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Image Processing Based Defect Detection and Identification Algorithm for Industrial Pipes and Raspberry Pi Based Industrial Process Monitoring

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Abstract **- This paper present an algorithm for detecting and distinguishing certain manufacturing faults that may arise in case of industrial pipes manufacturing. In many of the industries, detection of defect is performed manually by skilled person. The major difficulties of manual o inspection method are lack of visibility, time consuming higher cost, and comparatively less acurte Therefore, this paper plans a new methodology for the automated detection of defect in pipes manufacturing process. Presence of holes and cracks in pipe are an vital indicator in manufacturing process to be cost-effective and avoid environmental damage . Furthermore, the paper give attention on monitoring three major industrial factors like temperature, water level, and light intensity. This system is designed with various sensors and raspberry pi. The design includes interfacing of sensors with PIC controller and LCD display. Thus our system is designed for multiple input and output activities for industrial applications**

Index Terms: Defect detection, defect classification, PIC controller, raspberry pi.

I.INTRODUCTION

Currently, defect detection has receiving more attention as it has proved be significant and critical task in the field of image processing. This paper presents a system which permits the automated detection and classification of defects in pipe manufacturing process.

As compare to prior works, the this paper is based upon uses of raspberry pi kit. Therefore, a defect detection methodology and industrial parameters monitoring system based on image processing as well as embedded technique is proposed.

Our proposed algorithm is distributed among four sections. The first section is pre-processing operations like RGB to gray scale and gray to binary conversion, and edge detection [10]. In second section, some morphological operations are applied [12]. In third section, it computes the area and classifies the defects. In the first section, RGB image is converted into gray image and gray image is converted into binary image, and then edge detection is carried out by using Sobel Gradient Technique. Whereas in second section, certain morphological operations are applied on detected object to define the shape and connect the disjoined outer lines. In third section as the final point, area of the objects is calculated, and the detected objects were classified according to their area. In the last section, the industrial parameters such as fluid level, temperature and light intensity were monitored. Additionally, water level was displayed in two levels as full and low. temperature displayed in oc and light intensity measures into two stages- light and dark.

II. RELATED WORK

At present some systems have already been developed for monitoring and defect detecting industrial parameters. O. Duran, K. Althoefer and L. D. Seneviratne had designed a system by using artificial neural network for defect detection and classification [7]. Wu Xue-Fei, Baihua had designed a defect feature extracting method under HSV color space, which is based on image processing [8]. Md. Ashraful Alami , M M Naushad Ali Musaddeque Anwar AI-Abedin Syedi , Nawaj Sorifi , Md. Abdur Rahamani, had used morphological techniques for smoothing purpose, although they were capable to detect as well as categorize the defects [4]. Matthieu Jones, Donald Bailey, Liqiong Tang- haddeveloped a system for recognizing erosion in pipe by using high speed robot and their implementation is based on the Field Programmable Gate Array [9]. Tung-Ching Su, Ming-Der Yang, Tsung-Chiang Wu and Ii-Yuan Lin they were capable to detect faults such as few fractures, debris, hole, discontinuity in joining but not able to classify the defect [12]. Ragvaran K, J. Thiyagarajan implements industrial parameter monitoring scheme through wireless communication. They considered various parameters such as temperature, fluid level and light intensity, etc [1].

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Darshani B., E. Vigneswaran established industrial process monitoring and control system using raspberry pi. Their considered parameters are temperature, gas leakage. [2]. Amol Dharmapurikar, R.B. Waghmare had implemented a system for secured wireless communication by using GPRS and raspberry pi [3].

III. PROPOSED SYSTEM

The automated defect detection and industrial process monitoring system is proposed.

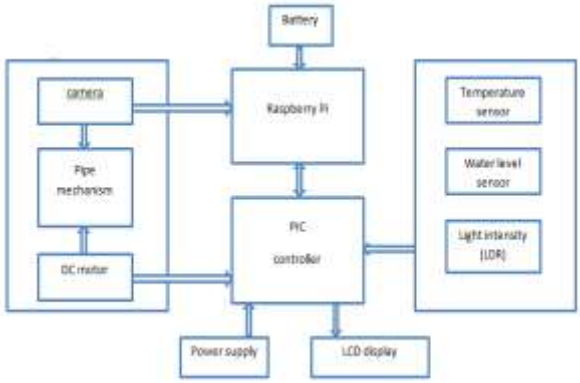

Fig 1- Detect detection and industrial parameter monitoring system

A) Detection of Defect in Pipe

The automated defect detection and identification algorithm is given below:

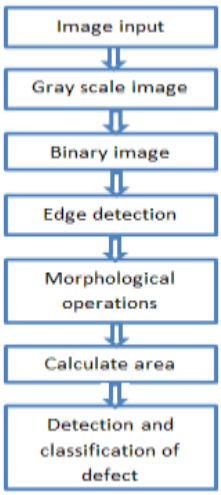

Fig. 2. The flowchart for defect detection in pipe.

a) Image conversion-

The input image taken from camera is RGB image, which was converted into gray scale image and then converted into binary image based on image processing technique.

