Metal Crack Detection Using Image Processing

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Abstract: *Production levels across all industries are rising at a very rapid pace. Industries are producing more goods than ever before. Therefore it is very important to integrate the best technological improvements so as to produce the best quality of product. This paper presents a system which detects cracks and holes on a metal piece using image processing. Raspberry pi is being used along with sensors such as infrared sensor and proximity sensor and a separator which helps to detect a defective metal piece and hence separate it from the good quality metal piece. Since manual separation is very time consuming and heavily dependent on individual's ability to work continuously for long hours, thus it is not the best way forward. This project will not only help in reducing dependence on manual labor on one side, but also a increase the efficiency and monitoring of production line. Internet of things is being used to transfer the relevant data from the raspberry pi to the cloud which can be accessed from anywhere, anytime.*

Keywords: Crack detection, infrared sensor, proximity sensor, raspberry pi, production line and image processing.

II. INTRODUCTION

Quality inspection at the end of a production line is an important stage in industry, especially for high-performance components. Parts undergoing strong mechanical and thermal stress should be carefully checked, since small defects can affect performance and reliability of a component. Crack detection is one of the most common checks to be performed, because cracks are a common source of failure, and they affect a high number of different productions.

Machine vision using image processing algorithms is one of the fastest growing and widely used technologies in the area of manufacturing and quality control due to the increasing quality demands of manufacturers and customers. Machine vision utilizes industrial image processing by the use of cameras mounted on production lines and cells in order to visually inspect products in the real-time without operator intervention.

The issue of Quality Control in metal object is an important aspect of today's highly competitive Industry. The quality of the end product can be improved by inspecting the product at each manufacturing stage in production line. However, manual inspection of end products slows down the entire process as it becomes costly, difficult, time-consuming and also may impact the effectiveness of human labor due to the hazardous atmosphere of the industry. Therefore, the process of inspection is also to be automated and inspection results should be fed back to the upstream manufacturing process for improvement of product quality. However, the Inspection system should be designed to be an efficient composition of human intelligence and experience along with the fastness of a machine. Machine Vision can be used very effectively to find out the faults in the metal object in the real-time industrial manufacturing process.

III. CLASSIFICATION AND FEATURES OF A DEFECTIVE CRACK METAL

The edge algorithm is used which helps the edges of the metal piece to be detected. This concept is used to detect the cracks in a metal object where the cracks are considered as the edges. Canny algorithm is used which is also capable to give the output as the threshold levels.

IV. TYPES OF THE DEFECTS IN METAL

1.1Surface defects

Surface defects are any abnormality present on the metal surface. The table 1.1 gives the types of surface the defects in metal.

The defect	Description
Crack	Unwanted discontinuity on the metal surface
Pinhole	Small pinpoint slots
Spot	Discontinuity of color on surface
Edge	Edge discontinuity
Scratch	Scratch on surface

Fig 4.1: Different types of cracks

1.2 Shape defects

These defects include any shape abnormality if present in the metal object. Shape Changes can occur in production line because of temperature difference, corner or edge breakdown etc.

V.THE ISSUES IN THE DEFECT INSPECTION

At present, there are commercially available products which can detect the presence or absence of surface defects at reasonable costs. However, this problem still remains an open research issue due to the difficulties faced during the real-time defect Detection, Identification and Localization as well. The major obstacles in this area are mainly due to the computational costs, lack of expert knowledge in the defect feature selection or modeling, availability of proper the defect samples and so on.

VI. CRACK DETECTION ALGOITHM

Canny edge detection algorithm is used. It significantly reduces the amount of data that needs to be processed by extracting only the relevant information. Canny edge detection is also widely used in various computer vision based systems. Canny used the calculus of variations – a technique which finds the function which optimizes a given functional. The Canny edge detection algorithm is composed of five steps. Noise reduction, gradient, calculation, non-maximum, suppression, double threshold, and edge tracking by hysteresis. Since all the edges detection contain noises, thus it is important to first remove them before starting to derive the information. To smooth the image, Gaussian filter is used to convolve the image. This step will slightly smooth the image to reduce the effects of obvious noise on the edge detector. An edge in an image may point in a variety of directions, so the Canny algorithm uses four filters to detect horizontal, vertical and diagonal edges in the blurred image.

