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A Contrast Adjustment Thresholding Method for Surface Detection Based On Mesoscopy

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Abstract

Titanium-coated surfaces are prone to tiny defectssuch as very small cracks, which are not easily observable by the naked eye or optical microscopy. In this study, two new thresholding methods, namely contrast-adjusted Otsu's method and contrast-adjusted median-based Otsu's method, are proposed for automated defect detection system for titanium-coated aluminum surfaces. The two proposed methods were compared with four existing thresholding techniques in terms of accuracy and speed of defect detections for images of 700, 900, and 1000 dpi obtained using high-resolution scanning. Experimental results have shown that the proposed contrast-adjusting methods have performance similar to minimum error thresholding (MET) and are generally better than Otsu's method.

Index Terms—***Coated surface inspection, defect detection, high resolution scanning, image analysis, image processing, mesoscopy.***

INTRODUCTION:

Inspection and detection of defects on coated surfaces are essential steps in the preliminary assessment of coating processes. Image acquisition is an important process in visual inspection.If the defects are detected earlier then there is a scope of getting best output product.In manufacturing industries this method is mostly useful to maintain the quality of product.

By using MATLAB software we can automatically detect the defects within fraction of seconds.This automated method doesn't require any special set up. So it is easy method.

LITERATURE SURVEY:

Detecting defects on the surfaces of stampings plays a critical role in the manufacturing process. Many methods have been proposed to detect and identify simple defects on stampings. However, these methods suffer from large system size, high cost, and low speed for inspection. This paper proposes a new visual system for detecting defects on the surfaces of stampings. A set of LED bar lights are used to illuminate the stamping surface from the four sides. This can ensure that the irradiation directions are parallel to the surface. Thus, it can enhance the imaging of the defects and punching edges in the vertical orientation of the surface, which facilitates the location of the defects such as scratch and pitting and the measurement of the punching sizes. Thereby, the defects can be classified using simple shape and dimension analysis. The proposed system is a part of the automated sorting system. Practical operations verify the effectiveness of the proposed system.

A system and process for detecting and monitoring defects in large surfaces such as the field joints of the container segments of a space shuttle booster motor. Beams of semi-collimated light from three non-parallel fiber optic light panels are directed at a region of the surface at non-normal angles of expected incidence. A video camera gathers some portion of the light that is reflected at an angle other than the angle of expected reflectance, and generates signals which are analyzed to discern defects in the surface. The analysis may be performed by visual inspection of an image on a video monitor, or by inspection of filtered or otherwise processed images. In one alternative embodiment, successive predetermined regions of the surface are aligned with

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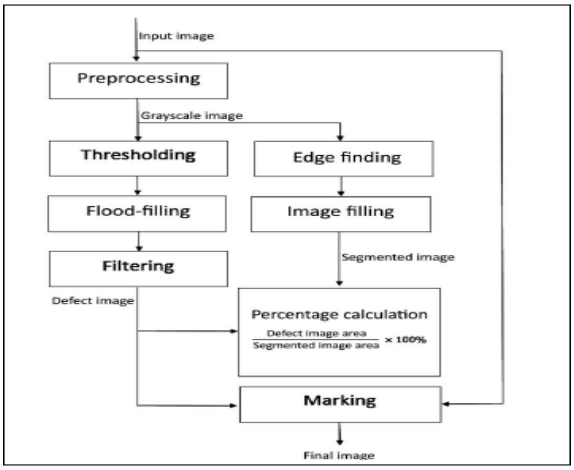
the light source before illumination, thereby permitting efficient detection of defects in a large surface. Such alignment is performed by using a line scan gauge to sense the light which passes through an aperture in the surface. In another embodiment a digital map of the surface is created, thereby permitting the maintenance of records detailing changes in the location or size of defects as the container segment is refurbished and re-used.
The defect detection apparatus may also be advantageously mounted on a fixture which engages the edge of a container segment.

PREVIOUS METHODS:

1. Median-based image thresholding
2. Fluorescence emission
3. Electrostatic methods
4. Thresholding method

PROPOSED METHOD BLOCK(FLOW) DIAGRAM:



PROPOSED METHOD:

Mesoscopy:

Mesoscopy is the science of bringing into sight the details in microscopic level of objects that are in dimensions of a few meters, and the mesoscope is the device used for this purpose. The term mesoscope that we use in our work is in analogy to the optical microscope. Optical microscopes that are used in daily industrial inspection process can give high-resolution images of low focal distances and narrow field of vision.

