Autonomous Robot For Crack Detection In Industrial Pipelines

Neha J[1], Nagapriya R[2], Pavithra J[3], Megha R[4] ,Komala Kumari[5]
[1, 2, 3, 4] Dept of ECE
[5]Assistant Professor, Dept of ECE
[1, 2, 3, 4, 5] Vidya Vikas Institute of Engineering and Technology, Mysuru, Karnataka, India

Abstract- *This paper proposes an effective algorithm for the detection of various defects in industrial pipelines. An autonomous robot is designed to detect the cracks. Many industries that involve transportation of different kinds of oils and gases through pipelines require regular maintenance of the pipes. Maintaining these pipelines periodically is a very tedious job but helps in increasing the safety of the industrial environment. Since performing manual inspection through human inspectors involves high cost and is also a time-consuming process, robots help in detecting the defects. They also help to reduce human efforts. Hence in order to overcome these drawbacks, the proposed method detects defects like cracks and holes in pipelines. The algorithm involves various steps for crack detection. It includes the conversion of images to grayscale and then contours identification and detection. Finally, the cracks that are detected are displayed and the distance measured is displayed on the PC using wi-fi.*

Keywords- Robot, crack detection, image processing, Distance measurement.

I. INTRODUCTION

In recent years visual defect detection has increased attention and has grown rapidly because it is an important and complicated task in the field of computer vision[2]. Almost every visual detection technique aims to detect imperfections and classify them for further processing. But the industrial applications need well-structured databases of the possible defect types. Many industries that operate on pipeline networks involve transportation of different kinds of oils, gasses, and other fluids over long distances. These pipelines require periodic maintenance which is very tedious jobs and involve human labor. Many defects that occur in pipes are due to corrosion, aging, and mechanical disasters[1]. Hence defect analysis and their identification becomes a crucial part during the post-manufacture process. Even though manual inspection can be done by humans they have many drawbacks such as decreased efficiency, high cost and it is also a time-consuming process[2]. Hence robots can be used for the inspection of pipelines. Nowadays, robots are extensively used in the present era of automation and in many manufacturing industries[1]. They reduce human efforts and interaction with the work.

In this paper, an autonomous robot is designed and developed in order to detect defects in industrial pipes. The algorithm is completely based on Image processing for the crack detection process. The robotic control is made wireless i.e, by controlling it using wi-fi. It involves a mobile application called Blynk and Raspberry Pi where the actual processing takes place. The robot also keeps track of the distance it has traveled and tells us the location of the crack from a predefined point. The proposed algorithm involves three important steps in order to determine the cracks. Firstly, the captured image is converted to a grayscale image. The next step involves scanning of resultant image for contours. The area of the contours is measured and is compared with a preset value. Lastly, the decision of the cracks is made and displayed on the pc using Wi-Fi.

II. RELATED WORK

"Crack and Object Detection in Pipelines using Inspection Robot" This paper aims to develop an autonomous robot which performs in-pipe inspections. This robot detects the cracks and obstacles inside the pipe. The robot incorporates the Light dependent resistor(LDR) and Infrared sensors for detecting cracks[1].

"Development of Android Based Remote Acquisition-Kroto Finder" With the help of sensors and camera, the pipe leakages and crack detection is observed in this paper. The sensors will detect the corresponding signals will be shown in the phone with which the sensors will be connected through Bluetooth. This method is mainly used in industries[2].

"Kroto Finder-Detection of Damages in Oil/Gas Pipes"A robot was designed in order to explore pipes which incorporates a camera to detect breakages, holes, leaks and any kind of defects in pipes. Here the alternating current field measurement (ACFM) technique was used and it is an electromagnetic inspection method which is capable of detecting and sizing surface breaking cracks in metal specimens[3].

"An Application of Image Processing to Detect the Defects of Industrial Pipes In this paper, the crack detection in industrial pipes is performed using the image processing. Here the image processing is carried out using Matlab. The Image processing is divided into three sections. In the first section, it carries out some 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[4].

"Robot for Crack Detection and Monitoring Pipelines" In this paper, the robotic car is designed to move inside the pipelines to monitor the cracks and damages which is present inside and it helps to inspect the damages and cracks present in the pipeline and can be monitored by remote user. The robot is controlled by using Arduino. A camera is fixed in front of the robot. With the help of camera we identify the cracks and other damages in the pipelines. The wireless zigbee transmitter is used to control the robotic car movements inside the pipelines[5].

"An Algorithm to Detect and Identify Defects of Industrial Pipes using Image Processing" An effective algorithm for detecting and distinguishing the defects in industrial pipes was proposed. This algorithm uses image processing for detecting the cracks which comprises of three steps. Firstly, it carries out some pre-processing in the whole image which includes the conversion of whole image of the pipe into gray scale and extracts the edge using sobel gradient method[6].

