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An Application of Image Processing to Detect the Defects of Industrial Pipes

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Abstract: In many industries, conventional defects detection methods are performed by experienced human inspectors who sketch defect patterns manually and then resolve them. However, such detection methods are much expensive, inaccurate, complicated as well as time consuming. To overcome these problems, a new method has been introduced to detect and identify the defects in industrial pipes, automatically and effectively which is based on image processing. The proposed method works in three steps. In the first step, it converts the RGB image of the pipe into a grayscale image. Secondly, it extracts the pipe and finally it detects and identifies the defect.

Keywords: Defect detection; defect identification; image processing; pipe industry.

I. INTRODUCTION

There is a growing interest in visual defect detection since it has been an important and complicated task in the field of computer vision. It has a wide range of application areas including automatic object detection, object surveillance activity analysis, fault detection, fault location and human computer interaction. In this paper, the method for detecting certain manufacturing errors that may arise in case of industrial pipes is developed, which the manufacturing company can then investigate and solve. The detection and identification of defects of industrial pipes is the most important step during the post manufacture inspection. Although, it can be performed manually by experienced human inspectors but such manual inspection method of industrial pipes has a number of drawbacks including high costs, laborious, low efficiency and time consuming. Therefore, an image processing based algorithm for the detection and identification of defects is proposed. There are also some existing systems for defect detection. However, since long time to cope with defect detection, several techniques have been proposed using image processing.

In this new method, detection and classification of defects in industrial pipes is completely based on image processing. The proposed method works in three steps. At the first step, it converts the RGB image of the pipe i.e. input image into a grayscale image. Secondly, it extracts the fault of the pipe and finally it identifies the defect.

II. RELATED WORK

Md. Ashraful Alam, M M Naushad Ali developed a method by using Sobel gradient algorithm. They proposed an algorithm for defect detection and classification of industrial pipes. They used an image processing based algorithm for detecting defects (crack and hole) in industrial pipes, simply from the images of the pipes. They identify the defects based on the detected edges of the defects and distinguish them into holes and cracks according to their size and shape [1]. Abdel-Qader O. Abudayyeh and M. E. Kelly proposed a method by using wavelet transform, Fourier transform, Sobel filter, and Canny filter for defect detection [2]. This paper also provides a comparison of the effectiveness of four crack-detection techniques. Those are fast Haar transform (FHT), fast Fourier transform, Sobel and Canny. To identify the concrete surface cracks, they proposed an image-based framework, where optical cameras provide the source images. Wu Xue-Fei, Bai Hua developed an automated method for defect detection in [3]. It is based on a defect feature extracting method under HSV (Hue, Saturation, Value) color space. They have used QFCM (Quick Fuzzy C-Mean clustering) segmentation arithmetic. This algorithm can identify defects from background, and the types of defects in the buried pipes [3]. T. C. Hutchinson and Z. Chen used a wavelet transform and canny filter for defect detection in [4]. There is another method which is based on morphological operation. It is used for underground pipe defects. Shivprakash Iyer and K. Sinha used smoothing using morphological operation, segmentation using edge detection in [5]. This method is based on mathematical morphology and curvature evaluation which is used to detect the crack-like patterns in a noisy environment. Recently, automatic defect detection and inspection system has been developed for inspecting the inner surface of Heating, Ventilation and Air Conditioning ductwork pipeline. Yongxiong Wang and Iianbo Su, worked on automated defect detection and contaminant inspection of HVAC duct [6].

In that paper instead of Sobel edge detection, they have used SUSAN edge detection where edges are detected by circular mask. Seeded k-mean clustering approach has been used to classify features such as hole, crack and rust. Tung-Ching Su, Ming-Der Yang worked on another important application of image processing that is the morphological segmentation based on edge detection captured by CCTV [7]. They have used the specific

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method to detect defects such as multiple fractures, debris, hole, collapse, open joint and so on. But they have not distinguished between defects, rather marked them only. Also it does not tell about major defect and minor defect. Most of these algorithms are designed to detect cracks for underground pipes. However, for the pipes in the industries, these algorithms may not always perform accurately to distinguish the defects i.e., holes and cracks. Rather some can classify holes and cracks but not diameter imperfection.

III. PROPOSED METHOD

In proposed system, the Image processing is divided into three sections. In the first section, it carries out some pre-processing in the whole input image including gray scale conversion, threshold effect and noisy object elimination. In the next section, the pipe is extracted from the whole image and in the last one, defect detection and identification method is applied.