An important process in image analysis is thresholding, which reduces the color or grayscale image into binary. Thresholding is the simplest technique to segment an image into regions having common properties. It creates black and white binary images from grayscale or color images by transforming the intensity ofall pixels to single values of either one or zero. Thresholding reduces the intensity of pixels below a certain value to zero (black), whereas pixels above the designated value are given one (white). Thresholding is useful for rapid evaluation on image segmentation due to its simplicity and fast processing speed.

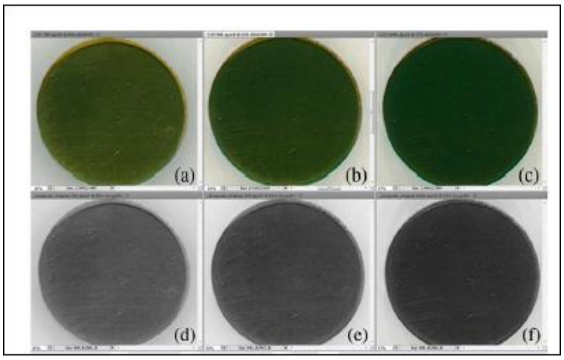


Fig. 2. (a) Original 700 dpi. (b) Original 900 dpi. (c) Original 1000 dpi. (d) Grayscale 700 dpi. (e) Grayscale 900 dpi. (f) Grayscale 1000 dpi.

In this proposed system, a contrast-adjusted Otsu's method and contrast adjusted median-based Otsu's method were developed to distinguish coated and uncoated regions of metal specimens by applying image-specific contrast adjustments and then utilizing Otsu's method and median-based Otsu's method for the thresholding process. The thresholding will classify the segments in the image into coated and uncoated regions.

STEPS IN PROPOSED METHOD:

Image Acquisition and Preparation: I mage acquisition is the process of taking images in MATLAB environment.

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We are taking 700,900 and 1000dpi titanium coated images and converted into gray scale image so that the color combination of image is reduced so it is easy to process the images.

B. Image Thresholding and Binarization:

For defect detection, the color image is first converted to grayscale and a thresholding technique is then utilized to obtain the corresponding black and white image. It is expected that the defect would be highlighted in a different color (white) as compared to the rest of the coating (black).

Thresholding is a technique to detect the maximum intensity pixel.
With the reference of that pixel we are rearranging pixels above the thresholding limit and below the thresholding limit. So that the image is converted into black and white.

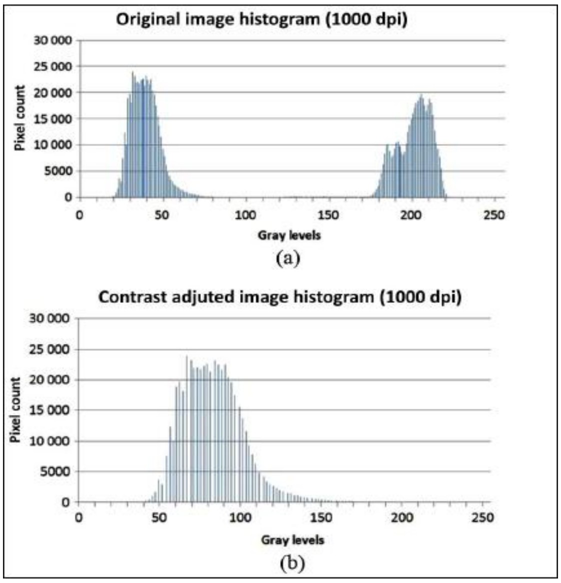

Fig. 3. (a) Original image histogram. (b) Histogram of an image that has undergone contrast adjustment subroutine with the background removed.

Proposed Thresholding Methods:

In this two methods are proposed. They are

1. Contrast-Adjusted Otsu's Method
2. Contrast-Adjusted Median-Based Otsu Method

Contrast-Adjusted Otsu's Method: In this study, a thresholding method is proposed that includes a contrast adjustment routine utilizing Otsu's thresholding to calculate the maximum cutoff value for image contrast stretching, and then to apply the same Otsu's thresholding method to calculate the threshold of the contrast-enhanced grayscale image for conversion to a black and white image.

