International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

To Detect and Identify the Defects of Industrial Pipe

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Abstract: ***In many of industries, conventional defects are detected by experienced human inspectors who sketch the defect patterns or types manually and then resolve them. However, such detection methods are more costly, less accurate, time consuming and complicated. To overcome these problems, a method has been developed to detect and identify the defects in industrial pipes, effectively as well as automatically which is based on image processing and embedded system. This method works on video streaming. This proposed method basically works in three steps. Firstly, it converts the RGB images of the pipe into a grayscale image. Secondly, it extracts the pipe as well as fault. Then finally it detects and identifies the defect and it gives the idea of major and minor defect. So, according to this decision will be taken whether to modify that pipe or remove that pipe from process.***

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

1. Introduction

Now a day, there is a growing interest in visual defect detection for the reason it has been an important and complicated task in the area of computer vision. It has very large number of application areas like automatic object detection and identification, fault detection, object surveillance activity analysis, fault location and human computer interaction, in agriculture also. In this paper, the method of detecting particular manufacturing errors like hole, cracks and diameter imperfection 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 or faults of industrial pipes is the most important step while doing the post manufacture inspection. Although, this process can be performed manually by experienced human inspectors but this manual inspection method of industrial pipes has a lots of drawbacks including less accurate, higher costs, more manpower, less efficient as well as more time consuming. So that, an image processing and embedded based algorithm for the detection and identification of faults is proposed. There are also some existing systems present for defect detection and identification. However, from a very long time to cope with defect detection and identification, several techniques have been proposed using image processing.

In this new proposed method, detection and classification of defects in industrial pipes is based on image processing. This proposed method works mainly in three steps. In the first step, it converts the RGB image of the pipe i.e. acquired input image into a gray scale image. Secondly, it extracts the faults located on the pipe and finally it identifies the defect and classifies it into a major or minor defect. According to this major or minor defect, decision can be taken on the defected pipe.

2. Related Work

Md. Ashraful Alam, M M Naushad Ali has proposed a method with the help of Sobel gradient algorithm. They proposed an algorithm for defect identification and classification of industrial pipes. They used an image processing based method for detecting defects like crack and hole in industrial pipes, simply from the images of the pipes. They detect the defects based on the detected edges of the defects in pipe and classify them into holes and cracks according to defects shape and size [1]. Abdel-Qader O. Abudayyeh and M. E. Kelly developed a method with the help of Fourier transform, wavelet transform; Sobel filter as well as Canny filters for defect detection and defect location [2]. This paper also gives a comparison of the effectiveness of this below listed four crack-detection techniques. These techniques are fast Fourier transform, fast Haar transform (FHT), Sobel filter and Canny filter. To detect and identify the concrete surface cracks, they have done an image-based framework, and where an optical camera provides the source images. Bai Hua, Wu Xue-Fei developed an efficient automated method for defect detection in [3]. It depends on a defect feature extraction method by HSV (Hue, Saturation, and Value) color space. They have used QFCM i.e. Quick Fuzzy C-Mean clustering segmentation arithmetic method. This method identifies the defects from background, and also the types of defects in the buried pipes [3]. T. C. Hutchinson and Z. Chen used a canny filter and wavelet transform for defect identification in [4]. There is also one important another method which is based on morphological operation. This method is used for underground pipe defects. Shivprakash Iyer and K. Sinha in [5]. They have used smoothing using morphological operation image processing, segmentation using edge detection. This proposed method is basically depends on mathematical morphology and curvature evaluation which is used to detect the defect patterns in a noisy environment. Most recently, automatic defect detection, identification and inspection system has been developed for the inspection of the inner surface of Ventilation, Heating, and also for Air Conditioning ductwork pipeline. Yongxiong Wang and Iianbo Su, they worked on area of automated defect location and contaminant mixture inspection of HVAC duct [6]. In this paper, they have used SUSAN edge detection where edges are detected by circular mask instead of Sobel edge detection. Seeded k-mean clustering technique has been used to identify and also 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 with the help of images captured by CCTV [7]. They have used the particular method to detect

and classify defects such as multiple fractures, hole, collapse, debris, open joint and so on. But the difference is that they have not distinguished between detected defects but they marked them only. Also it does not give any idea about the major defect and minor defect. Most of these above discussed algorithms are designed to detect holes and cracks for underground pipes. However, this techniques for the pipes in the industries, may not always perform accurately and effectively to distinguish the defects i.e., holes and cracks. Rather some of them tried to classify holes and cracks but not diameter imperfection.

