

Paper ID: IOTTSF02

## AUTOMATIC CRACK DETECTION

by USING VISION INSPECTION

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**Abstract:** The issue of detection is very critical in all the manufacturing companies. Therefore we intend to aid in defect detection by bringing in an automatic crack detection using digital image processing. When vision inspection of a product is done manually, there are chances of human error taking place or lack of efficiency or irresponsibility in some cases. This may bring a faulty piece in application leading to the possibility of failure of that component. In order to avoid such a risk, we are trying to develop an automatic crack detection system.

**Keywords:** magnetization, nondestructive testing, cracks, digital image processing, pixel, region of interest, RGB, grayscale.

### I Introduction:

Reduced life of any mechanical part or structure is accompanied by formation of cracks. According to Griffith theory small cracks are present on almost all materials but until a particular stress is reached crack will not propagate. And the value of stress depends on length of the crack.(2). Hence early detection of cracks is very important for long life of mechanical components. This process is normally carried out by visual inspection. So the results may differ from person to person depending on their visual ability, making detection process prone to more errors and inefficiency. Therefore an effort is being made to automate crack detection using digital image processing. Digital image processing is widely used in detecting cracks on forged metal and concrete walls as well.

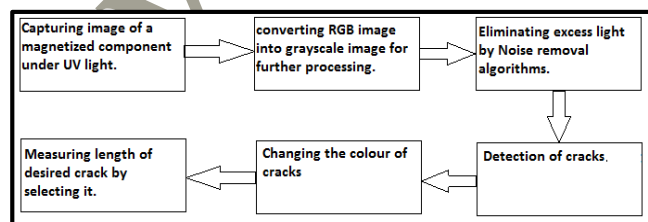


Fig 1 Block diagram

### II Testes used for crack detection :

#### A. Destructive testing:

The material to be tested is completely destroyed and cannot be used further. The only advantage is that the destructive testing can accurately determine the type and size of a flaw. But the severity of the flaw cannot be predicted. Destructive testing examples are as shown in fig 2

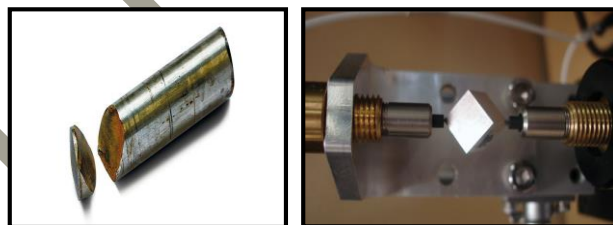


Fig 2 Destructive Testing

#### B. Nondestructive testing

We prefer non destructive testing over destructive technique as the components remains unharmed in testing process can be used further. Therefore every component can be tested before its use ensuring its safety. Nondestructive testing can be classified into 9 types' electric, magnetic, acoustic, high frequency, eddy current, electromagnetic, optical, radiographic and dye penetrant method. All the methods have their own special properties and depending on the task to be performed, one of the methods will be more suitable than other methods. Some methods detect flaws inside the material and some are able to detect only flaws on surface and near surface flaws. Considering detection using ultrasonic wave, Ultrasonic wave that has center frequency 2.25 MHz is unable to detect a surface crack whose depth is less than 3 mm, while the 10 MHz longitudinal wave fails to detect the crack whose depth exceeds 6 mm. Another nondestructive method is high frequency transmission (HFT) technique, can be used to detect cracks of width 0.5 mm and depth 1 mm. Hence the most suitable methods here are Magnetic particle Testing and Dye Penetrant Testing.

1. *Dye Penetrant Testing:* The principle is that a dye is drawn into surface by capillary action. Firstly all kind of dirt from the cracks is removed by cleaning it thoroughly. dye fluid is spread all over the component or component is dipped in the dye. The product may be soaked in a dye for dwelling time to ensure dye penetrates in the cracks. Excess dye is then cleaned. Flaws are then detected by visual inspection. Cracks are viewed as seen in fig 3. This method assures more accuracy and can make smaller cracks visible.