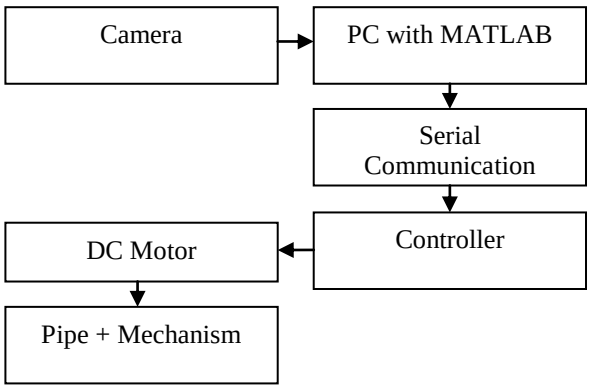

Fig.1. System Block Diagram

In section one, firstly the RGB image is converted to a gray scale image and then threshold effect is applied with some value. The resultant image may contain some noisy objects which can create erroneous results. To minimize their effect, these unwanted objects are eliminated according to their sizes. In second section a pipe is extracted from the image. Then these two images are subtracted and this resultant image will be the fault on pipe. Again the resultant image may contain some noisy elements. So to reduce their effect, these unwanted object elimination is done according to their sizes. Finally some fundamental features i.e., area and eccentricity are calculated for each object. Afterwards the defects such as hole and crack are distinguished based on their eccentricity. In proposed method detects and identifies the defects in the industrial pipes through image processing. This image processing part consist of Image acquisition, gray scale conversion, threshold effect, unwanted object elimination, pipe extraction and defect detection and identification. Summary of the proposed method is shown in below flowchart (Fig. 2).

A. Pre-processing:

The raw data (RGB image) acquired from digital camera are pre-processed for further data analysis. It includes the gray scale conversion, threshold effect and elimination of noisy objects which are present in the raw image. The different data-processing stages are described below.

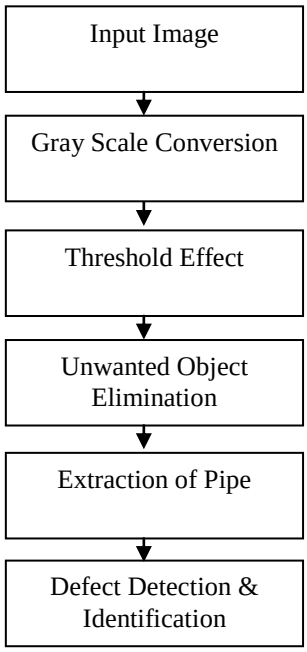

Fig2. Image Processing Steps of System

Fig 3 Input Image

Input image is acquired from digital camera and then it is converted into gray scale image.

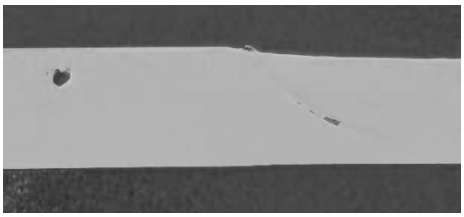

Fig4. Gray Scale Image

After Gray scale conversion threshold effect is applied with some value. It converts Gray Scale Image into Binary Image as shown in below fig.

Fig5. Threshold Effect

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After threshold effect some noise is generated in image. Some unwanted objects (some dots, some small objects and noises) remain in the image. The main purpose of this is to keep only the defects and pipe in the image. So, unwanted objects should be eliminated.

Fig6. Unwanted Noise Elimination

B. Extraction of Pipe:
After unwanted noise elimination, the separation of pipe from image is performed or only pipe image is generated by filling the region by selecting points interactively.

Fig.7. Extraction of Pipe

C. Defect detection and Identification:
By performing mathematical operations, the two images i.e. image with fault and only pipe image are subtracted and resultant image will have the only faults that are on the pipe. This is how the fault is detected.

Fig. 8. Detected Fault

Again this image contains some unwanted objects (some dots, some small objects and noises) in the image. So, by removing these small objects from binary image fault is detected.

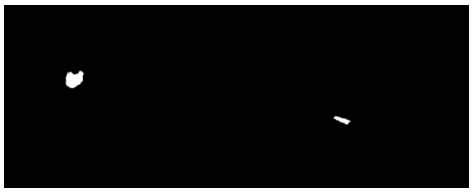

Fig.9 Unwanted Noise Elimination

Before detecting the defects, morphological morphology is applied on image. Dilation and erosion methods are performed to connect the disjoint lines. Then by calculating the area and eccentricity, defects are classified into hole and crack. After this by calculating no. of pixels of defect, the defect is classified into major defect or minor defect. So it gives the idea that pipe can be modified or replaced.

Fig. 10. Defects after Mathematical morphology

IV. CONCLUSION

In this paper, the analysis of different methods for defect detection and identification is done. An image processing based method for detecting defects (hole, crack and imperfection in diameter) in industrial pipes is proposed. In next task the defects will be distinguish according to their size and shape and overall system will be implemented. It will also give the idea about major defect and minor defect. Experimental results will demonstrate the system as effective for dealing with the industrial pipe images.

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