

A Survey on Raspberry Pi Base Industrial Process Monitoring and Detection of Defects in Industrial Pipe Using Image Processing

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ABSTRACT: This paper presents a three step method to automatic identification and classification of defect structure from pipe images. The proposed method is based on image processing. The input image converted to binary image because it is reliable form of image for image processing. Edges of image is spotted by using sobel edge detection method because the sobel operator is incredibly sensitive to noise, this is the reason the defects present in image detected fastly. After detecting the defects, the classification of defects is dependent on its area and shape. To calculate the exact area, some morphological operations are applied to the image. According to their shape and calculated area defects will be categorized. This paper also concentrate on monitoring several industrial parameters such as temperature, water level and light intensity. To carry out this multi-tasking process, the system uses multiple sensors and raspberry pi which is operated on Linux operating system. Thus our control system is designed for multiple input and output arrangements for industrial applications.

KEYWORDS: Defect detection, defect classification, morphological operations, sobel operator, raspberry pi.

I. INTRODUCTION

Now-a-days, the industrial monitoring field needs more manual power to monitor and control the industrial parameters such as temperature, water level, light intensity. This is one of the utmost forthcoming issues in the industrial zones. If the parameters are not properly monitored, it leads to a hurtful situation.

In modern industrial production, the functioning temperature change the operating status of machines and variation of many physical characteristics. So the temperature is most important parameter, which essential to be monitored. In the industrial monitoring area, the different sensors such as temperature sensor and level sensor are used for sensing the parameters and the sensed values are then displayed on LCD displays.

Visual defect detection has receiving more attention in recent few years as it has been very essential task in field of image processing. This paper presents an effective algorithm, which allows the automatic defect detection and its categorization. Defect detection process is distributed into three stage. The first stage includes pre-processing operations like image conversion[4]. At second stage, some morphological operations are applied [12]. In third stage, it calculates the area of object and distinguishes the defects. In our first stage, RGB image is converted into gray scale image and then it converted into binary image. The edges of image is detected by sobel edge detection method. In second stage, the detected object may have discontinuity, so to connect the disjoints some morphological operations are applied on detected object. In third stage, finally area of objects are calculated, and according to their area, the detected objects were distinguished.

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II. RELATED WORK

For defect detection some systems have been already developed. Wu XueFei et al. designed a defect feature extracting method under HSV color space [8]. Md. Ashraf Alam et al. used morphological operations for smoothing purpose. Although they were able to detect as well as classify the defects [4]. O. Duran et al. designed a method by using laser based profiler and artificial neural network for defect detection and classification [7]. Yong xiong Wang et al. they have used SUSAN (Smallest Univalve Segment Assimilating Nucleus) edge detection technique in its place of sobel edge detection method [10]. O. R. Vincent et al. established a descriptive algorithm for sobel edge detection [14]. Matthieu Jones et al. they established a system for identifying erosion in pipe. For this purpose they used high speed robot and their implementation is based on the FPGA [9]. Tung-Ching Su et al. they were able to detect defects such as several fractures, debris, hole, collapse, discontinuity in joining but not able to classify the defect [12]. Raguvaran. K et al. developed industrial parameter monitoring scheme through wireless communication. They considered various parameters such as temperature, fluid level and light intensity [1]. Darshini B. et al. developed a system for industrial process monitoring and control using raspberry pi. Their considered parameters are temperature, Gas leakage. Their systems logic is, if temperature exceeds above threshold level then cooling fan will and if gas sensor senses the leakage of gas then it will buzzer. The communication is take place using Zigbee interface [2].

III. PROPOSED SYSTEM

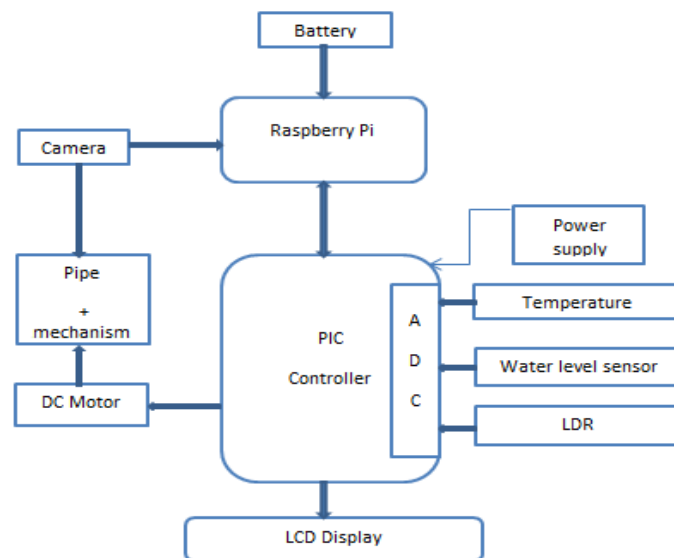


Fig 1- proposed system

The proposed system detects the defect in pipe as well as it monitor and control the various global industrial parameters. Our system arranged in four units.

