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Corner Defect Detection Based On Inverse Trigonometric Function Using Image of Square Ceramic Tiles

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Abstract- Today Ceramic Tile is mostly used in construction of floor at home, offices and shops and many other places. For user needs the ceramic tile industry demand increase, thus tile industry also increases the production, but the quality maintaining or quality control is also an important factor. This factor is directly related the production of ceramic tile. If quality is maintaining manually, it takes lots of time and some minor defect not finding by this process. In this paper we find corners defects of the ceramic tiles. We use image processing and Inverse Trigonometric Function. The angle of each corner square ceramic tile is equal to 90° means it is normal. Our proposed algorithm is classified in Upgraded Automatic Quality Maintaining Machine (UAQMM). By proposed algorithm we increase the efficiency rate and decrease the total computational time.

Keywords: UAQMM, Inverse Trigonometric Function.

I. INTRODUCTION

Due to technology development, the image processing is used in research for scientist and engineering in the computer science. Image processing uses three steps for processing of any image. First, it importing the real time sensor or scanner or digital camera, secondly in the image we are manipulating, enhancement, compression, feature extraction from the ceramic tiles, at least generate result after applying different analysis on the image [1]. After using image processing there is no any participation of human for finding the defect detection. Image processing used in various applications like Glass industry, Textile industry, Ceramic tile industry for quality control, industry uses automatic visual inspection machine. In ceramic tile

Defect name	Reason of defect how it occurs
Crack	Due to extra pressure and heat at the time of production it may occur.
Pinhole [3]	When mixing the material of the tile some granular particles are mixed with it.
Spot	Some technical fault drop of water is falls on the surface of tile.
Blob	Improper coloring on the surface.
Corner	Due to extra pressure and move it from one place to another at the time of production.
Glaze	Improper color mixing or painting on the surface.
Scratch	Friction of rough surface, it may occur.

we find different type of defect like: Crack, Pinhole, Spot, Blob, Corner, Glaze and Scratch [2]. These defects were found at the time of production by removing this type of defective tile at the time of packing. After using automatic visual inspection machine, we control the quality of the ceramic tile industry. If ceramic tile industry uses manually process for finding defect from the ceramic tile, this activity is so time consuming, and by manually we search only major defect but minor defect that not seen by naked eye's that are remaining same in ceramic tile. This type of production not fulfills the user needs, in this way quality of ceramic tile industry is decrease and production of industry is also decreases.

Figure 1: Reasons of defects in ceramic tile

The main goal of this research paper is design an algorithm for finding corner defect from the ceramic tile, this designing algorithm works on upgraded automated quality maintaining machine. By this we remove the corner defect at the time of production.

I. RELATED WORK

RowshanSahriar and Md. Belal Hossain [4] in their paper the author suggests the number of white pixels in test image is greater than the reference image or less than the reference image means the image is the tile is defective otherwise the normal. Author of this paper gives algorithm and a flow chart of each defect found in ceramic tile. But my thesis is based on corner defect detection. According to this paper corner algorithm the authors say each ceramic tile has four corners. Thus we set the count at '0' when the counter is equal to four means the tile corner is normal otherwise corner is defective.

F. S. Najafabadi, H. Pourghassem [5] in their paper the authors determine inner space or

Euclidean space of each four right-angle triangle. Each of right angle values in radian we convert it into a degree. After finding the angle we compare the angle if the angle is greater than 92 degrees or less than 89 degree the corner is defective or tile is defective otherwise it is normal.

C. Boukouvalas [6] in their paper the author the defect detection is detected when the image in converted it into Thresholding. White pixel represents as '1' and Black pixels are represented as '0'. For the grading of ceramic tile is based on the color of the histogram. We were comparing the histogram of test images and reference image. This paper is used for color and textured base grading or quality of the tiles.

J.M. Valiente [7] in their paper the test image is less than or greater than referenced images of beta angle means this type of tile is also defective and it is in third grade tiles. An automatic image registration method is accuracy is very high as compared to others. This paper helps for detecting error lower than 0.3 pixels and 0.02 degree in the registration parameters.

