COMPUTED RADIOGRAPHY VISION IN WELD TESTING “CR-VISION-WT”

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Abstract: With an aim of gathering some works carried out during several years within the Pattern Recognition team of Signal Processing and Imagery Division in our research center, we have conceived software which we have called “Computed Radiography Vision in Weld Testing (CRVision-WT)”. This software is dedicated to the image processing and analysis in industrial radiography for the purposes of detecting, locating, quantifying and identifying possible discontinuities and defects present in a welded joint. The ultimate processing step in this software is related to decision-making about the acceptance or rejection of the discontinuity in question according to international standards such as API 1104 and ASME Sect. V. For a given processing stage, the software offers sometimes several routines in order to seek, in an interactive way, the more appropriate ones for the current processed radiographic image.

Keywords: radiographic testing, weld defect, image processing and analysis, software.

1. Introduction

The interpretation of possible weld discontinuities in industrial radiography is ensured by human interpreters. Consequently, it is submitted to subjective considerations such as the aptitude and the experiment of the interpreter, in addition of the poor quality of radiographic images, the weak size of defect, etc., due essentially to the exposure conditions. These considerations make sometimes the weld quality interpretation inconsistent, labor intensive and biased. It is thus opportune to develop computer-aided techniques [1-14] to help the interpreter in evaluating the quality of the welded joints. We present in the Fig. 1 a general configuration of a radiographic testing system used in the inspection of the welded joint.

![Fig. 1 – General configuration of a welded joint inspection system using radiography](image)

In the software proposed in this paper, a toolbar provide shortcuts to some processing operations (see Fig. 3).

![Fig. 3 – The software: Computed Radiography Vision in Weld Testing, “CRVision-WT”](image)

2. Image operations

In the first rubric, we present to the user various operations to handle the image to be processed. For example, load image, select the region of interest, display and save the resulted images (Figs. 4 and 5).

![Fig. 2 – Global structure of the proposed software](image)
Fig. 4 – Handle the image to process and the resulted images

Fig. 5 – Select the region of interest

3. Preprocessing

This rubric in Fig. 6 proposes several preprocessing algorithms to enhance the quality of the image to be processed. We can find:

- Noise removal using the filters (Fig. 7)
- Contrast enhancement by image stretching, (Fig. 8)
- Contrast enhancement by mathematical morphology, statistical and adaptive enhancement (Fig. 9).

Fig. 6 – Preprocessing and image improvement

Fig. 7 – Example of median filter

Fig. 8 – Image stretching

Fig. 9 – Example of statistical enhancement

4. Segmentation

The segmentation is the main step of image processing. From this operation, we try to delimitate the region of the object representing the discontinuity or the defect in the welded joint (Fig. 10). This software offers several segmentation methods

- **Binarization:**
  - Histogram 1D: Otsu, Kapur, Kittler et Tsai,
  - Histogram 2D: local, joint and relative entropies,
  - Adaptive locally: Niblack and Sauvola (Fig. 11),
- **Active contours:** polygonal statistical (Fig. 12) et polygonal statistical with automatic ROI,
- **Finite mixture models:** Gaussian (Fig. 13) and generalized Gaussian distributions.

Fig. 10 – Select the region of interest representing the discontinuity or the defect in the welded joint
5. **Post-processing**

The procedures in this rubric aim to improve the results of segmentation in order to better fit the object representing the weld defect. In post-processing (Fig. 14), we have:

- Median filter
- Morphological operators, dilation, erosion, opening, closing, artefact removal, etc. (Fig. 15)

6. **Description or feature extraction**

In this rubric (Fig. 16), we compute the geometric descriptor (Fig. 17) and the generic Fourier descriptor (GFD) in order to describe the defect in terms of shape (elongation, rectangularity, symmetry, etc.). These descriptors constitute the inputs of the weld defect classification stage.
7. Classification

We have chosen four types of weld defects for this software: Crack (Cr), Lack of penetration (LP), Porosity (Po) and Solid inclusion (SI). In the rubric classification (Fig. 18, 19), our purpose is to classify the defect indication present in the radiographic image, if it exists, into one of the cited defects using several classification and clustering techniques such as finite mixture model, support vector machine, artificial neural network and Bayesian networks.

8. Diagnosis/Standards

In this rubric, we apply the international standards dealing with radiographic testing in order to accept or reject a weld (Fig. 20). These international standards are based on criteria computed according to the dimensions of the extracted defect indications. Here, API 1104 standard is used in the proposed software (Fig. 21).

The software application on the other standards (ASME Sect. V, API 5L, etc.) are under construction.
9. Conclusion

The software CRVision-WT is an image processing tool dedicated to nondestructive testing of weld by radiography. From the input radiographic film image of a weld, the software apply incrementally all the processing stages involved in a machine vision system, namely, preprocessing, segmentation, feature extraction, classification, decision-making based on norms and standards governing NDT by radiography.

10. References