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Detecting and Locating Blisters in Underground Pipeline

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Abstract: In the field of industry, corrosion and defects are regarded as important issues. This paper describes a methodology for automatic analysis of the inner surface of pipelines by means of digital image processing. We introduce an image processing method for automatically detecting the defects in pipelines. We show how a barely visible defect can be optically enhanced to improve manual assessment as well as how descriptor-based image processing and machine learning can be used to allow automated detection. Image enhancement is also performed. We implement this simulation using MATLAB R2015a.This algorithm provides about 80% accuracy in final result, which highlights the main purpose of DIP technique.

I. INTRODUCTION

Digital image processing is the use of computer algorithms to perform image processing on digital images. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. It allows the use of much more complex algorithms, and hence, can offer both more sophisticated performance at simple tasks, and the implementation of methods which would be impossible by analog means.

DIP has its wide implication in the pipeline network industry. Its aim is to look or have a careful examination of the inner and outer surface of the pipeline, for finding any traces of defects, cracks, and corrosions.[1]In image processing system, the algorithm has to be developed in such a way that achieving the desired result must reduce the cost and time required to achieve the solution. A combination of robotic devices and the intelligent programs led to several prototypes. One such combination of the digital image processing involving camera attached to mobile robot gives us detailed information of pipeline. The visual and non-destructive testing of the pipeline networks can be done using a mobile robot. Inspecting an environment that is not easily accessible under human observation is always a topic of interest. There is no established connection between the theory and practical application for image processing. Thus, the objective is to implement an image processing system specifically developed in MATLAB, to resolve the above-mentioned problems.

II. INSPECTION METHOD

A. Digital scanning

This paper uses camera-based inspection method namely digital scanning.[1] We can even use conventional CCTV cameras but wide-angle lenses and high-resolution ability

are positive factors for going into digital scanning method. The operation is done by inserting the robot into the pipe which in turn takes video of the inner surface of the pipe. Then the video is processed and converted into images which are further used for processing using MATLAB.

B. Dip Inspection Method

After recording a video from the inner pipe surfaces, the video is converted to an image format suitable for MATLAB,[1] and the process flow of the project begins. Image processing and analysis are time-consuming as numerous images are being processed each may show different defect on it. As a result, a code is created, which has to be able to process almost all images and provide details of suspicious images or anything that looks hazardous to pipeline safety.

The created code will convert the video into images as frames per second. It takes two seconds to get a 3-minute video processed in the MATLAB.

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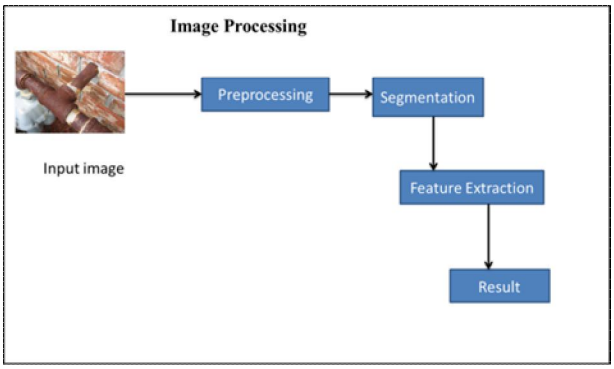
The result provides valuable information regarding any dangerous crack, the width of corrosion and its distance from the start point.

C. Process flow



The proposed system involves five major steps Image acquisition, pre-processing, image segmentation, feature's extraction, and the pattern classification.

1) *Step 1: image acquisition:* Image acquisition in image processing can be broadly defined as the action of retrieving an image from some source, usually a hardware-based source, so it can be passed through whatever processes need to occur afterward. Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image no processing is possible. Here image Acquisition is to acquire a digital image. We use a digital camera which is inserted by mounted on a robot to take video of the inner surface of the pipe and the video is converted into digital images.

Fig1. artificial cracks

After the image is fed into the MATLAB code, it is considered as an original image and pixel calculation is done. Using the pixel calculation the area of the original image is calculated using the given formula.

Area= ((sqrt/pixels)*0.264/10)

Here,0.264 is the resolution of our camera used. This may
vary according to the camera we use.

