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AUTOMATIC DEFECT DETECTION AND CLASSIFICATION OF CERAMIC TILES

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ABSTRACT

This paper presents the development and application of image analysis and computer vision system in defect detection of ceramic tiles. Computer vision is a rapid, consistent and objective inspection technique, which has expanded to varied industries. Monitoring and detecting defect is becoming a very important issue in ceramic tiles industry since maintaining rate of production with respect to time.

For the ceramic tile industry maintaining quality is more important, bulk amount of ceramic tiles are manufactured; it is very difficult to monitor the quality of each and every tile manually.

Lot of human resources is required for the defect detection of the tiles. Also it is quite tedious and time consuming method. Considering this criteria, an automated defect detection and classification technique has been proposed for the better quality of tiles in manufacturing process as well as production rate. The proposed method consist three basic steps. The first step is preprocessing the image. Preprocessing operation consists image acquisition, image enhancement, noise reduction, edge detection. In second step, we applied proposed flaw detection technique on tiles image to verify whether the tiles is faulty or not.

Keywords: Quality control, Image acquisition, image enhancement, noise reduction, edge detection,

I.INTRODUCTION

Six types of defects from the defect detection method. These types of defects are shown in the following Table As the price of ceramic tiles depend on its limpidness and precision of surface texture, color and shape, it's in fact a great challenge to control surface eminence and uphold production rate in the field of industrial fabrication of ceramic tiles. Under consideration these criteria, an enhanced automatic surface flaw detection and categorization procedure that is able to guarantee the quality of ceramic tiles as well as production rate in industrial fabrication. The proposed model plays an important role for automatic revealing of surface flaw during production and packaging. This proposed model includes an automatic categorization technique using computer vision that helps us to make sense about the pattern of surface defect within a very short time and also helps to make quick decision about the recovery process. Moreover, it also ensures the quality of tiles automatically during packaging procedure so that the defected tiles may not be mixed up with the fresh tiles. Objective of this project is to propose an efficient surface flaw inspection and categorization procedure which will be able to uncover the surface defects of ceramic tiles at a high rate within a dumpy time. We generally have found total:

Table 1. Defects present in ceramic tiles.

Name of defect	Description
Crack	Breakdown of tile
Blob	Water drop spot on tile surface
Pinhole	Scattered isolated black-white pinpoint spot
Spot	Discontinuity of color on surface
Edge	Break down of edge
Corner	Break down of tile corner

Although automated defect detection method have been deployed in ceramic tiles industries since few years but there still have complex procedure to classify defects using human vision i.e. automated classification and grading mechanism of packing have not been implemented yet. Again human judgment may be inclined by anticipation and aforementioned to awareness. In fact, most inexperienced observers have the same opinion that the flaw may have still there, when they cannot classify the structure of tiles properly. Such a monitoring task is naturally wearisome, prejudiced and costly in terms of production environment. Objective of this research paper is to propose an efficient surface flaw inspection and categorization procedure which will be able to uncover the surface defects of ceramic tiles at a high rate within a dumpy time.

II.BACKGROUND

Since last decade, some defect inspection mechanisms have been proposed to identify the surface flaw of industrial products (i.e. ceramic tiles, steel bar and wooden surface) by capturing their real time surface image. Their proposal can be described briefly as follows:

A. Elbehiery et.al. , proposed a method to identify the surface flaw of ceramic tiles. Their proposed method is divided into two distinct portions. First portion of this method consist with the captured image of tiles as input and output of this portion is histogram equalized image with intensity adjustment. After that, they use the output of first portion as input for the second portion. Furthermore, second portion also comprises with different complementary image processing operations so as to identify and to classify a variety of surface and structural defects. Their proposed system is not automated rather it emphasizes on the human visual inspection of defect classification in industrial environment. Moreover, this system is suffered by redundant operation since they apply the second portion on every test image to identify and classify various types of defects. Thus this system is time consuming as well.

