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Measuring the Dimensions, Detecting the Defects And Measuring Flatness of the Tiles

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Abstract

Quality control in the ceramic tile industry is the crucial step of the manufacturing process to insure the tiles will maintain their structural integrity when installed on ground or on any other surfaces. Ceramic tiles should not crack, bend or break entirely under normally applied pressure on them. This can only be avoided by ensuring good quality control. We present an optimised approach of quality control in the ceramic tile industry for smaller businesses. Currently there are two ways available for Quality Assurance which mostly Rely on third party inspection using experienced supervisors with keen eye or simply installing expensive machinery specifically designed as per quality control requirements which is expensive. The goal of this system is to catch a middle ground between these two by being as affordable and as accurate as possible. This system uses digital image processing to measure the dimensions of the tiles, Flatness and also as many unintended design defects as possible. We hope to achieve minimal hardware via digital image processing ultimately making the product Affordable, Reliable and Compact.

***Keywords*— Flatness, Tile Defects, Digital Image Processing, Matlab, Quality Assurance, Etc.**

I. INTRODUCTION

In India while there are many large scale Tile Manufacturing Companies, there are also small businesses which produce tiles on a daily basis. These tile businesses are often a startup or small scale factories that don't have technology as sophisticated as some other large companies. It is observed that these factories rely more on Human Supervisors to keep an eye on quality of the tiles throughout the manufacturing process. This is simply due to the Quality assurance machinery required for this is quite expensive for these businesses. Human error factors a lot when it comes to Quality Assurance. Human supervisors, however much experienced it is inevitable to have errors. A human eye can only see so much and the defects in tiles such as Cracks, Holes, Dents, Etc. can be miniscule to the naked eyes.

However, human error is not the only concern in these factories. It is often observed that these supervisors are often dangerously situated over the machinery. The safety in such small factories is almost of no regard. To solve this problem in this model we have suggested a Safe, Cost Effective, Low Maintenance and Fully Automated Quality assurance system for tile manufacturers.

II. LITERATURE REVIEW

1. For defects analysis and improvement on the images of Tiles(C. Boukouvalas, J Kittler, R Marik, M Mirmehdi and M Petrou).This paper proposes a system for morphological images and cleaning of images to reduce the noise disturbance in the image.The system helped in improvement of clarity of images and performing various operations on image processing to evaluate the structural tile defects.[1]

2. Measuring the tiles algorithm by setting protocols (Martin Coulthard, Mark E. Lehr and Keh-Shin Li) In this paper, a system is proposed which is helpful for the upgrading the system with measurement feature to the tile analysis The study of measurement of tile by bounding box image and calculating the dimensions results better accuracy. The output results with much improved data and closer to expected data.[2]

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3. Upgrading the machine vision algorithm for a fast response(Yonghuai Liu and Macros Rodrigues) This paper describes the design and implementation of a workflow of all combined data and aggregating the results in one format and single page, decisions are based on user requirement and sorting is done with machine given desired outputs.[3]

4. Testing Quality of Ceramic Tiles in Order to Evaluate Condition of the Manufacturing Process (Bohdan Stawiski and Tomasz Kania).This paper proposes methods of calculations on various cross sections to control the strength of the tiles. It further discusses the consequences on the placing of tiles on over 23 floor tiles where they observed various defects.[4]

5. Advanced Grading System for Quality Assurance of Ceramic Tiles based using Digital Image Processing (Ravindra Singh Rathore and Yogesh Kumar Sharma).In this paper, a grading system is proposed to achieve a constant quality of tiles and maintain it in the manufacturing process as well. In this grading system they have divided the grading system during quality assurance in six parts which makes it a convenient process to sort tiles.[5]

III. METHODOLOGY

This model is capable of creating a visual data system for detecting the defects and other physical errors of the tile. It gives the ability to users to have a collection of data of different error prone subjects i.e. cracks, Holes, etc. This makes it possible for the model to adapt to any new types of errors as well. The collection of images can further help the study to improve on the algorithm and thus making the model better along the way. The overall flow of the process is as follows:

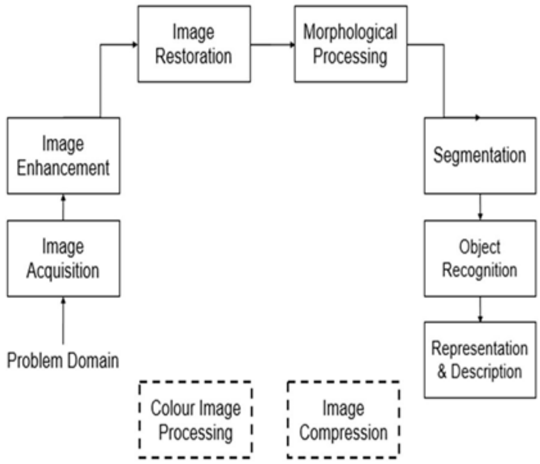

Fig1. Flow of Image Processing

A. Image Acquisition

In image processing for tile QA, it's the action of retrieving an image of tile from the camera, usually set-up at the end of manufacturing cycle for processing. It’s the primary step within the workflow sequence of this model because, without a picture, no processing is feasible. The image that's acquired is totally unprocessed.