2) *Step 2: Image Preprocessing*

a) *Color To Gray Image:* In the image processing stage, original color images are converted to gray-scale images. A color image consists of three primary colors. Red, Green and Blue. A color can be generated by numerical proportion of the three components. Each primary color axis has 256(2^8) levels of color shade, which means a total of 2^{24} colors can be generated technically from the color space. The point (0, 0, 0) indicates black and (1, 1, 1) indicates white.

Gray-level images are represented by only 8 bits. There are lots of sophisticated gray levels between white and black. Therefore, image sizes can be significantly reduced by converting to gray-scale images, while improving computing efficiency.

The reason for converting from RGB to gray scale has many reasons. Some of them are

Signal to noise. For many applications of image processing, color information doesn't help us identify important edges or other features. There are exceptions.

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Complexity of the code. If you want to find edges based on luminance AND chrominance, then it is hard to justify if the additional color information isn't helpful for applications of interest.

Difficulty of visualization can be overcomed.

When it is either black or white, we can easily identify the defect. Here we use the function rgb2gray (image) for converting.

b) Image Enhancement: After image acquisition, image enhancement is done. Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind an enhancement technique is to bring out detail that is obscured, or simply to highlight certain features of interesting an image. A familiar example of enhancement is when we increase the contrast of an image because “it looks better.” Here we use the function imadjust (gray_image) to enhance the gray image and a median filter is used to eliminate the noise.

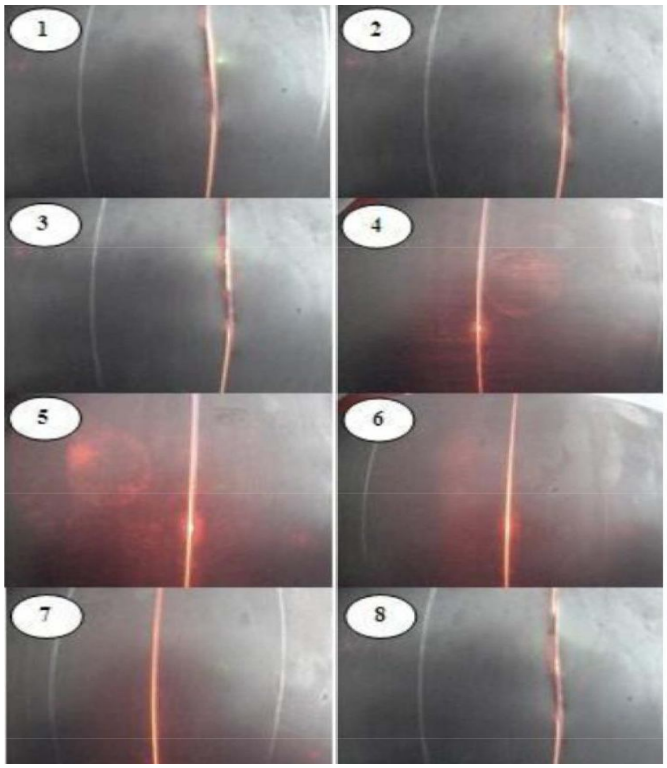

Fig2.Original images taken from the processed video

c) Disk Calculation: Disk calculation is nothing but when the area of the defect is calculated, it also considers the surrounding of the particular defect and along with that the area will be calculated. This is done to make sure that the whole defected area is identified so that when changes has to be made to eliminate the defect ,the whole of the defect should be considered.

3) Step 3: image segmentation: Segmentation procedures partition an image into its constituent parts or objects. In general, autonomous segmentation is one of the most difficult tasks in digital image processing. This paper uses FCM (Fuzzy c-means) algorithm for segmentation process.

The Fuzzy c-Means algorithm is a clustering algorithm where each item may belong to more than one group (hence the word ‘fuzzy’),[2] where the degree of membership for each item is given by a probability distribution over the clusters. It was developed by Dunn, and later on improved by Bezdek[2]. It is useful when the required numbers of clusters are pre-determined; thus, the algorithm tries to put each of the data points to one of the clusters. What makes FCM di□erent is that it does not decide the absolute membership of a data point to a given cluster; instead, it calculates the likelihood (the degree of membership) that a data point will belong to that cluster. Hence, depending on the accuracy of the clustering that is required in practice, appropriate tolerance measures can be put in place. Since the absolute membership is not calculated, FCM can be extremely fast because the number of iterations required to achieve a specific clustering exercise corresponds to the required accuracy.