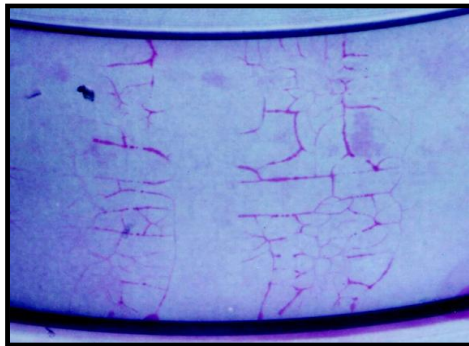


Fig 3 Dye penetrant

2. *Magnetic Particle Testing (MT) :* It uses properties of magnetic fields to indicate defects. The method is able to detect surface and near-surface flaws in ferromagnetic materials. The basic principle uses the fact that magnetic flux is sustained more by a ferromagnetic material can sustain more than air. This is pictographically explained in fig 4. When the magnetic particles are spread over component either by directly spreading it or mixing it in water, the magnetic flux present in the crack due to magnetization attracts these particles and allow them to settle inside it. These fluorescent particles then make the crack visible under ultraviolet light. The fluorescent dye is more convenient to use to make digital processing on image easy. This fluorescent dye has to be illuminated with an ultraviolet light. This method takes much less time compared to dye penetrant method so we have used this testing method in our process.

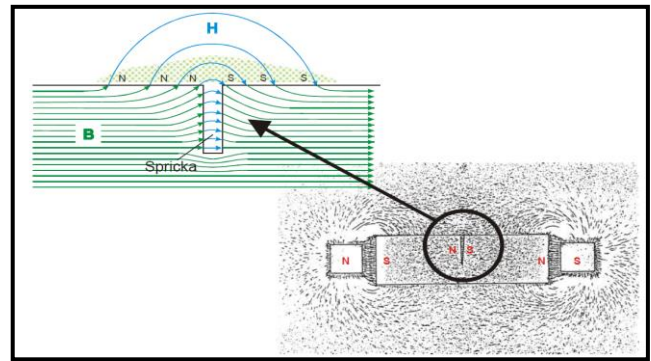


Fig 4 Magnetic particle testing



Fig 5 Image of component under simple and uv light

### III Techniques for surface crack detection:

The two commonly used methods are Sobel edge detector and Canny edge detector made available in Matlab. These are applied for detecting the surface cracks on the image captured. The results of Sobel and Canny detectors are as in fig 6 and fig 7 respectively. If compared to Canny's algorithm based on spatial gradient algorithm, Sobel edge detector is very simple and fast. And it is a convolution filter(4) compared to Canny's algorithm(3). Canny method is a convolution filter. It is also slightly powerful than Sobel detector(7). But both these methods are edge detection techniques and does not give desirable results therefore segmentation i.e thresholding method was used. Region Of Interest (ROI) thresholding method was best suited for detection shown in fig 8. ROI uses the range of pixel values of cracks in grayscale. The range of pixel values to be considered may differ according to different criteria of cracks to be detected. As the intensity of cracks differ based on their depth.

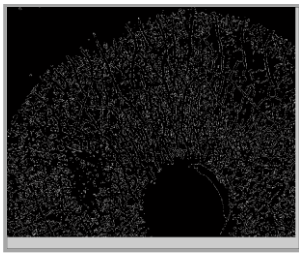


Fig 6 Sobel edge detection result

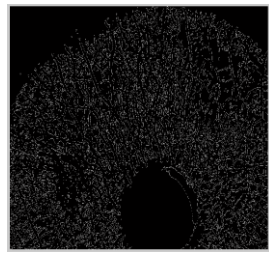


Fig 7 Canny edge detection

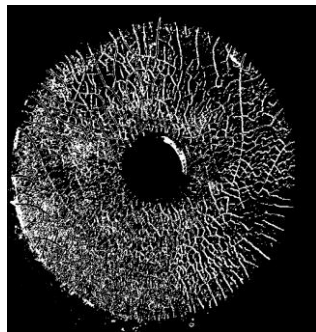


Fig 8 using ROI function (Segmentation method)