Now the incoming image is transformed into a voltage by the mixture of input electric power and sensor material that's aware of a specific sort of energy being detected. The camera is able to capture images frequently and these images are stored for further processing and future references.

B. Image Enhancement

Image enhancement is the procedure of improving the image quality and properties of original image before processing. Contrast enhancement, spatial filtering, density slicing are some methods used to enhance an Image. Contrast enhancement or stretching is done by linear transformation

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expanding the original range of grey level. Spatial filtering improves the naturally occurring linear features like fault, shear zones, and lineaments. Density slicing converts the continuous grey tone range into a series of density intervals marked by a separate colour or symbol to represent different features.

FCC is commonly used in remote sensing compared to true colours because of the absence of a pure blue colour band because further scattering is dominant in the blue wavelength. The FCC is standardized because it gives maximum identical information of the objects.

C. Image Restoration

Image restoration is the operation of taking a corrupt/noisy image and Recovering the clean, original image. Corruption may be present in many forms such as motion blur, noise and camera Out of focus.[1] Image restoration is performed by reversing the process that blurred the image and such is performed by imaging a point source and use the point source image, which is called the Point Spread Function (PSF) to restore the image information lost to the blurring process.

Image restoration is different from image enhancement in that the restoration is designed to focus more on features of the image that make the image more pleasing to the observer, but not necessarily to produce realistic data from a scientific point of view. Image enhancement techniques (like contrast stretching or de-blurring by a nearest neighbour procedure) given by imaging packages use no *a priori* model of the process that produced the image.

With image enhancement noise can effectively be eliminated by sacrificing some resolution, but this is not acceptable in many applications. In a fluorescence microscope, resolution in the z-direction is bad as it is. More advanced image processing techniques must be applied to recover the object.

The purpose of image restoration process is to reduce noise and recover resolution loss in Image processing techniques are performed either in the image domain or the frequency domain. The most Efficient and a conventional way to achieve image restoration is De convolution, which is performed in the frequency domain and after computing the Fourier transform of both the image and the PSF and restore the resolution lost by the factors that led to blurring. This De-convolution technique, because of its direct inversion of the PSF which typically has poor matrix condition number, amplifies noise and creates an imperfect Blur free image. Also, conventionally the blurring process is assumed to be shift-invariant. Hence more advanced techniques, such as regularized de blurring, have been developed to offer robust recovery under different types of noises and blurring functions. It is of 3 types:

1. Geometric correction
2. Radiometric correction
3. Noise removal

D. Morphological Image Processing

Morphological Image Processing is used for working with shapes or any morphological entities. Morphological operations depend solely on the corresponding ordering of pixel values and not on their numerical values. That is why morphological Image Processing is mainly used for processing binary images. Morphological operations can also be applied to grey scale images as their light transfer functions are not known, ultimately making their absolute pixel values irrelevant in the process.

Morphological technique introduces a small shape or template called a structuring element in the targeted picture. This structuring element is put at all possible spots on the picture and it is compared to all the pixels around them. Some of these processes test whether the element is suitable in that pixel spot or if it interferes with other pixels overlapping them.

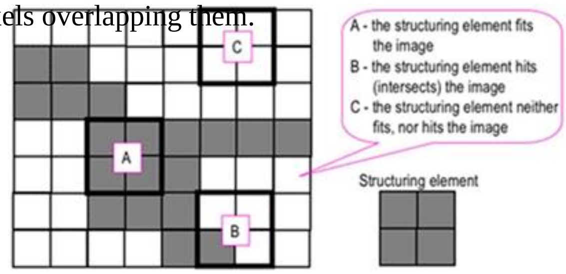

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Fig. 2 Probing of an image with a structuring element (white and grey pixels have zero and non-zero values, respectively).

A morphological operation on a binary image creates a new binary image in which the pixel has a non-zero value only if the test is successful at that location in the input image.