3. Proposed Method

In this proposed method, the Image processing is basically divided into three main sections. In the first part, it works on some pre-processing part in the whole input image which includes RGB images conversion, gray scale conversion, threshold effect and also the noisy object elimination. In the second part, the pipe and defects are extracted from the whole image and lastly, defect detection and identification method is applied and according to that major defect and minor defects are decided.

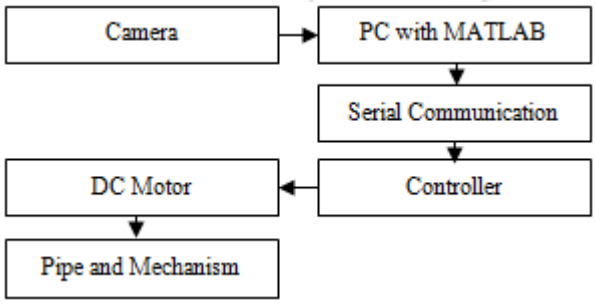

Figure 1: Block Diagram

The overall system involves some part of embedded system and some part of image processing. The total assembly is made with help of PIC Controller, DC motor, serial communication. This system is works on video streaming input. Firstly camera acquires the input. Then further process in done in MATLAB. For communicating PC to the controller serial communication is used. Mechanical assembly is made with the help of DC motor, Pipe and wheels. This developed method detects and classify the defects present in the industrial pipes with the help of image processing. This image processing session consist of Image acquisition, gray scale conversion, threshold effect, unwanted object elimination, pipe extraction and defect or fault detection and identification. Summary of this proposed method is shown in the below given flowchart (Fig. 2).

3.1 Pre-Processing

The raw data i.e. sequence of input images acquired from digital camera are pre-processed for further data analysis. These pre-processing parts have to perform the multiple operations like gray scale conversion, threshold effect and noisy objects elimination which are present in the images. The different data-processing steps are shown and also described below.

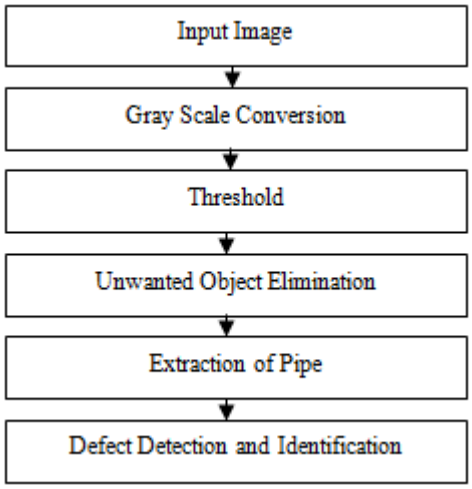

Figure 2: Image Processing Steps

Camera acquires sequence of input images. It takes video of ongoing pipe checking process.

Figure 3: Input Image

Sequence of input images is acquired from digital camera and then it is converted into gray scale image.

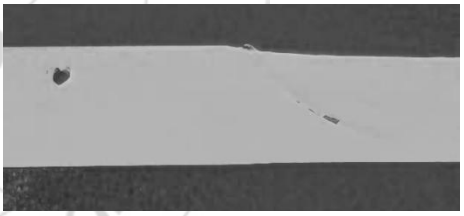

Figure 4: Gray Scale Image

After Gray scale conversion threshold effect is applied with the particular value. As a result we get Binary Image from the Gray Scale Image as shown in below figure.