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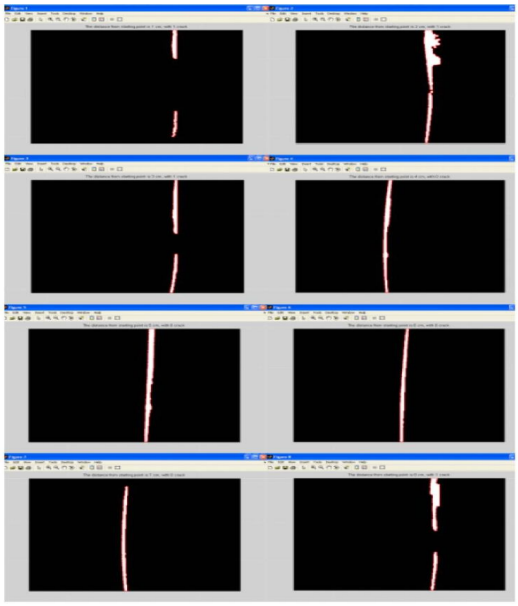

Fig 3. Images processed by MATLAB

The FCM algorithm attempts to partition a finite collection of n elements, $X=\{x_1,x_2,\ldots\ldots\ldots\ldots x_n\}$ into a collection of c fuzzy clusters with respect to some given criterion. Based on this algorithm, MATLAB software is used to detect the defects.

In FCM, hole fill is done so that not even a single piece of defect is left out. Then true pixels are calculated which are the pixels of the defected area. Then the area is calculated and compared with the values in the database. Thus the severity of the defect is also known.

Fuzzy partitioning is carried out through an iterative optimization [2]of the objective function shown above, with the update of membership u_{ij} and the cluster centers c_j by:

$$u_{ij} = \frac{1}{\sum_{k=1}^{C}\left(\frac{\|x_i - c_j\|}{\|x_i - c_k\|}\right)^{\frac{2}{m-1}}} \quad , \quad c_j = \frac{\sum_{i=1}^{N} u_{ij}^{m} \cdot x_i}{\sum_{i=1}^{N} u_{ij}^{m}}$$

4) step 4: feature extraction

Feature extraction is done to represent the images in its compact or unique form of single number or matrix. Feature extraction extracts features from the original features by linear or nonlinear transformation [3]. Here we use SVM-Support Vector Machine for feature extraction. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into the same space and predicted to belong to a category based on which side of the gap they fall. 2 Dimensional Discrete Wavelet Transform (2D-DWT) method [3] is used to extract features from original features. For object detection and classification wavelet transform is widely used. Experimental results show that the SVMs achieve significantly higher search accuracy than traditional query refinement schemes after just three to four rounds of relevance feedback. After feature extraction, final image is obtained. We find the Kurtosis value which gives the sharpness of the output image.

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III. RESULT

The final step which represents the result of the process is to represent all images together. Each image is supposed to show the number of cracks or defects in the image and the distance from the starting point.

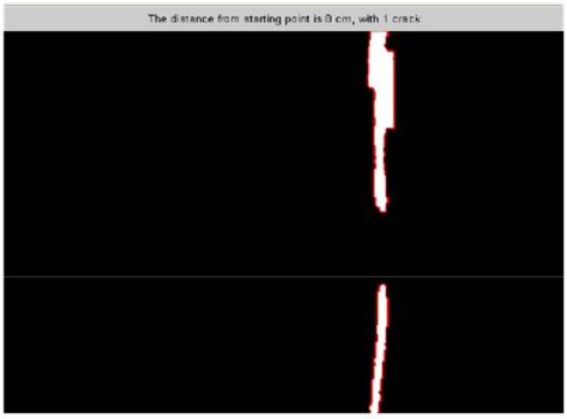

Fig 4. Shows one of the images after processing

IV. CONCLUSION

The main aim of this paper is to use Digital Image Processing technique in pipeline network which results in examining the defects in each image. At first, this kind of process has been examined by some functions like point processing, image smoothing, segmentation, filtering etc. It helps in determining the defects and then related details such as the number of cracks or corrosion and distance from starting point as an output. Corrosion is an emerging issue that requires urgent attention through the development of new designs and mechanisms of prevention and control.