III. HARDWARE REQUIREMENT

Latest technology of digital cameras can collect the hundred times clearer than the naked eyes. We connected two digital cameras both are same quality. In these two cameras we also attached light, at the time of snapped 'on' this and by using this image is so clear and saving the electric energy. They can easily snap the digital image of ceramic tile. These two cameras snap both four corners. First camera C0 can snap right side both top and bottom corners and C1 can snapped left side, both top and bottom. Both cameras C0 and C1 snapped RGB image. We used shaft based rotator they help with movement of the conveyor belt. The conveyor belt is a type of surface according to the length of ceramic tile [8], by which we easily placed the ceramic tile on the surface of this belt [9]. Conveyor belt is used for movement of ceramic tile from right to left side [10]. In classification actuator, it classify the each corner is right angle means normal tile. We connecting display unit with computer system and classification actuators.

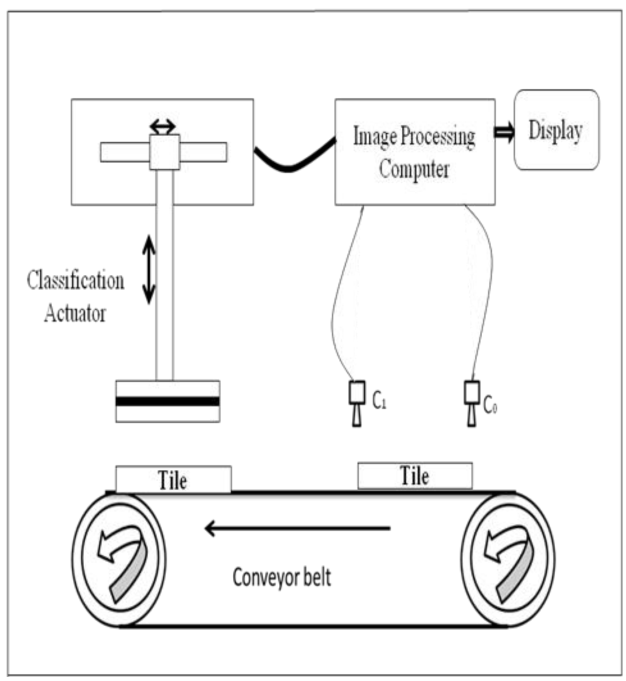


Figure 2: Concept of UAQMM

IV. OUR PROPOSED ALGORITHM

Before snapping the image first clean the lens of all cameras, because sometime dust particle on the lens of the camera we snapped the image that have low quality, by low quality every calculation of find corner is incorrect. Thus when snapped the image of ceramic tile first clean the dust for the good quality of image. Block diagram of our proposed algorithm in fig