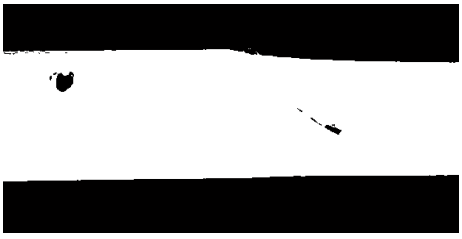

Figure 5: Threshold Effect

After applying the threshold effect, some noise gets added in the image. Some unwanted objects like some dots, some small objects and noises remain in the image. The main purpose behind this is to keep only the defects and pipe in the image. So, unwanted objects can eliminate.

Figure 6: Unwanted Noise Elimination

3.2 Extraction of pipe

After performing the operation of unwanted noise elimination, the separation of pipe from image or extraction of pipe is performed by filling the regions by selecting points interactively.

Figure 7: Extraction of Pipe

3.3 Defect Detection and Identification

By doing some mathematical operations on this two images i.e. image with fault and only pipe image. These two images are subtracted and resultant image will have the only faults that are present on the pipe. By this method the faults are detected.

Figure 8: Detected Fault

Again this image has some unwanted objects like some dots, some small objects and unwanted noises in the image. So, by removing these small unwanted objects from binary image defect is detected.

Figure 9: Unwanted Noise Elimination

Mathematical morphology is applied on the images before identification of the defects. Dilation and Erosion operations are performed to connect the disjoint lines. Then by calculating the area and eccentricity of detected defect, these defects are classified into hole and crack. If eccentricity is greater than 0.8, it is classified as a crack and if eccentricity is less than 0.8 then it is classifies as a hole. If crack and holes are detected then it gives the result as minor defect. If imperfect diameter is detected then it is classified into major defect. So this gives the idea that pipe can be modified or replaced.

Figure 10: Defects after Mathematical morphology

Figure 11 shows the final result window. It gives the defect area, defect eccentricity, defect type and notification of defect.

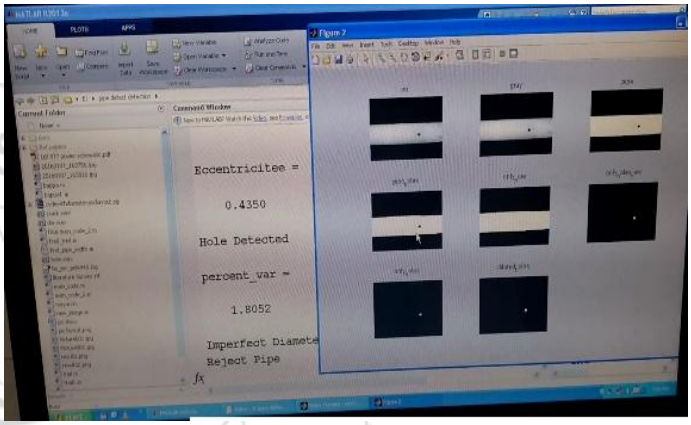

Figure 11: Result Window

Figure 12 shows the overall system design. This assembly is built with the help of DC motor, PIC controller, serial communication, pipe and mechanism.

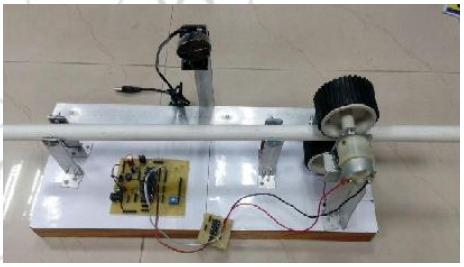

Figure 12: Image of overall system design

4. Conclusion

In this paper, the analysis of different methods for defect detection and identification is done. An image processing based method for detection and identification of defects like hole, crack and imperfection of diameter in industrial pipes is proposed. The defects are distinguished according to their size and shape. It also gives the idea about minor and major defect.

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