The structuring element is a small binary image, i.e. a small matrix of pixels, each with a value of zero or one:

- The matrix dimensions specify the *size* of the structuring element.
- The pattern of ones and zeros specifies the *shape* of the structuring element.
- An *origin* of the structuring element is usually one of its pixels, although generally the origin can be outside the structuring element

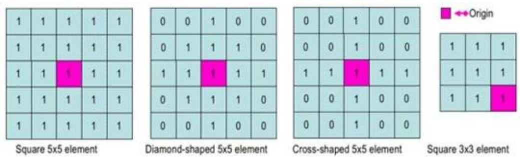

Fig.3 Examples of simple structuring elements

A common practice is to have odd dimensions of the structuring matrix and the origin defined as the center of the matrix. Structuring elements play in morphological image processing the same role as convolution kernels in linear image filtering.

When a structuring element is placed in a binary image, each of its pixels is associated with the corresponding pixel of the neighborhood under the structuring element. The structuring element is said to fit the image if, for each of its pixels set to 1, the corresponding image pixel is also 1.
Similarly, a structuring element is said to hit, or intersect, an image if, at least for one of its pixels set to 1 the corresponding image pixel is also 1.

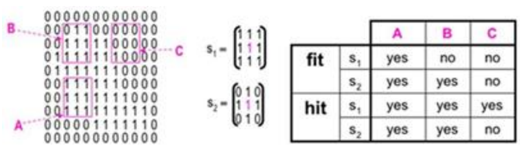

Fig. 4 'Fit' and 'Hit' test of a binary image with structuring elements s1 and s2.

Zero-valued pixels of the structuring element are ignored i.e. indicate points where the corresponding image value is irrelevant. The fundamental functions performed are: Erosion and dilation also known as opening and closing.

E. Segmentation

In digital image processing and computer vision, image segmentation is method of breaking a digital picture into more than one segment (sets of pixels, also known as image objects). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.[1][2] Image segmentation is usually used to locate objects and

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edges(lines, curves, etc.) in images. More precisely, image segmentation is the process of marking every pixel in an image with label such that pixels with the same label share certain characteristics.

The result of image segmentation is a set of pieces of images that together make the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in the region are similar with respect to some features or computed property, such as color, intensity, or texture.

F. Object Recognition

Picture detection is the ability to detect entities or characteristics in a digital imaging or video from a computer-
driven camera. It is a tool for photographs to be captured, processed, examined and studied. Computer s use machine-
view technologies powered by an artificial intelligence algorithm to classify and recognize objects. A standard algorithm for picture recognition includes:

• Matching pattern and gradient matching • Face recognition • Matching licence plates • Scene detecti on

IV. DEFECT DETECTION

A. Dimension measurement

The tile is placed on the conveyor belt under the camera. Then the length and breadth are measured and displayed.

B. Crack Detection

The tiles are placed under the
Camera the camera captures its image the on the image the following process is done:

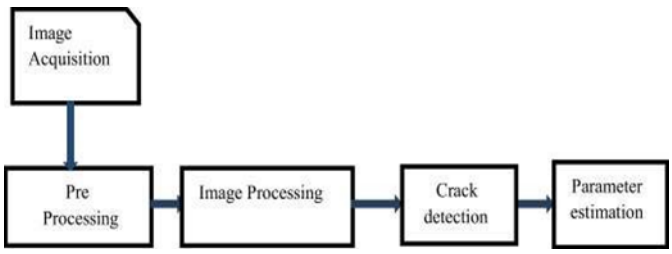

Fig.5 Crack detection process

C. Flatness detection

There are two servo motors that rotate the tile placed on it in a particular direction and a laser beam is sent across the tile from one end to the other; on the other end there is a light sensor which will ensure that the beam passed across it successfully. If the beam does not pass through it successfully that means there is access material on the tile surface.

The laser and sensor are at the fixed position the servo motor rotates in a particular angle and at every angle the laser is passed through it to detect the flatness.

V. ALGORITHM

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The Image acquisition is established and image pixels are converted from BGR format to Binary Image format. To check the detail of edges and noise reduction we swap the background foreground of the pixel to analyse the details in a more affirmative decision. We consider integer I in the loop for rows and j in the loop for columns. This displays an alternative image of two tiles by displaying two images. Cleaning of Image is done by morphology of image and displayed.

Anything less than 1% of noise distribution is supressed by rounding with multiplication of 0.01 to the image

Measurements are taken by using sprint function to convert into vector format and plotting it. Bounding the box image in the region and evaluating its width and height for further analysis we declare a variable and display it in the dialog box.

The Flatness of tiles are one of the key aspect to validate on and it is done by using laser light spreader on the light to analyse whether the tile surface is even or not, by interfacing with Arduino and display result on the screen.

VI. CONCLUSIONS

The model makes the manufacturing process safe and it is effective for small businesses. It is possible to reduce cost as well as get increased Quality Assurance performance. Although this reduces human labour opportunity it will be safer to implement this system. The end product is defect free and the tiles with defects are detected effectively.

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