B. Boukouvalas et al. , they applied separable line filters for flat tiles to identify crack and pinhole defects. Again, they applied winger distribution for crack detector and a novel conjoint spatial-spatial frequency representation for textured tiles. In terms of color textured tiles, this type of detection algorithm which looks for abnormalities both in chromatic and structural properties. However, use of separate filtering technique for identifying distinct defect is not a good practice.

Consequently, high computational time is taken while we are to handle a large number of operations during production time. It also proceeds with visual defect classification with human intervention.

Se Ho Choi et al. applied a real time mechanism for surface flaw detection of steel coil and bar in high speed production environment. They used a scheme named "edge preservation" for noise cutback and performance improvement. In addition, they used "second derivative Laplacian" filter to differentiate gray scale images from each other. Finally, they applied "double thresholding" technique to formulate binary images. Still, this type of technique is unable to find the orientation of the edge of surface, because they use "second derivative laplacian" filter which malfunctions for corner and curves flaw detection as well . In contrast, they hadn't developed any automatic classification mechanism rather it was also a human vision process to classify the surface flaw. After thoroughly revision of previous research paper, there may exists eight types of defects which may occur during production time and/ or packaging time.

III. METHODOLOGY FOR DEFECT DETECTION AND CLASSIFICATION

3.1 Introduction

A new surface defect detection and classification method has been proposed by this section. Our proposed method consists of two major portions. One includes some pre-processing image operations to contrast features. And another portion includes some prominent feature extraction operations to identify defects and to classify those defects as well. Our proposed model also introduces several algorithms by which we can boost up the system performance at a higher rate than existing one during production time. Thus it also can reduce the computational time all together. Here, we applied our mechanisms step-by-step on ceramic tiles image which is captured before by a digital camera.

3.1.1 First Step: Performing Some Image Pre-Processing Operations

Earlier than applying our proposed defect detection method, initially, we must make use of several image pre-processing operations on the input images. Pre-processing operations include RGB to Binary conversion, image enhancement, noise reduction etc. Pre-processing operations are imperative for renovating the captured RGB image.

A) Image Acquisition

.**B) Image Enhancement**

$$O(x,y) = (I(x,y) - \min)\left(\frac{n_i}{\max - \min}\right) + i$$

Where, O(x,y) represents the output image, I(x,y) represents the pixel position in input image. In this equation, ni correspond to the number of intensity levels, i stand for the initial intensity level, "min" and "max" represent the minimum intensity value and the maximum intensity value in the current image respectively. Here "no. of intensity levels" refers the total number of intensity values that can be assigned to a pixel. For example, normally in the gray-level images, the lowest possible intensity is 0, and the highest intensity value is 255. Thus "no. of intensity levels" is equal to 256. The contrast stretching operation is applied on the grayscale images in two passes. In the first pass the algorithm calculates the minimum and the maximum intensity values in the image, and in the second pass through the image, the above formula is applied on the pixels. In the proposed method, we enhance the gray level image to improve its visual quality and machine recognition accuracy using the following formula,

G=INTRANS(F',stretch',M,e)

Here, performs the intensity or gray level transformations and G computes a contrast stretching transformation using the following MATLAB expression:

contrast=1./(1+(M./F+eps)).^E)

Where, parameter M must be in range [0,1]. The default value for M is and the default value for E is 4. Here, F is gray-level image and M is such result which is found by applying image double and median filtering operation on F. eps returns the distance from 1.0 to the next largest double-precision number, i.e.

eps=2^(-52)

C) Noise Reduction

a. Consider each pixel in the image.

b. Sort neighboring pixels into order based upon their intensities.

c. Replace the original value of the pixel with the median value from the list.

A median filter is a rank-selection (RS) filter, a particularly harsh member of the family of rank-conditioned rankselection (RCRS) filters ; a much milder member of that family, for example one that selects the closest of the neighboring values when a pixel's value is extremely in its neighborhood, and leaves it unchanged otherwise, is sometimes preferred, especially in photographic applications. Median filter technique is good at removing salt and pepper noise from an image, and also causes relatively little blurring of edges, and hence is often used in computer vision applications.