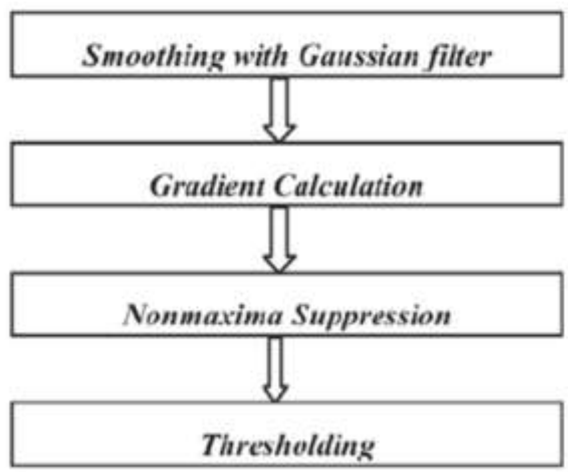

Fig 6.1: Canny edge detection algorithm

VII. PROCEDURE APPLIED AND CLACULATIONS

1.Smooth the image with a Gaussian filter to reduce noise and unwanted details and textures.

$$g(m,n) = G_\sigma(m,n) * f(m,n)$$

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where

$$G_\sigma = \frac{1}{\sqrt{2\pi\sigma^2}} exp\left(-\frac{m^2+n^2}{2\sigma^2}\right)$$

2. Compute gradient of g(m,n) using any of the gradient operatiors (Roberts, Sobel, Prewitt, etc) to get:

$$M(n,n) = \sqrt{g_m^2(m,n) + g_n^2(m,n)}$$

and

$$\theta(m,n) = tan^{-1}[g_n(m,n)/g_m(m,n)]$$

3. Threshold M:

$$M_T(m,n) = \begin{cases} M(m,n) & \text{if } M(m,n) > T \\ 0 & \text{otherwise} \end{cases}$$

where T is so chosen that all edge elements are kept while most of the noise is suppressed.

4. Suppress non-maxima pixels in the edges in Mt obtained above to thin the edge ridges (as the edges might have been broadened in step 1). To do so, check to see whether each non-zero Mt(m,n) is greater than its two neighbors along the gradient direction theta(m,n)$. If so, keep Mt(m,n) unchanged, otherwise, set it to 0.

5. Threshold the previous result by two different thresholds T1 and T2 (where T1<\T2 to obtain two binary images T1 and T2. T12with greater T2 has less noise and fewer false edges but greater gaps between edge segments, when compared to T1 with smaller T1.

6. Link edge segments in T2 to form continuous edges. To do so, trace each segment in T2 to its end and then search its neighbors in T1 to find any edge segment in T1 to bridge the gap until reaching another edge segment in T2.

VIII. EXAMPLE

Fig 8.1: A sample picture on which Canny algorithm is performed

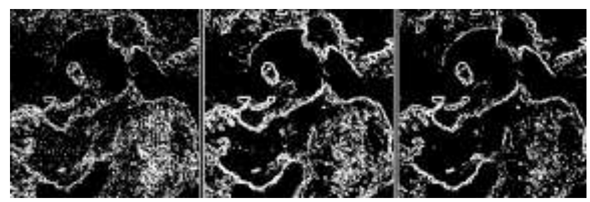
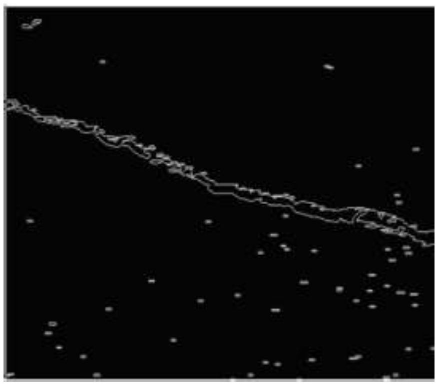


Fig 8.2:Edge detection by gradient operators (Roberts, Sobel and Prewitt)

Fig 8.3:Edge detection by Canny method (sigma=1,2,3, T1=0.3, T2=0.7)

The software's main function includes image reading, image preprocessing, threshold segmentation, edge detection and crack identification. The function and identify interface diagram is shown below

1.



2.

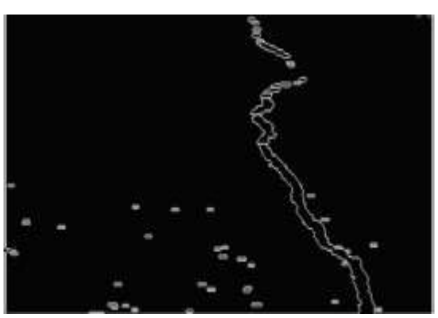


Fig 8.4: Before and after edge detection

IX. CONCLUSION

In this project, efficient surface defect detection is presented based on different thresholding techniques. The real-time defected metal surface image is used in this approach. In order to identify the defects, the input image is transferred to grayscale. Then the binarization is done using different thresholding, in which the defect region is differentiated from the non-the defect region. Experimental results prove that the presented defect detection approach using thresholding provides promising performance for the real-time metal surface images. Automotive defect detection will help the industry to maintain the quality of product with less false detection and increased speed also the updated information about the quality of metal or the object under inspection is sent through raspberry pi to the IoT such as mobile automatically, even when the user is not using it. This will completely eliminate the need for the human expert from quality inspection.

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