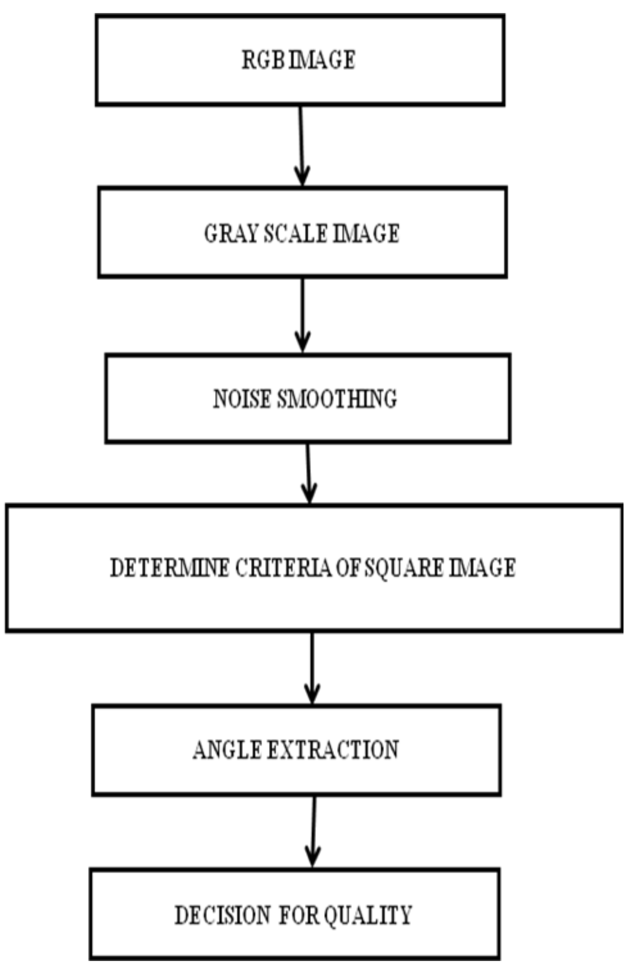


Figure 3: Block diagram of our proposed algorithm

Step 1: RGB IMAGE

We use two digital cameras in Upgraded Automated Quality Maintaining Machine (UAQMM) these are C0 and C1. These two cameras are of NIKON D800E. C0 can capture Right side, top and bottom corners and C1 can capture left side top and bottom corners. These two cameras can capture the image, this image belongs from the RGB color model [51] and the image is saved in JPEG format. The extension of this format is .jpg. The dimensions of RGB image of the given ceramic tile are 771×744.

Step 2: GRAY SCALE IMAGE

After converting gray scale image, in this type of image found only two types of pixel one is black and second is white. Black pixel is represented as ‘0’ and White pixel is represented as ‘1’. In gray scale image we calculate the minimum and maximum intensity value of every pixel in the given image. The minimum intensity value of black pixel is ‘0’.

Step 3: NOISE SMOOTHING

In this step we are smoothing the noise present in gray scale image. In gray scale image we found some blur and edges present, thus this type of noise is called salt & pepper. The salt noise refers white pixels in the image and it is represented as '1' and pepper noise refers black pixels in the image and it is represented as '0'. This type of noise filtering or smoothing form non-linear filter is also called Median filter. The median filter stored all information about the image.

Step 4: DETERMINE CRITERIA OF SQUARE IMAGE

The output of noise smoothing we remove the salt & pepper type of noise by using median filter. The given window of size 3×3 is placed in x and y axis. For find the criteria of square image. The given ceramic tile image is square shape, thus four corners are in the given gray scale image. For finding the corners we move horizontally for finding value of x axis criteria and vertically moving for finding value of y axis first corner (X_{min}, Y_{min}), second corner (X_{max}, Y_{min}), third corner (X_{min}, Y_{max}), fourth corner (X_{max}, Y_{max}).

Step 5: ANGLE EXTRACTION

In previous step determine the criteria of square image for each corner value. After this we extract the angle of each corner. For finding the angle of each corner we use some mathematical concepts [11]. In this step we use a combination of geometric and trigonometric operation for finding the angle each corner. There are two steps for finding the angle of each corner in the ceramic tile.

Step 1: In this step, we use square image of ceramic tile applying 1st diagonal on the image, this diagonal divide the image into two triangles. Similarly the same square image of ceramic tile applying 2nd diagonal on the image, this diagonal is also dividing the image into two triangles. These entire four right angle triangle follow the Pythagorean Theorem

$$X^2 + Y^2 = Z^2 \qquad (1)$$

Where X represents length of x axis and Y represents length of y axis and Z represents diagonal of right angle triangle.

All right angle triangles follow the Pythagorean Theorem, then us applying the Inverse Trigonometric function (ITF) on these trigonometric formulas:

$$\text{Sin } \alpha = \text{length of Y / length of Z} \qquad (2)$$

$$\text{Cos } \beta = \text{length of X / length of Z} \qquad (3)$$

Step 2: Every angle given in Radian form thus, by this formula help for converting it into radian value into degree.