Fig. 3. Gray scale image

Fig. 4. Binary image

b) Edge detection-

For the purpose of edge detection sobel gradient filter is used which detect the sharp and minor fluctuations, to preserve the imperfections [10],[14]

Sobel operator preserves the outline of objects [10]. In x and y direction, the components were measured. The component were measured by using equation (1) and (2).

$$\frac{\partial f(x,y)}{\partial x} = \Delta x = f(x+dx,y) - \frac{f(x,y)}{\partial x} \quad (1)$$

$$\frac{\partial f(x,y)}{\partial y} = \Delta y = f(x,y+dy) - \frac{f(x,y)}{\partial x} \quad (2)$$

Whereas, $\boldsymbol{f}$ is the intensity function. To find the gradient disjointedness, the minor variation in gradient at (x, y) is calculated. The magnitude (M) is measured by using equation (3).

$$M = \sqrt{\Delta x^2 + \Delta y^2} \quad (3)$$

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Fig. 5. Image contains edges of pipe and defects

c) Mathematical morphology-

Morphological techniques such as dilation and erosion were performed to join the disjoined outer track [12]. After performing the dilation, the area of the object was expanded and the gap between the pixel was removed.

For recovering the original size of object, erosion technique was used[12].

Fig. 6. (a) Defects before dilation (b) image after removing dilation

d) Defect detection-

At this step the algorithm detects the presence of all major and minor objects in the, rather than the objects which have large area. In the above image, the object spotted in the pipe is considered as defects.

e) Defect classification-

Area of the detected defect plays a vital role in classifying the defects. Therefore, after detecting the defects in pipe, algorithm calculates the area and perimeter of that defects and then derives the ratio of area and perimeter (4)

$$rap = \frac{obj(i).Area}{obj(i).Perimeter} \qquad (4)$$

In the example of a hole, the area and perimeter are approximately similar to each other. So if these parameters are similar to each other, then the defect is considered as a hole [4].

In the example of the crack, the perimeter is fairly small or greater than the area. In this circumstances, the defect is considered as a crack [4].

Fig. 7. Defects classifies as crack and hole

B) Industrial Parameter Monitoring System

This system monitors the several parameters such as temperature, light intensity, water level [1]. The primary functionality of our system is as follows:

a) Temperature measurement

To measure temperature IC LM35DZ is used.. It is a three pin IC. The three pins are: supply voltage (Vcc), output voltage (Vout), ground (GND). Operating range of LM35 is from -55oC to +150oC with scale factor 0.01V/oC. It operates in 2 volt to 35 volts and draws lesser than 60μA [1],[2].

b) Light Intensity Measurement

To measure the intensity level, a Light Dependent Resistor (LDR) is used. To measure intensity level, a dark/light activated switch, which is present on system, is used according to this intensity level the switch will turn on and off. Here, BC547 transistor is used with its base connected to voltage divider. The voltage divider had potentiometer of 50K with the protective resistor and Light Dependent Resistor. When light falls on the device (LDR), the resistance of the device changed because when light have enough energy to strikes on the device more and more electrons are excited to conduction band from valance band, which results in the more and more current starts flowing through device hence it is said that resistance of the device decreased [1].

c) Water Level Identifier

When the tank is empty, the switch is open and resistor of 180K set the switch to open, so system will indicate low level. When water starts filling the tank, the wire is connected to the threshold level. The switch

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changes its position from low to full. And when tank is full with water with switch is its higher position, our system will indicate that the water level is full [1].

d) PIC 16F877A

PIC 16F877A is idyllic for low power consumption and high speed flash/ EEPROM technology. The main features of PIC 16F877A controller is 14 Kbyte program memory and 256 byte EEPROM data memory, 10-bit analog to digital converter, 33 I/O lines, two 8-bit and one 16-bit timer, two comparators. It has wide operating range 2V to 5.5V [1].

e) Raspbian Operating System

Raspbian is an open operating system based on debian enhanced for the raspberry pi. Here, raspberry board BCM2835 is used, which include ARM 1176JZF-S, 700MHz processor, 512 MB RAM, 4 Graphics Processing Unit. Each raspberry pi's GPU provides 24 gigaflops in graphical processing power [1],[2].

IV. RESULTS

As a result, this algorithm recognizes multiple defects along with their area.

Fig. 8. The output of defect detection algorithm with one small hole and crack with their area

If there is discontinuity in defect, algorithm applies morphological operation on defect to remove the gap between defect and then classify and calculate the area of defect.

Furthermore, this system monitors considered industrial parameters. Temperature measured in oC. Light intensity measured in two levels viz. light and dark and water level also measured in two levels, full and low.

Fig. 9. Image shows temperature(370c), light intensity(light) and water level(full)

Fig. 10. Image shows temperature(390c), light intensity(dark) and water level(low)

V. CONCLUSION

The research done by us conclude that the objective of this system is fulfilled by automatic detection and classification of defect in pipe. Classification of defect is based on their area and shape. To get exact shape and area, some morphological operations were applied on defects. The system also provids the automatic control of global parameters such as temperature, water level and light intensity in industrial application.

VI. FUTURE PROSPECTIVE

the study has scope to work on detect the additional defects such as faultiness in diameter, open joint, debris as well as additional parameters like pressure, gas leakage, smoke detection can be monitor and control along with temperature, light intensity, water level. We can monitor and control the various parameters through wireless communication.

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