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Detecting and Analyzing Cracks for Oil Pipeline with Mobile Robots

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Abstract - Cracks and Holes that occur in an oil pipeline were detected with the help of X-ray machines that lead to many problems in reducing the inspection time to an absolute minimum. Inspected pipelines were not legible to notify a crack or a hole. To rectify this problem manual inspection was decided to replace with a computerized detection with the help of digital cameras. These cameras had problems with fiber optic cables that is connected with them.To overcome this problem a bug sized Robotic was planned to replace the existing digitized inspection mode. This paper presents the structural and logical operations for image processing applications. Edge detection operations are performed to detect the edges or corners and the results are observed through computed tomography software. The digital camera that is implemented in the Robot is designed to fetch pictures for the calculation of pixel position, to determine the defects in the image. The result should show that the proposed mobile robot for image processing will be able to analyze pixel routing of the images. This research paper is a novice technique to replace the existing digital camera with a mobile robot.

Keywords: MobileRobots, Computed Tomography Software,Pixels

I. INTRODUCTION

Pipelines are a safe and efficient means of transporting large quantities of crude oil and natural gas over land. Each and every day, oil companies transport enough crude oil and petroleum products to fill 15,000 tanker truck loads and 4,200 rail cars. pipeline network transports three million barrels of oil every day[courtesy: offshore pipelines, *boyunguo, PHD, shanhong song, ph.d., ali ghalambor, PHD and tian ran lin, phd]*.Everything from water to crude oil even solid capsule is being transported through millions of miles of pipelines are vulnerable to losing their functionality by internal and external corrosion, cracking, third party damage and manufacturing flaws. If a small water pipeline bursts a leak, it can be a problem but it usually doesn't harm the environment. However, if a petroleum or chemical pipeline leaks, it can be an environmental and ecological disaster [reference from US pipeline accidental reports at the national transportation safety board]. Thus, for keeping pipelines operating safely, periodic inspections are per formed to find cracks and damage before they become cause for serious concern. When a pipeline is built, many inspection methods can be used to evaluate its quality such as visual, x-ray, magnetic particle, and ultrasonic. These inspections are performed as the pipeline is being constructed, so gaining access to the inspection area is not a problem. Most pipelines are buried except some pipelines, that are underwater [courtesy the Alaskan oil pipeline].once the pipeline is buried, it is undesirable to dig it up for any reason. Therefore, much remote visual inspection equipment to assess the condition of the buried pipe has been developed. For inspection and recovery action of damaged pipeline, robotic crawlers of all shapes and sizes have been developed to navigate the pipeline. The video signal is typically fed to a truck where an operator reviews the images and controls the robot.

Mobile Robot

A **mobile robot** is an automatic machine that is capable of moving around. **Mobile robots** have the capability to move around in their environment and are not fixed to one physical location. [def:wikepedia]

Figure 1 Mobile Robots(Picture courtesy DrRobot.com)

Indication

The idea of replacing a digital camera to robot budded with the hazards that rose during the intervention of the camera in the oil pipeline path and the cable connected to it got sticky and oily, thus resulting in the replacement of the cable every time it is inserted inside the path for inspection. Pixel analysis was made difficult and the outer covering of the camera had to be replaced every six months, leading heavy expenditures. The pixel images were disturbed by the surface ruptures and the pixel flow was not smooth. This resulted in the uneven distribution of pixels in the images sent by the camera. To resolve this problem, a mobile robot was planned to replace the existing digital camera. A Mobile robot requires a multiple sensored CCD Camera, ultrasonic and infrared sensors to locate its position to avoid snags and to find a proper path leading to the destination to detect the cracks. The Robot connects all the information acquired from these sensors and makes decision to control its direction and speed.The objective of this paper is to discuss the basic concepts required to identify the images sent from a mobile Robot for hole or crack detection. The main prominence is based on mobile robot propulsion, image capture and mapping.

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II. BACKGROUND WORK

Proposed Mobile Robot

The proposed mobile robot is designed to virtually detect the holes and cracks using a computed tomography software that helps to analyze the image captured inside the pipeline. An embedded, real-time, and low power obstacle avoidance system is a critical component towards fully autonomous robots that can be used in safety missions, space exploration, and transportation systems among others. In this paper a complete prototyping platform for the evaluation of obstacle avoidance systems and autonomous robots is realized on reconfigurable hardware. The system receives image data from a vmodvam module and a decision making algorithm based on edge detection algorithm is applied on a specific region of interest (RoI) as inspected by the camera fitted in the robot. These results are further mapped to identify through the pixel image using the algorithms to detect the defects. The algorithm is also designed to remove the obstacle that comes across and make a clear path for the robot to move free around the prescribed distance for detection.

III. SCOPE OF RESEARCH

This research focuses on solving the issues in image detection communities that can help the system operator to maker-processing, classification, labeling of data and to mitigate the outcome of image data. The system administrator finds it difficult to pre-process the data. Even though it has been done successfully, the overwhelming output of the images makes the task a failure and even sometimes images go unidentified. To overcome this situation, frequent updation of data is needed. In order to reduce the workload of the administrator four major image analysis and processing technique involving pattern recognition task has been introduced. In this research, for classification of network data, several existing algorithms like Kohonen-cluster algortihm, Canny's edge detection algorithm and Mathematical morphological operator algorithm for the simulation of images are implemented.

