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Low Level Processing of Radiographic Weld Images Using SUSAN Edge Finding Operator.

P Chitra*.

Department of Electrical and Electronics, Sathyabama University, Chennai 119, Tamil Nadu, India.

ABSTRACT

This paper presents a novel method for detecting the edges of the defects in radiographic image. Due to the noisy nature and less contrast of the radiographic image it is first subjected to preprocessing algorithms. The preprocessing algorithm includes noise reduction filters such as median, weiner and homomorphic filter. Of this entire filter the weiner filter gives better result and this image is subjected to edge detection algorithm. Comparing to all the edge detecting method SUSAN edge finder gives better result in detecting the defect region present in the digitized radiographic image.

Keywords: Edge detection, SUSAN edge detection, Digitized Radiographic image, Defect detection

Corresponding author

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INTRODUCTION

Conventionally film radiography is widely used for recording the images. In the present day context, power plants and components are expected to perform for over 40 to 60 years. It is thus necessary to have all the design and inspection records appropriately archived so that it can be used later. Digital archiving of data has unlimited life and retrieval capacity.

Once the radiography is digitized computational intelligence and image processing methods can be applied for enhancing the quality of the radiographic image and for improving its sensitivity. As manual interpretation of weld radiographs is subjective in nature and is affected by operator fatigue, it necessitates automated interpretation of weld radiographs. For automatic detection of radiographic detection of radiographic defects there is an need of suitable image processing algorithm. Edge detection algorithm plays an very important role in detecting the boundaries of the defects which is further used for characterization of defects.

Karargyris and Bourbakis proposed a method for detecting protrusions and perforated ulcers in wireless capsule endoscopy (WCE) images using SUSAN edge finder. The SUSAN is applied to extract the polyp occurring in small intestine. Gabor filter is used for segmenting the texture features and then SUSAN operator is applied for extracting the detailed boundaries of the image [1].

Zhang and Wang [2] applied SUSAN method for detecting crack like defects in radiographic image of aluminium alloy cast. The result is also compared with other edge detection methods such as Robert, Krisch and sobel. Huanli Li [3] proposed a method for detecting the corner of the teeth in radiographic image using improved SUSAN method. Median filter is used for removing the noise present in the image. Thresholding method based on gray value is used for segmentation.

Zhi-qiang et al.,[4] integrates a method of SUSAN and K-Mean clustering for detection of moving targets. The fusion of the methods produces satisfactory result. Dixit and Silakari[5] applied SUSAN edge detection method for extracting the facial features such as eyes, nose, lips, mouth and eyebrows. This output is further used for face recognition. Neural network is trained with obtained features by bezier curve method. The recognition rate obtained by this method is 85%. Edge detection is one of the low level processing step which describes the structure of defects present in the image. This paper discusses about the SUSAN edge detecting methods applied on the radiographic image.

Radiographic Defects

It is well known that welding is done by melting the work pieces and adding a filler material to form a weld pool that cools to become a stronger joint. Welding is performed using different sources such as gas flame, electric arc, a laser, an electron beam, friction and ultrasound. After welding, discontinuities or interruptions may occur in the structure of the base metal, weld material, or in the heat affected areas. Discontinuities, which do not meet the requirements of the codes or specification, are referred to as defects. The most commonly occurring weld defects includes lack of fusion , lack of penetration or excess penetration, porosity, inclusions , crack and undercut.

The defects present in the material affect the quality of the material. Hence there is need for Non Destructive Technique (NDT) to examine the subsurface and surface of the weld, surrounding base metal, to reveal the defects which are not visible during visual interpretation. The five commonly used methods to evaluate the weld are Visual, Liquid penetration, magnetic particles, ultrasonic and Radiography.

Once the radiographic film is digitized, computational intelligence and image processing methods can be applied for enhancing the quality of the radiographic image and for improving the sensitivity. The image processing is used to speed up the process of evaluation and also to make it more reliably by reducing the person fatigue and can also be used in interpretation and sizing of features detected in the radiography.

Preprocessing of Radiographic image

Preprocessing is improving the contrast and removal of noise present in the radiographic image. Noise in the radiographic image may cause the change in brightness level even thought there is no detail in the image. Sometimes it reduces the image quality of the radiographic image [6]. The most commonly occur noise in the radiographic image is visual noise and quantum noise. The presence of visual noise gives the radiographic image grainy, textured, or snowy appearance. In all radiographic system using X-ray and gamma rays as source quantum noise is present due to the random distribution of photons in the image. The quantum noise in the radiographic image is reduced by increasing the photon concentration i.e exposure. In digital radiographic by using proper exposure factor and optimum technique used for each procedure an image with acceptable noise level is developed. The noise reduction filters applied on the radiographic image are weiner filter, median filter and homomorphic filter. The performance of these filters is evaluated by image quality parameters. Of this weiner filter gives better result.