In the end, there is a bright future for vision and image processing in the pipeline inspection field. In order to achieve this goal, DIP processing is essential and would be the most crucial problem-solving method for numerous problems that confront the pipeline industry.

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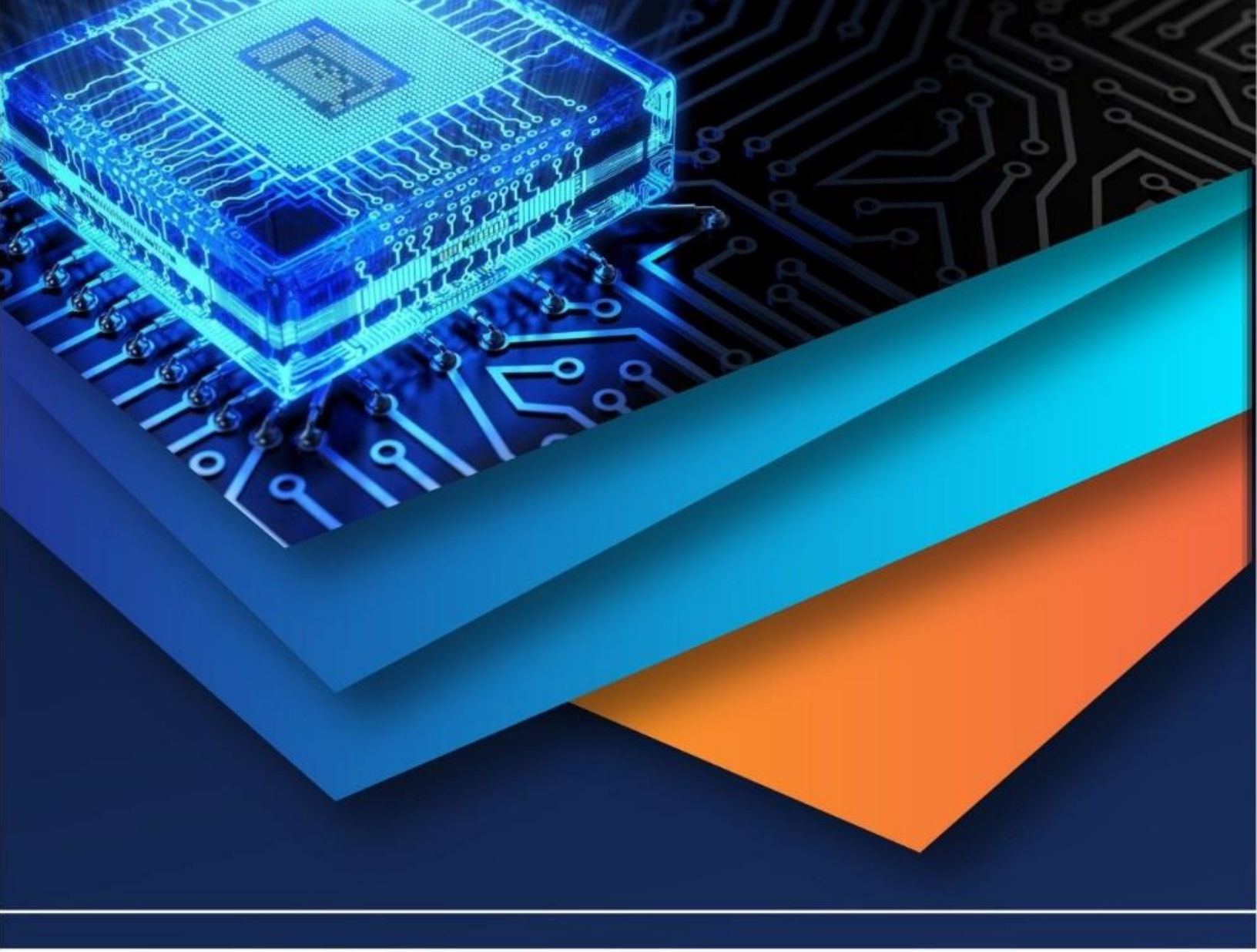

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