Fig 2.Pipeline Showing Crack with Measurement **(Picture Courtesy-SADARA, KSA)** A diagram showing the implementation of an edge detection algorithm.

Edge detection has to be carried out, to know the actual area or length of a pipe line under analysis. After series of evaluation and careful study, mathematical morphology is applied to detect the crack defects in the images taken from an oil pipe line. At certain situations it developed to show shadow images. Though it is avoidable, it is necessary to develop an algorithm to rectify this problem, if not this will be a big ladder down strike in developing this research paper. Image shading mainly occurs at the point wherever the pipe line is smooth and deep, because of the oil transportation. This occurs due to the yearlong use of the pipe line, for carrying the oil.

IV. METHODOLOGY

This paper paves way to replace the existing digitized camera with the robot.Robot is mounted on a small sensitive membrane for testing,if this comes across any leaks the robot will be directed to travel towards the leak.once the crack or hole in the pipe line is identified it is sent as images to the system that is connected with the robot.the work of robot continues until it travels to the entire distance.Now the images sent to the system are converted to Raster images to convert the images to pixel point readers.With these pixel points and by applying the algorithm for edge detection,k-cluster for thickely covered pixel points the area defected in the pipeline is identified,later it is recovered by the mechanical department.

First the image to be dilated is collected from the images sent by the Robot (a signal sensor is connected) .These sensors carry communication signals using pulses of light. The second step is to collect the samples from the image, it is a set of coordinate points, usually small known as a structuring element. It is this structuring element that determines the precise effect of the dilation on the input image. Thus the data is gathered by the images that are sent by the camera (for one second minimum 500 images). 1's represent the Foreground pixels and 0's represent the background pixels. An example of a structuring element with a 3 x 3 squares and origin in the center is shown in Table 1 and then these images are scanned for pixels:

Table 1: Showing the Values for Evalution of 3 x 3 pixels

1	1	1
1	1	1
1	1	1

V. IMPLEMENTATION

As a step of implementation this model will be submitted to the SADARA group KSA for further review and development. Implementation for this research work starts with the pixel reading, the data in the database is read, and each and every pixel is verified using the unsupervised algorithm. During pixel examination, even a small error or blurred image, whose pixels are stored as mismatched data, are identified and they are further studied to find the defected part in the pipeline. If there is a hole or a crack in the pipeline, the pixel image is not a clear one, the image is not visible properly and the data

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stored as pixel bits, will show the level of the defect with the help of the density of the bit-map or raster image.

VI. DISCUSSION

The main contribution of this research for the replacement and improvement of manual evaluation are as follows:

1. Discovered a mechanism for the replacement of digital pipeline intervention technique. This mechanism is applicable for any type of pipeline transportation.
2. The position and size of the pixels are defined. The required number of bits are evaluated and stored in the buffer area.
3. Image without defects were evaluated using the algorithms developed. The algorithms are independent of each other. The speed of processing is more. Hence the evaluation of the images was achieved without any hurdles.
4. Computed data points between the old and new bits of each pixel groups that were generated in clusters are identified.
5. Finally the proposed computer based monitoring system was tested with different set of images. The results show that the proposed image analysis and processing model using computed tomography software implemented through mathematical morphological operator is better than the existing digital systems.

VII. SIMULATION RESULTS

To know the pixel position, the image is evaluated by applying the set of algorithms; totally so far 5000 images as samples were used to evaluate the proposed approach. The cluster algorithm evaluates and identifies the pixel position. Since the data is voluminous it takes little time to do the process, this can be overcome by reading the data sets according to the length of the pipeline. Data stored as bits is fed accordingly and this rectifies the error. We considered the simulation time as a pixel lifetime and pixel lifetime is a time when no point is available to analyze the cluster. Simulation time is calculated through the CPUTIME function of MATLAB. The results show that the total cluster analysis energy performs better than the maximum number of pixels with defects in terms of cluster lifetime. A time and distance graph will be able to show the pixel evaluation with travelling distance of the mobile robot inside the oil pipeline. If the distance is less time taken to evaluate the cluster region reduces and vice versa.

VIII. CONCLUSIONS

The drawbacks of the existing model and the amount of human error caused while analyzing a pipeline manually motivated to implement this research work. The existing model performs the same operation but not time consuming, men and material wastage is more. In the existing model, the restriction also lies in the usage of more number of devices to perform the task of finding the defects. This Mobile robot uses only minimized physical devices and it is cost effective. The algorithms developed give a clear image analysis and processing to achieve the goal of defect free image of a pipe line. This can be extensively implemented for any kind of pipeline that carries liquids or gases. The memory area used to store the bit values is also temporary, so after mathematical evaluation, the buffer area can be removed, according to the user need. There is no question of bit bouncing, because of this nature of handling the memory area. The proposed Mobile Robot model is faster and time consuming than the existing digitized camera model.

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Biography

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