Edge detection

Abrupt change in gray level of an image constitutes edges. An edge is the boundary between two dissimilar region in an image [7][8]. Edge based segmentation distinguish the boundary separating these regions. Edge detection techniques are broadly classified into gradient based edge detection (first derivative) and zero crossing (second derivative). This section discusses the SUSAN edge detector technique applied on the radiographic image.

Smith et al., [9] proposed SUSAN (Smallest Univalue Segment Assimilating Nucleus) edge detector which detect edges based on the brightness level of the center pixel value with respect to the neighbouring pixel value. The method uses an annular mask containing 37 pixels. The mask is moved to each pixel of the image, its value is compared with the center pixel of the mask according to the equation defined by

$$c(x_0, y_0; x, y) = \begin{cases} 1 \ when \ |f(x_0, y_0) - f(x, y)| \ \leq T \\ 0 \ when \ |f(x_0, y_0) - f(x, y)| \ > T \end{cases}$$

Where $f(x_0,y_0)$ is brightness value of the pixel in the position x_0, y_0 of the image considered. f(x,y) is the brightness value of pixel in the mask. Where ' T' is the threshold value. T value is the minimum contrast value of the pixel which should be detected. The running total $S(x_0,y_0)$ of $c(x_0, y_0; x, y)$ is given by

$$s(x_0,y_0) = \sum_{x,y \in n(x,y)} c(x_0, y_0; x, y)$$

$s(x_0,y_0)$ describes the USAN area. Initial R corresponding to the edges is calculated by comparing S with respect to threshold which is set half maximum of S. this shows the simple principle of SUSAN for detecting the edges.

RESULTS AND DISCUSSION

Radiographic image is subjected to preprocessing steps which is used for removing noise present in the image. Noise content in the image may be reproduced as false edges while applying edge detection algorithm, so noise removing filter weiner is applied on the radiographic image. After noise removal edge detection technique is applied on the radiographic image. Radiographic image containing four different shapes and two natural occurring defects such as slag inclusion and crack is considered for analysis. These images are subjected to five edge detection technique such as Robert, prewit, sobel, canny and SUSAN. The output obtained by these techniques is shown in fig1 to fig 6. From the result it was found that SUSAN method provides better result in all radiographic images considered. . From the SUSAN output it was found that the edges are marked with black border so that it is made visible in edge detected image. The boundaries of the edges obtained by this method is continues compared with canny and other edge detecting methods. The experimental result shows that appreciable improvement should be made in detecting corner edges using SUSAN techniques.

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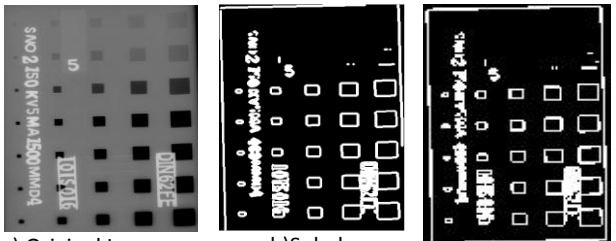
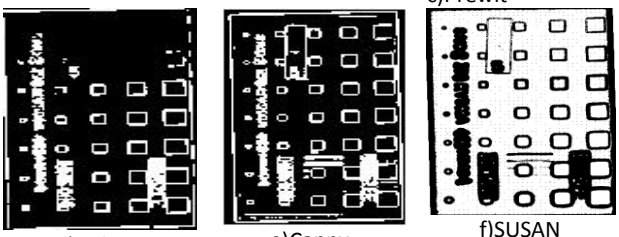
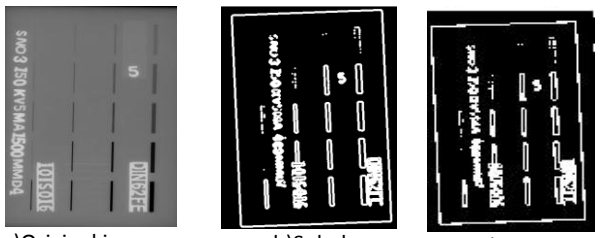


a) Original Image b)Sobel c)Prewit

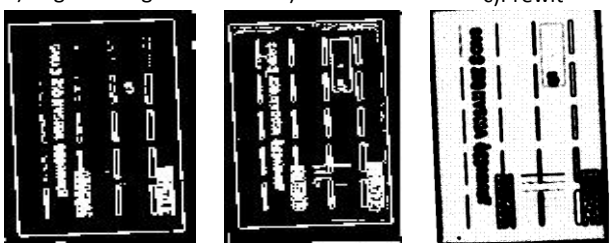


d)Robert e)Canny f)SUSAN

Fig.1 Edge detection output obtained using various edge detection methods on a radiographic image of square shape notch made on a stainless steel plate.