A) Detection of Defect in Pipe

To detection and identification of defects , an image processing based a new algorithm is planned. The algorithm is all about image conversion, edge detection, defect detection, applying morphological operations, area calculation and finally classification of defects according to their area.

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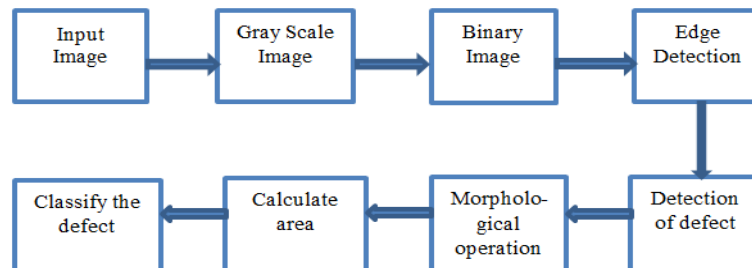


Fig 2- Flowchart of the defect detection in pipe

a) Image conversion-

The image captured from camera is RGB image, which is converted into gray scale image and then gray scale image converted into binary image using MATLAB function.

b) Edge detection-

For this purpose sobel gradient filter is used which detect the sharp and minor changes, to preserve the defects. Sobel edge detector preserves the outline of object [10][14]. The gradient is vector. In x and y direction, the components are measured. The component are measured by using (1) and (2).

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

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

Where, f is the intensity function. To detect the gradient discontinuity, small change in gradient at (x, y) is calculated. The magnitude (M) is measured by using (5).

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

c) Morphological operations-

The operations of mathematical morphology are more useful than the convolution operations employed in signal processing because the morphological operators relate directly to shape. Dilation and erosion are morphological operations which are performed to connect the disjointed outer track [12]. After performing the dilation, the area of the object is expanded and the gap between the pixel is removed.

For recovering the original size of object, erosion method is used [12].

d) Defect detection -

At this stage algorithm works such a way that every single present object in pipe is detected. Detected objects in pipe is considered as defects.

e) Defect classification-

After detecting the defect in input image, algorithm calculates area and perimeter and then derives ratio of area to perimeter.

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$$rap = \left(\frac{\text{area}}{\text{perimeter}} \right) \quad (4)$$

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

In case of a crack, the perimeter is fairly small or greater than area. If this condition satisfies the defect is considered as a crack [4].

B) Industrial Parameter Monitoring System

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

a) Temperature measurement

For temperature measurement IC LM35DZ is used. The three pins are supply voltage (Vcc), ground (GND), output voltage (Vout). Operating range of LM35 is from -55°C to $+150^{\circ}\text{C}$. It operates in 2 to 35 volts and draws less than $60\mu\text{A}$ [1][2]. With LM35, temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1°C temperature rise in still air

b) Light Intensity Measurement

A Light Dependent Resistor is used to measure the intensity level. A light/dark activated switch which is present in system is used to measure intensity level, according to this intensity level the switch will turn on and off. Here, transistor BC547 is used with base connected to voltage divider. The voltage divider has potentiometer of 50K with the protective resistor and LDR. When light falls on device (LDR), the resistance of the device is 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 pulls the switch to open, so our system will indicate low level. When water starts filling the tank, the wire is connected to the reservoir. The switch 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 ideal for low power consumption and high speed flash/ EEPROM technology. It has wide operating range 2V to 5.5V [1]. It has 5 port, 3 timers(two 8-bit and one 16-bit timer), 2 PWM modules, 2 comparators, 10 bit ADC, 33 i/p pins. In this system PIC worked as mid-way between various sensors and raspberry pi.

e) Raspbian Operating System

Raspbian is an open operating system based on debian enhanced for the raspberry pi. Raspbian operating system comes with over 35,000 packages and pre-compiled software bundled in a nice format for easy installation on raspberry pi. Raspbian operating system is still under development to improve stability and performance of as many debian packages as possible [1] [2].

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IV. CONCLUSION

This paper explores an algorithm for defect detection and identification. This algorithm detects the defects based on the spotted edges of the object. In next task the defects will be categorized according to their area and shape and overall system will be implemented. Along with defect detection it also monitors the various industrial parameters like temperature, light intensity and water level. The communication between different sensors and PIC controller is carried out via serial communication.

V. FUTURE WORK

In future there are plans to work on detect the additional defects such as imperfection in diameter, open joint, debris. Additional parameters like pressure, gas leakage, smoke detection can be monitor and controls along with temperature, light intensity, water level. We can monitor and controls the various parameter through wireless communication.

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