Military Technical College
Kobry El-Kobbah,
Cairo, Egypt

6th International Conference
on Electrical Engineering
ICEENG 2008

Detection of steel defect using the image processing algorithms

By

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Abstract:

In this paper, detection and classification of steel surface defects is investigated. Image processing algorithms are applied for detecting four popular kind of steel defects, i.e., hole, scratch, Coil break and rust. The results show that the applied algorithms have a good performance on steel defect detection. Numerical results indicate that the implemented image processing algorithms have 88.4%, 78%, 90.4%, 90.3 % accuracy respectively on the hole, scratch, Coil break and rust defect.

Keywords:

Automatic inspection, Image processing, Steel defect

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1. Introduction:

Automatic metal surface inspection is a well known problem and is being considered for more than two decades [1, 2]. The Steel quality control is currently done mainly by human visual inspection. Human inspectors classify the defects according to their cause and origin because the inspection results are used as feedback to correct the manufacturing process. The experience of the inspector is essential, because there are no fixed defect criteria. The inspector's pass/reject decisions seem to be based on the types of defects and their extent, the maximum number of defects per unit of surface area and the total number of defects on the entire inspected strip. In addition, the inspector's knowledge of the customer and the use of the strip have a great impact on the decisions.
As the human visual inspection is an unreliable, tedious and boring task, automation of the visual inspection can provide a reliable quality control system for steel manufacturers. We are aiming through this research to detect steel defects by the image processing algorithm.
This paper is organized as follows. In the next section steel defect types is described. Steel defect detection will be presented in the third section. The numerical results present in the fourth section. Finally, conclusion of the work is discussed in the fourth section.

2. Steel defects:

It has been determined about 210 defects on the steel surface in the Mobarake steel complex which is the biggest steel manufacturer in the Iran as well as in the Middle East. However, the most important and the most occurred defects are hole, scratch, Coil break and rust. This research aims to detect these defects on the steel sheet images.
For this research, we have collected an image database of steel defect images. Image database consists of 93 images of real defects which 59 images has been collected from the university of Kanpur(India)[3,4] and the rest has been collected from the Mobarake Steel Complex(Isfahan, Iran). Because of the limited access to the factory, we have generated 157 synthesized images by photo shop software and added to the database. A sample of real and synthesized images of hole defect has been presented in the figure 1 and 2.

Fig.1 A sample of hole defect

Fig.2 A synthesized hole defect using the photo shop software

3. Defect detection:

Some of the common operations for defect detecting are: Theresholding, Noise removal, Edge detection and Segmentation [5]. We have tested several image processing algorithm and selected the high performance method. In the following, defect detection will be described with details.

3.1 Hole and scratch detection:

Theresholding is the first step in the hole and scratch detection. The second step is the hough transform [5]. Experimental results show that the hough transform of the hole defect has a Gaussian function with a large σ (Fig.3) and the scratch defect has a small σ (Fig.4). The algorithm has 88.4% accuracy on the hole detection and 78% accuracy on the scratch detection.

