Detection Of Flaws In Weldment Images Using Region Growing Segmentation Technique

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Abstract

This paper presents an efficient detection method to highlight the flaws present in weld images. The obtained results further help in finding the size and location of the flaw. The method is applied on X-ray images having flaws generated during the welding process. Using region-growing method we merge the adjacent detected pixels on homogeneity criteria, to obtain the flaws. Region growing starts with seed(s). The seed value is determined with the help of histogram analysis. The peaks and valleys of histogram help in determining the seed value.

The developed algorithm is explained and applied on the welding images and some preliminary results are shown which are encouraging.

Key words - segmentation, region growing, flaw detection, seed, and homogeneity

INTRODUCTION

Images are preprocessed to remove noise and artifacts; segmentation of an image is done to interpret the image. Segmentation of an image has always been a key problem in computer vision. Image segmentation is a process in which regions or features sharing similar characteristics are identified and grouped together. Image segmentation is based on thresholding, edge detection, region detection or combination of any of these techniques. The segmentation should separate the regions that are homogenous to the particular criteria chosen for analysis, so that the variations of segmented area should be considerably less than the variation at borders. The segmented area should have smooth shedding and texture there should not be large variation in homogeneity criteria with in a single segment. Small data must be clear for further analysis and the position of border obtained after segmentation must mach with local maxima, ridges and saddle points of local gradient the measurements [1-2].

Segmentation basically divides an image into segments having of the following characteristics.

- Looks uniform
- Belongs to single object
- Have some uniform attributes
- All pixels related to it are connected

Most segmentation techniques are either based on discontinuity or similarity criteria. Segmentation based on discontinuities – edges and similarity based segmentation - thresholding, region growing, split and merged [3].

- Edge based technique is based on discontinuities criteria. Edges are detected where there is an abrupt change in gray scale among the neighboring pixels [4-6], the edge-based segmentation demarcate the boundary, which separates different regions. These edges are then grouped into contour or surface that represents the boundaries of an object. Usually filter is used to get first order and second order image gradients then edges are extracted by thresholding the gradient [7-9]. Problem with edge-based segmentation is that edges do not give close contours. The edges detected are incomplete, specially in noisy images and linking of broken edges is a difficult procedure.
- Region based technique is based on the grouping of the common patterns of intensity values within a cluster of neighboring pixels. The cluster is refreshed as region.

The regions grouped according to their function or anatomical role, basically based on criteria of homogeneity. So the segmentation is a process of extracting and representing information from an image in the form of group of pixels having homogeneity. Different criteria's like texture, colour, gray level etc. can be used, even in combination for region-based segmentation. Goal of the technique is to determine the region of pre-defined homogeneity criteria. Two of the most widely use methods are split and merge and region growing. [10-11]

Region growing technique gives good results where borders are difficult to detect and to generate better results in noisy image. We studied the region growing approach to segmentation of weld image. The region growing starts with seed and small areas are merged to obtain a region having all the pixels having predefined criteria. Merging of regions is often based on comparing the difference of their feature measure with a predefined value known as segmentation threshold. Threshold determination is difficult to select, an appropriate threshold is crucial to get successful region growing results. In the existing method the most suitable threshold value is determined by histogram analysis. Although single threshold may be sufficient to segment an image but multiple thresholds give better results in complex image. With the help of iteration the threshold value that gives best results can be obtained easily. Existing algorithm applied for region growing has multiple threshold and these are clubbed together to get best results. It is a position dependent threshold method determined using a prior knowledge about image or by local thresholding techniques applied on different parts of image [12-13]. Local thresholding technique is used on different parts of image to select the most suitable threshold for merging.

REGION GROWING METHODOLOGY

Region growing is a technique, which helps to extract boundary of an image. In this process the pixels are grouped or sub regions are combined to form large regions, based on predefined criteria. The predefined criteria may be based on different homogeneity properties of an image i.e. intensity value of pixels texture, motion, shape, size, variance and colour. In region-growing the basic idea is to divide an image into zones of maximum homogeneity [14-15].