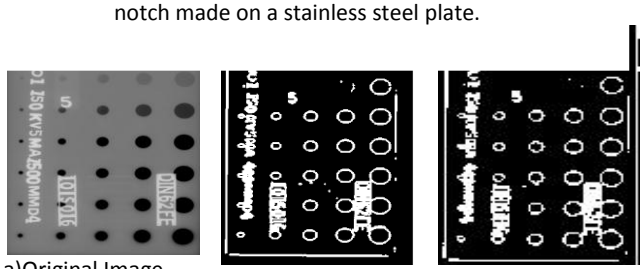


a)Original image b)Sobel c)Prewit

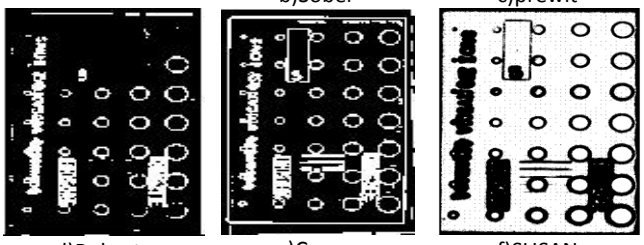


d)Robert e)Canny f)SUSAN

Fig.2 Edge detection output obtained using various edge detection methods on a radiographic image of line shape notch made on a stainless steel plate.

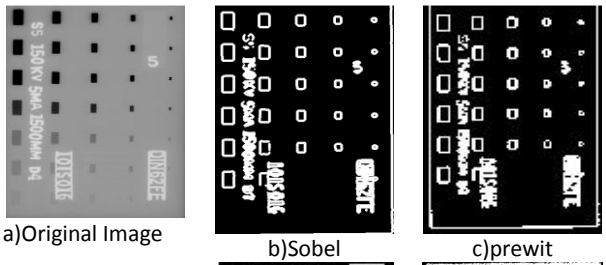


a)Original Image b)Sobel c)prewit

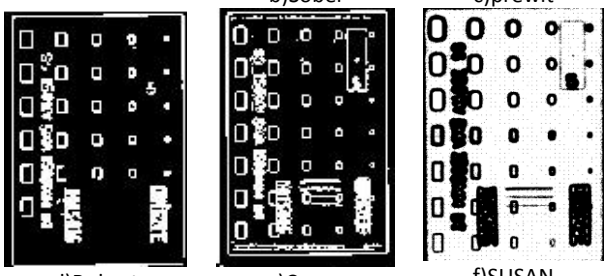


d)Robert e)Canny f)SUSAN

Fig.3 Edge detection output obtained using various edge detection methods on a radiographic image of circle shape notch made on a stainless steel plate.