D) Edge Detection

Every edge extraction techniques are consists of two distinct phases:

a. Finding pixels in the image where edges are likely to occur by looking for discontinuities in gradients.

b. Linking these edge points in some way to produce descriptions of edges in terms of lines and curves.

For the proposed method, we detect edge using sobel edge detection method upon the resulting image. Actually there are many kinds of edge detectors. We use first derivative edge detector (sobel) to detect edges of the image.

IV. APPLYING THE PROPOSED DEFECT DETECTION PROCESS

All preprocessing operations are applied to the reference image, stored in the computer database to compare with the test image. Let, the resulting image is I2. Now we consider I1as the resulting image found from the test image after applying all preprocessing operations. We propose here a new technique. We store I1 and I2 as matrix form to a file. Let, these two matrices are named as m1 and m2. Then we count the total number of black pixels (in binary, it is represented as 1) in m1 and that in m2. These two are then compared. If the number of black pixels in m1 is greater than the number of black pixels in m2 then we can make decision that defect is found in the test image, otherwise we can say that no defect is present to the test image. To understand this concept clearly, consider the following example:

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Let, we have a test image and a reference image of equal size. Now applying preprocessing steps on the test image we find matrix m1 whose value is:

$$m1 = \begin{pmatrix} 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 \end{pmatrix} \qquad m2= \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

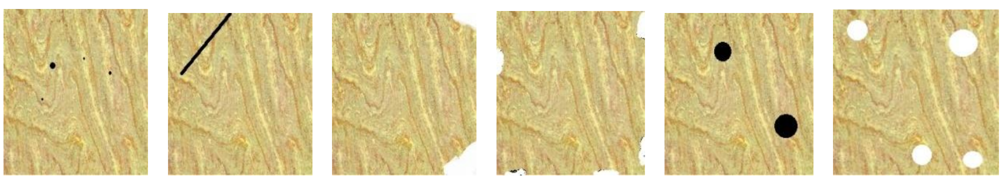
Here, number of black pixels for reference image is2 and for the test image is 6. So here ,no. of black pixels for test image is greater than reference image. So defect is present on the test image.

V. EXPERIMENTAL RESULTS AND DISCUSSION

Defect Detection

The proposed system detects surface flaw both for plain and textured tiles successfully. In this section, represents the experimental result of our proposed defect inspection technique. We also classify here different types of defects found through defect detection process. Here it is needed to mention that during the production, many numbers of tiles are produced in industries at the same time of same colors, shape and pattern. So, all the tiles of one shape are compared with that particular type of standard tile while processing through the computers. To get practical realization of our proposed surface flaw detection process, we have applied the proposed procedures on a sample RGB image of flat tiles. After that we check whether there is any kind of defect exists in this test image or not by applying our proposed preprocessing operations on this sample RGB image (i.e. image enhancement, noise reduction and edge detection). This is shown in the following Figure. In this Figure, we also show the reference RGB image for that test image and the output after applying preprocessing operations on it.