Basic purpose of region growing is to segment on entire image R into smaller sub images R_i =1,2.....N which satisfy the following conditions.

a) $R=\bigcup_{i=1}^{N} R_i$;

b) P (R_i) = True; i=1,2.....N;

c) $R_i \cap R_j = \emptyset$, $i \neq j$

Where R_i and R_j are adjacent

d) P (R_i U R_j) = False, $i \neq j$

In region growing an initial set of small areas is iteratively merged according to similar constraints. Starting up with seed point and compare it with neighboring pixels, region is grown from the seed pixel by adding in neighboring pixels that are similar in predefined criteria. The size of the region increases by using 4 adjacent or 8-adjacent neighbor. When the growth of one region stops other seed pixel which does not belong to any region is chosen and start again. This whole process continued until all pixels belong to some region. It gives good result that corresponds well to observed edges. Starting with one seed gives, bias results in favors of seed chosen first, so simultaneous region growing technique are used. A number of regions are allowed to grow simultaneously and similar regions will gradually merge with each other.

In region growing adjacency is major control it can be 4 neighbor (adjacent) or 8 neighbor (adjacent), pixel similarity is secondary

4	3	2	3	4			2	2	2	2	2
3	2	1	2	3			2	1	1	1	2
2	1	0	1	2			2	1	0	1	2
3	2	1	2	3			2	1	1	1	2
4	3	2	3	4			2	2	2	2	2

Proximity; define connection between image pixels 4 neighbor (adjacent) or 8 neighbor (adjacent)

Suppose A=(p1,q1), B=(p2,q2) are two image points; D(A,B)

$$= \sqrt{(p1-p2)^2+(q1-q2)^2}$$

$$D_4(A,B) = |p1-p2|+|q1-q2|$$

$$D_8(A,B) = \max\{|p1-p2|,|y1-y2|\}$$

Region Growing Algorithm

- Start at some location (s) (seeds)
- Propagate from seed or seeds to its neighbor
- Only add adjacent pixels that satisfies with homogeneity criterion of region
- Repeat the Steps from 2 to 3 until it reaches the boundary of the region

Figure 1 Original X-Ray image having incomplete penetration

Figure 2 Segmented images obtained after implementation of region growing method on image of Fig.1.

- Can grow multiple regions in parallel and in competition [16-17]

DISCUSSION AND RESULT

In region growing approach the segmentation of welding images start with 'seed' and small areas get merged to obtain a region having all the pixels with pre-defined characteristics. Merging of region is often based on comparing the difference of their feature measure with a predefined value known as segmentation threshold. Threshold determination is difficult. To select an appropriate threshold is crucial to get successful region growing results. In the applied algorithm, the threshold value is determined by histogram analysis. The valleys and peaks of histogram help in determining the threshold values. Although single threshold may be sufficient to segment an image but multiple thresholds give better results in complex images, with

the help of iteration method the threshold which gives best result can be obtained easily. Existing algorithm applied for region growing has multiple

threshold and these results are clubbed together to get best results.

It is a position dependent threshold method. Local thresholding technique is used on different parts of image to select the most suitable threshold for merging two regions. Fig.1 shows a radiographic image of weldments having incomplete penetration. Flaws are clearly identifiable after the application of algorithm .The segmented image, depicting the flaws is shown in Fig. 2.

CONCLUSION

It is very useful to detect flaws in industrial application to improve the quality and reduce the cost of product. The image obtained after the implementation of region growing technique produced high quality segmentation on the wide range of gray-scale image. It can easily be adapted to different image applications by substituting the suitable feature measure. By using region-growing technique the size and position of flaws can be depicted more accurately

A limitation of this algorithm is that the threshold value has to be judged by the expert, based on histogram of the iimage

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