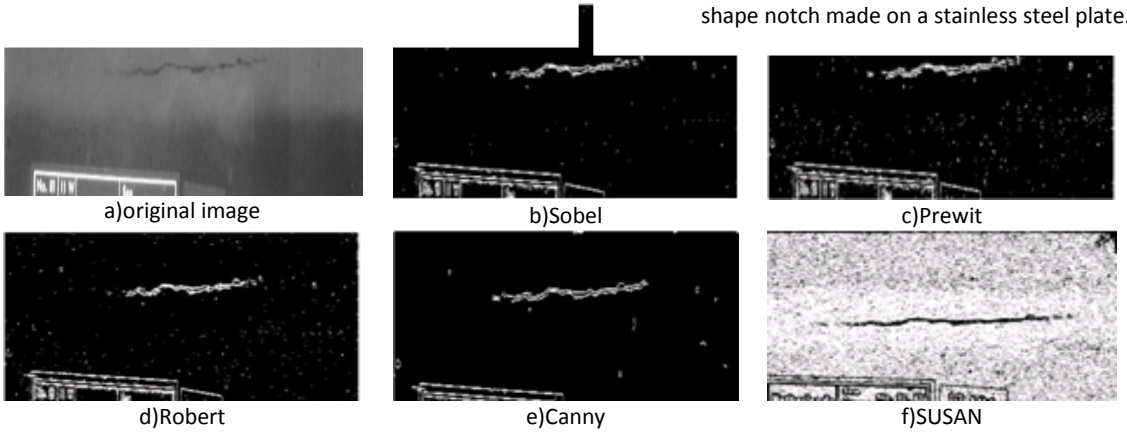


a)Original Image b)Sobel c)prewit



d)Robert e)Canny f)SUSAN

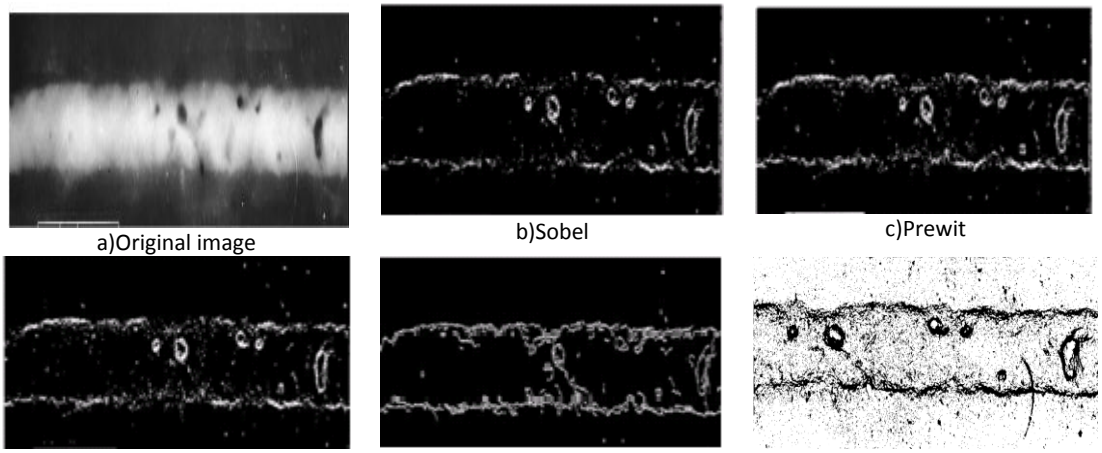
Fig.4 Edge detection output obtained using various edge detection methods on a radiographic image of rectangular shape notch made on a stainless steel plate.



a)original image b)Sobel c)Prewit

d)Robert e)Canny f)SUSAN

Fig.5 Edge detection output obtained using various edge detection methods on a radiographic image containing defect crack



a)Original image b)Sobel c)Prewit

d)Robert e)Canny f)SUSAN

Fig.6 Edge detection output obtained using various edge detection methods on a radiographic image containing defect slag inclusion

In order to remove edges of the defect region from the radiographic image SUSAN edge detector is applied. The result is compared with other edge detector techniques, from the result it was found that SUSAN edge detector gives smooth edges. However the method needs much more improvement in detecting corner edges. Once the defects are characterized it can further quantified using quantification algorithms.

REFERENCES

[1] Alexandros Karargyris and Nikolaos Bourbakis. IEEE Transactions On Biomedical Engineering 2011;58(10):2777-2786.

[2] Yaoyu Cheng-Shuxian Zhang and Yan Hu-Yu Wang. Edge Detection Algorithm Based on SUSAN Operation on Auto Hub Image, Proceedings of the 9th WSEAS International Conference on Multimedia Systems & Signal Processing, pp 63-66.

[3] Huanli Li, Lihong Guo, Tao Chen, Xinzui Wang, Huanli Li and Limei Yang. The Corner Detector Of Teeth Image Based on the Improved SUSAN Algorithm", 2010 3rd International Conference on Biomedical Engineering and Informatics (BMEI 2010), pp 609-612.

[4] Kang Zhi-qiang, Shi Xiu-hua and Li Qi Feng Bin. Study on The Detection Method of SUSAN Operator and K-means Clustering algorithm Fusion", IEEE 10th international conference on Signal Processing(ICSP 2010) proceeding, pp 817-820.

[5] Manish Dixit and Sanjay Silakari. International Journal of Advanced Science and Technology 2014;71:41-48.

[6] Jiun-Jian Liaw, Ssu-Bin Lian, Yung-Fa Huang, and Rung-Ching Chen. 2009, "Atmospheric Visibility Monitoring Using Digital Image Analysis Techniques", Proceedings of the 13th International Conference on Computer Analysis of Images and Patterns (CAIP -09), Vol 5702, PP.1204-1211.

[7] Juneja M and Sandhu PV. International Journal of Computer Theory and Engineering 2009;1(5):614-621.

[8] Saluja S, Singh AK and Agrawal S. International Journal of Advanced Research in Computer and Communication Engineering 2013;2(1):994-999.

[9] S Smith and J Brady. International Journal of Computer Vision 1997:45-48.