A. Test images



B. Preprocessing Steps on Test Image

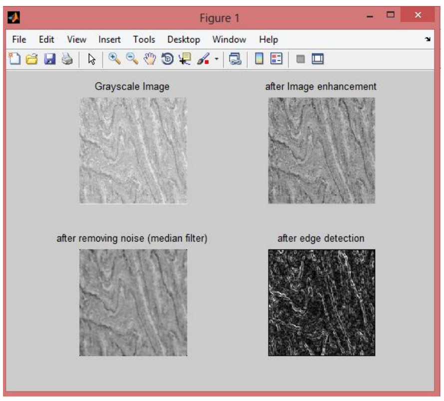


Fig 1: Result for reference image

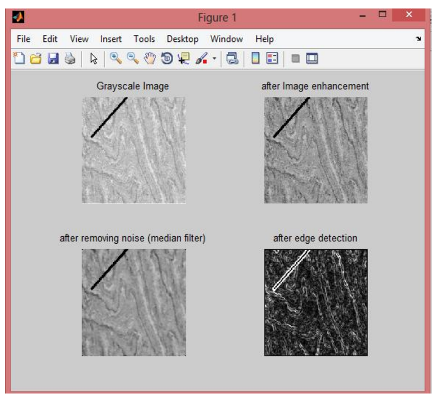


Fig 2: Result for test (crack defected) image

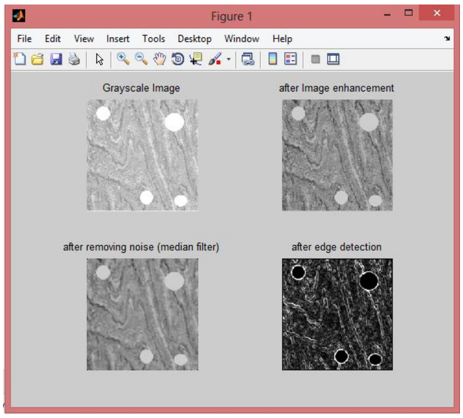


Fig 3:Result for blob defected image

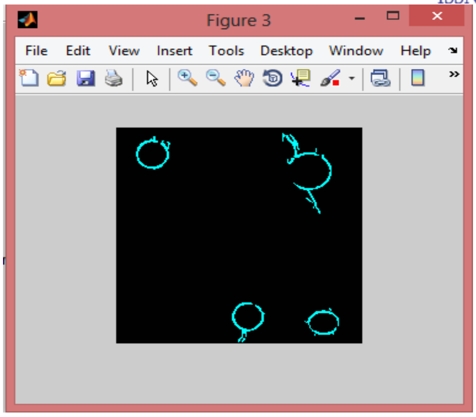


Fig4: Result for blob defected image

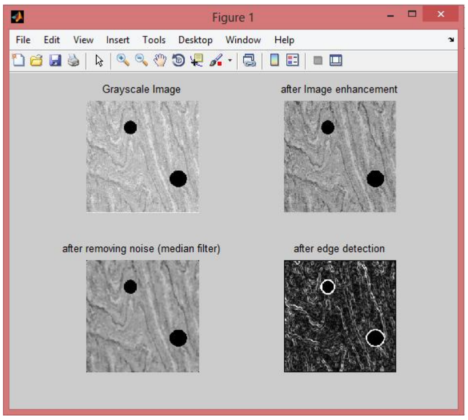


Fig 5: Result for spot defected image

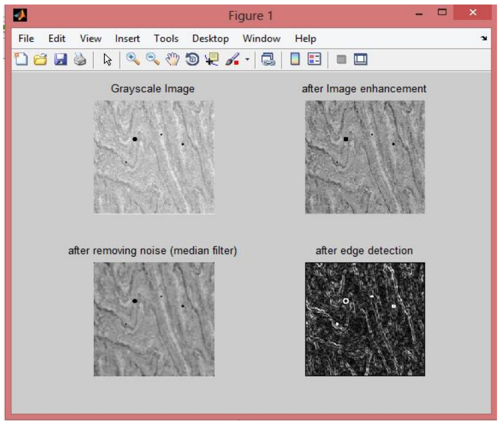


Fig 6: Result for pinhole defected image

Defects	**Identification of defects**	**Computation time in second**
Blob	Found	1.2429
Crack	Not Found	0.7634
Edge	Found	0.1693
Corner	Not Found	0.1650
Spot	Not Found	0.2694
Pinhole	Found	0.2642

Table 2: Classification Results

VI. CONCLUSION

The six kinds (crack, blob, pinhole, spot, corner, edge) of defect can be classified using given method .The proposed method fails to detect the glaze and scratch faults. However, it may be future work to detect and classify the glaze and scratch faults. We haven't measure yet the computational time of the proposed categorization technique. In this case, future work may be calculation of the computational time and provide an efficient method of reducing computational time for defect classification.

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