It is mostly used method for thresholding and defect detection. As Otsu's method calculates the threshold to divide the image into two classes according to the gray levels, using the threshold value as the maximum cutoff value for image contrast stretching yields a unimodal histogram, as indicating that the image is uniform. The contrast adjustment was made by mapping the foreground class $[1, 2, \ldots, t]$ to the original range of the image $[1, 2, \ldots, L]$.

This can be expressed in pseudocode as follows:

. . .
GrayscaleImage**I** [image.rows, image.columns];
MaximumGrayLevel**L** = 255;
Threshold **t** = Otsu_Method(I);
forr = 1:image.rows
forc = 1:image.columns
I [r, c] = (I [r, c] / t) ∗L;
End
End

The resultant image is then converted to a binary representation, utilizing the threshold value calculated by Otsu's method .As Otsu's method assumes that the image histogram is bimodal, applying it on the contrast-enhanced image will split the unimodal distribution into two. This characteristic enables the contrast-adjusted method to be more accurate, as the defects on the coated material are categorized along with the background of the image resulting to a simpler image for segmentation.

2) Contrast-Adjusted Median-Based Otsu Method:

This method is similar to contrast adjust otsu's method but here we are applying median filter on the gray

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image then again that image is converted to black and white.

Since the coating is assumed to be uniform, binarization will completely represent coated surface to black. Defects will be highlighted since their pixels representation will be converted to 1 (white) in the binarization process.

Defect Detection and Analysis:

Defect Filtering and Recording: After binarization, the area containing defects is distinguishable, as the defects will have the same pixel values as the white background. A flood fill algorithm is used to find connected components with eight-connected neighborhood. The connected components are caluculated.
Then the area of the components arecaluculated.Tocaluculate area we are finding the centroid of the image.

Sample Surface Area Estimation: The surface area is calculated to determine the area of defects with respect to the coated sample surface area. In this study, an image segmentation technique is used for edge determination using the Sobel operator . The edge detection was applied on the grayscale image, which resulted in a binary gradient mask that exhibited a stark contrast between the sample and the background, which can then be segmented effectively. The surface area of the coated samples was computed based on the filled binary gradient mask, as it represents the surface of the sample given by *AT* .

Calculation of Defect Percentage: The percentage of the sum of defect area as compared to the total size of the samples is calculated to determine the extent of defects detectable using the methods proposed. The total defect surface area *AD* is represented by the summation of surface areas of *Ak*for *N* number of detected defects, denoted as

Percentage caluculation= (Defect image area/Segmented image area)*100

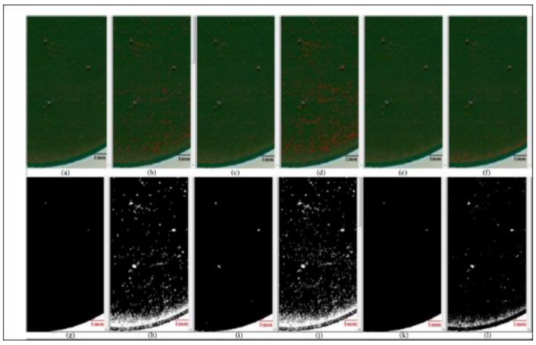

Fig. 4. Defect detection results from (a) Otsu's method; (b) Median-based Otsu; (c) Contrast-adjusted Otsu; (d) Median-based contrast adjusted Otsu; (e) MET; and (f) Median-based MET and the corresponding filtered binary representation containing defects under it. (g) Otsu. (h) Median-based Otsu. (i) Contrast-adjusted Otsu. (j) Median-based contrast adjusted Otsu. (k) MET. (l) Median-based MET. The red crosses indicate position of the defects that matches the defects (white) position in the filtered binary images. All the images are from 1000 dpi results.

ADVANTAGES:

1. Automatic inspection of materials.
2. Quality product manufacturing
3. Early defect detection

APPLICATIONS:

1. Used in automobile industries
2. Used in metal industries

Conclusion:

Two thresholding methods, contrast-adjusted Otsu's method and contrast-adjusted median-based Otsu's method, were developed for the detection of defects on high-resolution images of titanium-coated aluminum specimens. The performance of the two methods was compared to four existing thresholding methods. It was found that the proposed methods were able to correctly detect the highest number of predetermined defects in different sets of image resolution and performed better than MET and Otsu's method. However, the lighting and shadow effects were found to influence the accuracy of defect detection. Thus, it is recommended

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that a *fuzzy clustering algorithm* or *wavelet analysis* is incorporated into the image preprocessing to distinguish affected regions and reduce false detections.

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