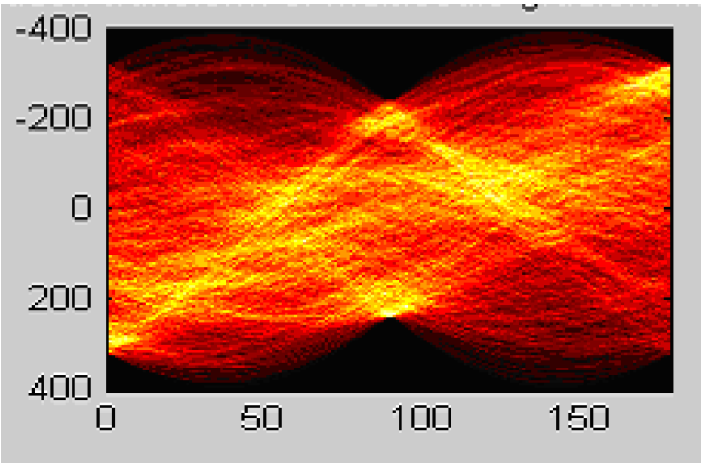


Fig.3 Hough transform of a sample hole defect

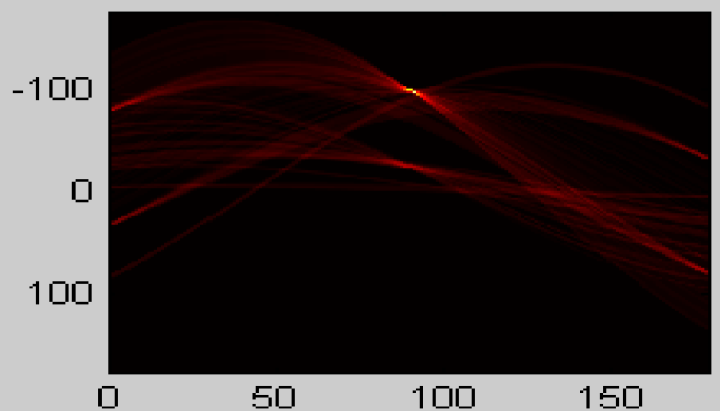


Fig.4 Hough transform of a sample scratch defect

3.2 Coil break detection:

Pixels of this defect type have been distributed over the wide range of the steel sheet. Experimental results show an evident difference between the histogram of this defect image and the other defects (Fig.5). For finding this defect, we have defined two thresholds T1 and T2 respectively named up and down thresholds. A defect will be the coil break if two below conditions are satisfied:

1. More than n1 percents of the image pixels have gray level of more than T1 threshold.
2. More than n2 percents of the image pixels have gray level of less than T2 threshold.

For finding parameters i.e. T1, T2, n1, n2, we applied the algorithm for different parameter values and evaluated it on the coil break detection. As can be seen in the Fig.5 , the best parameters are:

n1=1.8 n2=2.2

T1=.9 T2=.35

We applied the algorithm on the 250 images of different defects; we achieved 90.4% for the coil break detection.

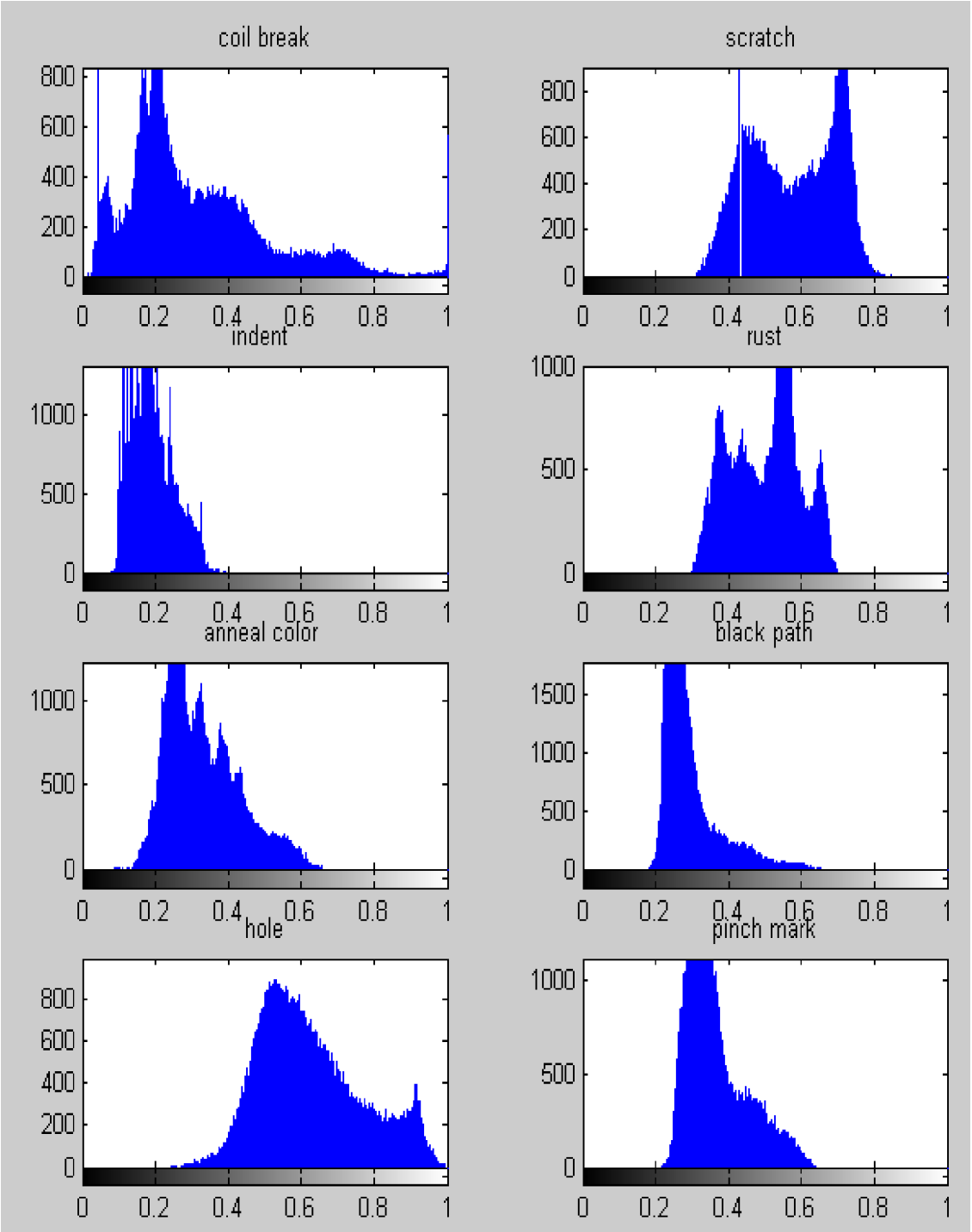
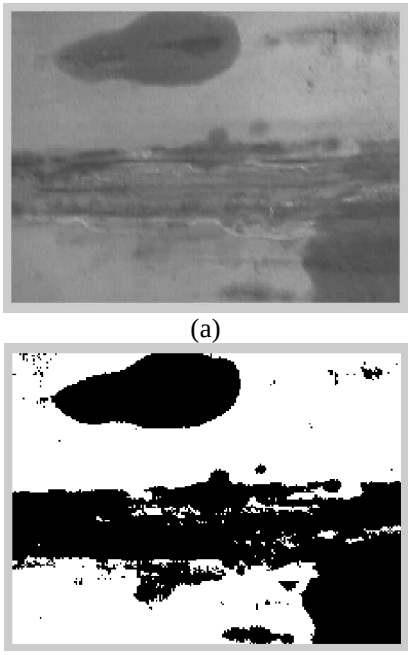


