discussed shows improvement by measuring the image quality after removing the noise and enhanced by using filtering technique. Table 1 has shown PSNR, MSE and NAE results, which connecting to elimination of noise and reducing of error in the picture.

**Table. 1 Image Quality Measurement Result**

Weld Defect	Quality Performance
Incomplete root fusion	MSE = 950.3119 PSNR = 18.3521 NAE = 0.1910
Blow hole	MSE = 6245.7420 PSNR = 10.1750 NAE = 0.5842
Porosity	MSE = 1906.2669 PSNR = 15.3290 NAE = 0.2589

MSE embodies the collective squared error between the compressed and the original image. PSNR, on the other hand, characterizes a value of the error of the peak. Peak Signal to Noise Ratio (PSNR) is normally deployed to examine the image, sound and video files quality in dB (decibels). A lower value for MSE means less error and greater value of PSNR is adequate because this suggests that the signal to noise ratio is greater [7].

$$MSE = \frac{1}{mn} \sum_{x=0}^{m-1} \sum_{y=0}^{n-1} [f(x, y) - f^*(x, y)]^2 \quad (1)$$

$$PSNR = 20 \log_{10} \left( \frac{MAX}{MSE} \right) \quad (2)$$

$$NAE = \frac{1}{N.M} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} [f(x, y) - f^*(x, y)] \quad (3)$$

$$\sum_{x=0}^{m-1} \sum_{y=0}^{n-1} f(i, j)$$

where:

mn= image dimension in row, m and column, n

f(x,y)= the pixel value at (x,y) of the original image

f\*(x,y)= the pixel value at (x,y) of the processed image

MAX = maximum value of image pixel value.

Normalized Absolute Error (NAE) is a measure of the distance of the rebuilt image from the original one, with the value of zero being the perfect fit. High value of NAE shows a unsatisfactory quality image [13][14]. Table 1 below shows the quality performance results for three weld defects based on Figure 5, Figure 7 and Figure 9.

## VI. CONCLUSION

The defect on the radiographic image of a pipe were identified and have been classified by using two method of image processing which are image enhancement and detection. The image is enhanced thus giving a clear vision of its defect which is then used and analyze by image detection process. As the current industry is growing rapidly through the years, the needs for the latest product are in high demands. In the welding inspection, the use of digital radiographic testing in non-destructive testing (NDT) has become more relevant as the industry develops but the high cost for the latest digital radiographic x-ray device are becoming a major drawback to some company. Additionally, the maintenance cost of a digital radiographic image is too high to be affordable by the small and average company in the country. Although the industry is going through a major revolution with the industry, there still some limitation in the current industry that needs to be consider such as the use of radiography film is still popular among the companies in the country.

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