III. METHODOLOGY

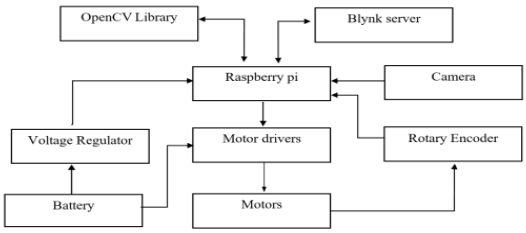

Fig.1. Block Diagram Of the proposed system

The robot is powered on and is connected to a wireless network. A mobile application called Blynk is used to get data from the robot. Blynk is an Internet of Things platform to connect embedded devices to the cloud, design applications to control them, and manage the deployed product at scale. The robot is made to move through the target pipe which is to be analyzed for cracks. As it moves it keeps capturing the images of the area inside the pipe. In parallel, it also keeps track of the distance it has traveled. For this, a feedback setup is used where a rotary encoder is targeted at an encoder disc attached to the shaft of one of the driving motors. The encoder disc has equidistant holes along its circumference. Thus, when the wheel starts rotating, the rotary encoder sends pulses to the control unit. The count of these pulses is directly proportional to the distance traveled by the robot. The conversion of the count of pulses to distance is done by using the circumference of the wheel which is a known factor.

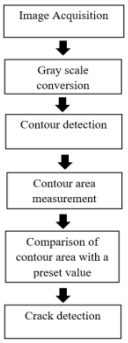

Fig. 2. The process flow of the crack detection algorithm

The steps involved in image processing are shown in figure 2. The image of the target is captured using Pi Camera and is transferred to the Raspberry Pi. A Python script is written on the Raspberry Pi in order to perform image processing so as to identify the cracks. Firstly, the image captured is imported to the script with the help of OpenCV – an open-source computer vision package for Python. It is a library of programming functions mainly aimed at real-time computer vision. The image undergoes some pre-processing wherein it is converted into grayscale. The grayscale image is scanned for contours. A contour is a curve joining all the continuous points (along the boundary), having the same color or intensity. The contours are a useful tool for shape analysis and object detection and recognition. The areas of all the contours are determined with the help of OpenCV functions. The values of the areas are compared with a preset threshold. The contours with negligible areas are discarded and the ones with the larger areas than the threshold are considered as cracks. The distance to the point where the crack is detected is updated on the Blynk application. After scanning the complete length of the target, the robot returns to the origin.

A. RASPBIAN OS

An operating system is the set of basic programs and utilities that make your Raspberry Pi run. Raspbian is a Debian-based computer operating system for Raspberry Pi. Raspbian uses PIXEL, Pi Improved X-Window Environment,

Lightweight as its main desktop environment as of the latest update. It is composed of a modified LXDE desktop environment and the Openbox stacking window manager with a new theme and few other changes. Raspbian is highly optimized for the Raspberry Pi line's low-performance ARM CPUs.

B. PYTHON

Python is an interpreted, high-level, general-purpose programming language. In this project, Python scripts are used to control the processes, interface the hardware, and monitor the operations. A Python script is a program written in a Python Language on a development environment such as Python IDLE. The scripts are saved with .py extension. The process is initiated by executing these Python scripts.

C. OPEN CV

OpenCV (Open Source Computer Vision Library) is an open-source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in commercial products. OpenCV Python is nothing but a wrapper class for the original C++ library to be used with Python. Using this, all of the OpenCV array structures get converted to/from NumPy arrays. This makes it easier to integrate it with other libraries that use NumPy. For example, SciPy and Matplotlib.

D. Image Processing using OpenCV

Step 1: An image captured by the camera is imported to the script

Step 2: An OpenCV function reads this image and features a file, at this point, there are NumPy arrays at the primary data points.

Step 3: Using various functions of OpenCV, contour detection, contours area measurement which helps in identifying the cracks, are performed.

IV. CONCLUSION

In this paper, the crack detection algorithm is proposed based on image processing techniques to detect defects like cracks and holes in industrial pipelines. Here, the decision of the crack is done depending on the area of the contour. This system can be an efficient and effective replacement for the existing methodology as it tells the exact location of the crack detected using a rotary encoder. The robot helps in the improvement of proper inspection and detection ability without human intervention.

REFERENCES

[1] Hemavathi R and Pushpalatha BA . “Crack and Object Detection in Pipelines using Inspection Robot”(IJTSRD) 2018, Volume 2, Issue VI, September

[2] Thanuja I K, Sheeba Kumari M, Vineeth Reddy M, “KROTO FINDER- DETECTION OF DAMAGES IN OIL/GAS PIPES”, (IJAER) 2016, Vol. No. 12, Issue No. VI, December

[3] Md. Ashraful Alami, M MNaushad Ali2, Musaddeque Anwar AI-Abedin Syedi, Nawaj Sorifi, Md. Abdur Rahamani, “An Algorithm to Detect and Identify Defects of Industrial Pipes Using Image Processing”,2014 IEEE

[4] Linija Shylin, Sudha M, Prasoona O, Rhituporna Sarkar, Tejashree M S, “Development of Android Based Remote Acquisition- Kroto Finder”, Vol 4, Issue 5, May 2017

[5] Mayuri Dharma Shinde, Prof. Kishor Wane, “An Application of Image Processing to Detect the Defects of Industrial Pipes”, Vol. 5, Issue 3, March 2016

[6] M.Gowtham1, K.Vidhya2,” ROBOT FOR CRACK DETECTION AND MONITORING PIPELINES”, Volume 2 Issue 4 Apr 2015

[7] Rafael c.gonzalez and Richard E .words, Digital Image IProcessing.3rd ed, New Jersey: Pearson Prentice Hall.2008.

[8] Shiv Prakash Iyer and S.K Sinha .” a robust approach for automatic detection and segmentation of cracks in underground pipeline images” image and vision computing,vol 23,no/10,pp.921-923,September 2005.