Fig.5 Comparisons of the coil break defect image histogram with the other defects

3.3 Rust detection:

The first step in finding the rust defects is segmentation. For segmentation, image has been tresholded. For thresholding, many methods such as Maximum Entropy Sum Method, Entropic Correlation Method and Renyi Entropy are reported [15].However, in this research we have chosen Renyi Entropy.

Based on the nature of this defect, it uniformly covers major parts of the steel sheet. Therefore, after binerization(Fig.6), we should count the ones in the image and compare with a threshold. We have defined T1 and T2 respectively for the boundary of rust and the rust defect level. We experimentally found T1=22 and T2= 55 and achieved 90.3% accuracy on the rust detection (Fig.7).



(a)

(b)

Fig.6 (a)original image of a rust defect (b)Global thresholded image of the rust defect

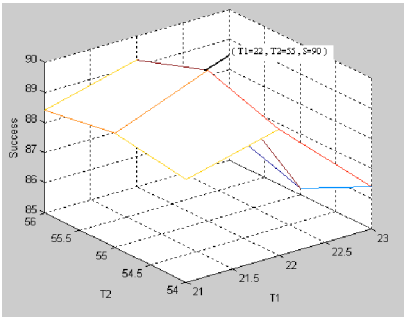


Fig.7 Performance of the rust detection method based on the different T1 and T2

4. Conclusions:

In this paper, detection and classification of steel surface defects were investigated. Image processing algorithms are applied for detecting four popular kind of steel defects, i.e., hole, scratch, Coil break and rust. A set of 250 steel defect images were used for testing the proposed method. The results show that the applied algorithms have a good performance on steel defect detection. Numerical results indicate that the implemented image processing algorithms have 88.4%, 78%, 90.4% , 90.3 % accuracy respectively on the hole, scratch, Coil break and rust defect.

Acknowledgement:

The author would like to thank the Mobarake Steel Complex for supporting this research.

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