#### IV Experimental setup:

The experiments were carried out using Magnetic Particle Inspection on a component which had considerable cracks on it. The material taken was stainless steel. After the settlement of magnetic particles in the cracks, the component was viewed under ultraviolet light in the artificially created darkness. Artificial darkness was created using a rectangular black box. The camera of 8 megapixels was used to capture the image of the component. The type of camera changes according to the surface of the component to be detected. The camera was mounted on a tripod as shown in fig 9. The wavelength of ultraviolet light used is 350 nm. Observing the cracks without florescent liquid becomes difficult for naked eyes and also under camera.



Fig 9 Experimental Setup

#### V Results:

All the cracks on the surface were detected. We created a colormap and applied it on a binary image. Color was changed for representing the cracks in a better way. Colored cracks are seen as in fig 10. The length of desired crack was measured using distanceInPixels function. distance was obtained as shown in fig 11. We can get this length in mm by calibrating it.

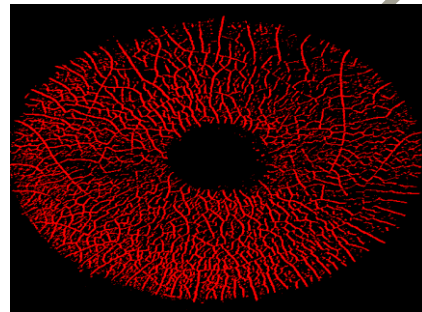


Fig 10 Color of cracks changed

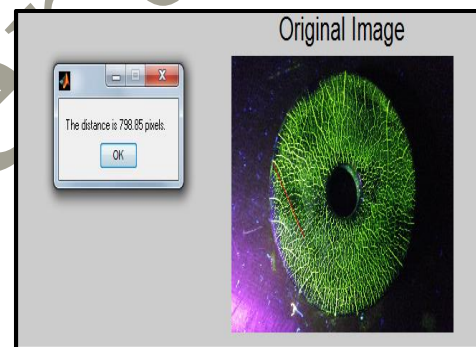


Fig 11 length in terms of pixels

#### VI Future Scope:

We can create a database which will include analysis of components tested, on daily basis. We can also keep a count of accepted and rejected components on the basis of rupture done to the component. We can frame all the detected cracks and count number of cracks found on each component individually.

#### VII Conclusion:

According to the results shown, surface cracks of width and height can easily be detected by image processing on component processed with Magnetic Particle Inspection. The process of magnetization can be considered primitive. After using commonly used techniques of image processing for crack detection and comparing the results, it was found that region of interest function was more effective and suitable for this detection.

**ACKNOWLEDGMENT:**

We would like to thank Mr. Abhishek Dandekar and DYEGLO.Pvt.Ltd. for supporting us.

**REFERENCES:**

[1]"Surface crack detection by flash thermography on concrete surface" by F C Sham, Nelson Chen and Liu Long,INSIGHT published by the British Institute of Non-Destructive Testing.

[2]Mechanical Failure of Materials.chapter2.

[3]P E Ikhlas Abdel-Qader, P E Osama Abudayyeh and K E Michael, Analysis of edge-detection techniques for crack identification in bridges', Journal of Computing in Civil Engineering, pp 255-263, 2003.

[4] J R Parker, 'Algorithms for image processing and computer vision', New York, Wiley, 1997.

[5]Automatic defect recognition in Magnetic Particle Inspection Application by mark wilcox.

[6]Automatic crack detection in forged metal parts an image analysis approach , Master of Science Thesis MARTIN LUNDH, Department of Signals and Systems ,Division of Signal Processing and Biomedical Engineering,CHALMERS UNIVERSITY OF TECHNOLOGY ,G'oteborg, Sweden 2012,Report No. EX073/2012.

[7]J F Canny, 'A computational approach to edge detection', IEEE Trans Pattern Anal Mach Intell, Vol 8, pp 679-698, 1986.

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