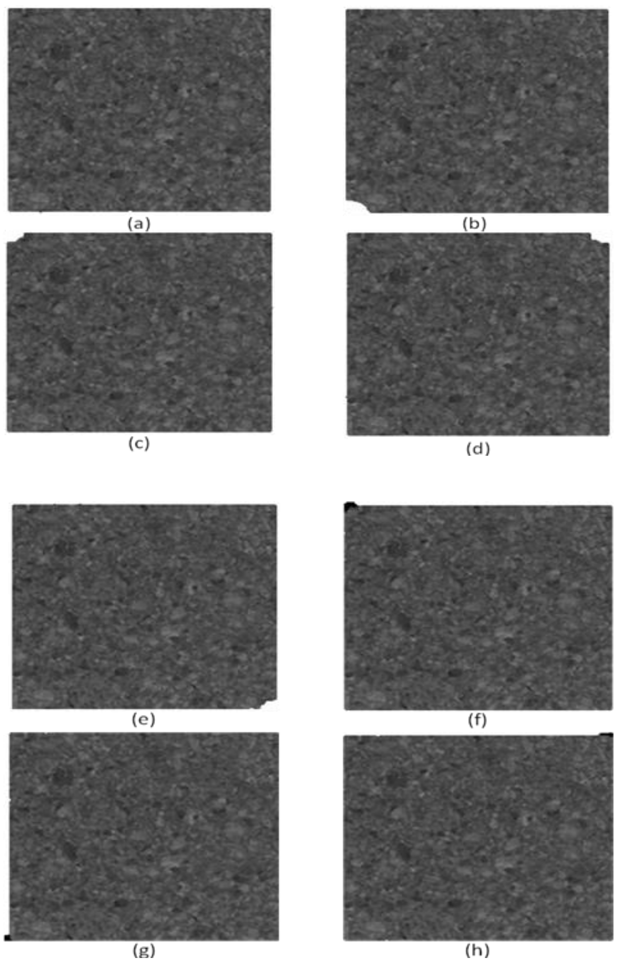
$$\text{Degree} = \text{Radian} \times (90 \times 2/\pi) \qquad (4)$$

Step 6: Decisions for Quality

This step we check condition after angle extraction from the image of ceramic tile. If angle of any corner is equal to right angle or 90˚ means this type of corner is normal. Otherwise, it is defective.

V. EXPERIMENTAL RESULT

For experimental result, we run our proposed algorithm in MATLAB R2011a and configuration of the system is Dual-Core Processor, 3GB RAM 32-bit Operating system.



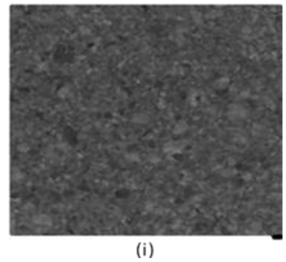


Figure 4: (a) it is normal tile (b, c, d, e, f, g, h, i) these are defective tiles

We have been tested in our proposed method for corner defect detection on about 100 ceramic tiles images.

Number of Ceramic tiles	Efficiency of Corner defect detection (%)	
	Existing Method[31]	Our Proposed Method
20	86.78%	99.50%
40	84.33%	97.33%
60	80.30%	95.76%
80	81.46%	92.17%
100	80.99%	97.86%
Average	**82.772%**	**96.524%**

Figure 5: Efficiency rate of Corner detection

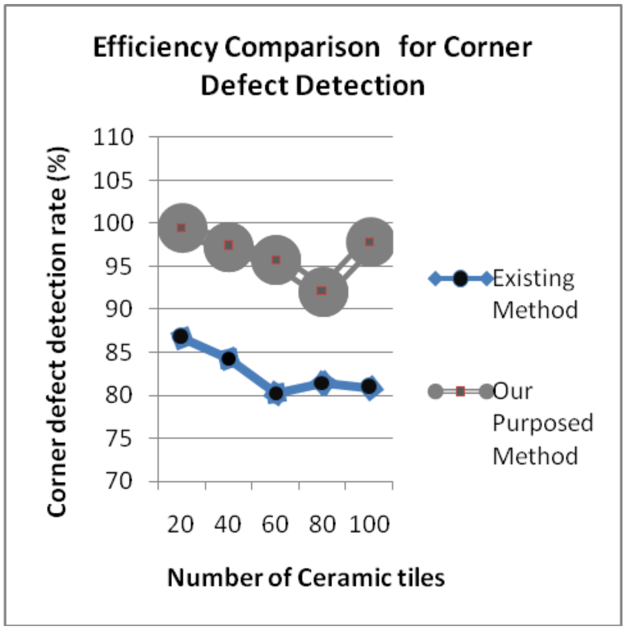


Figure 6: Efficiency rate chart of Corner detection

Number of Ceramic tiles	Required time for Corner defect detection(in sec)	
	Existing Method[31]	Our Proposed Method
20	12.6213	6.5341
40	15.4321	8.4269
60	18.8147	10.7217
80	21.6315	12.9626
100	24.5242	15.6712
Average	**18.6048**	**10.8633**

Figure 7: Required time comparison for Corner detection

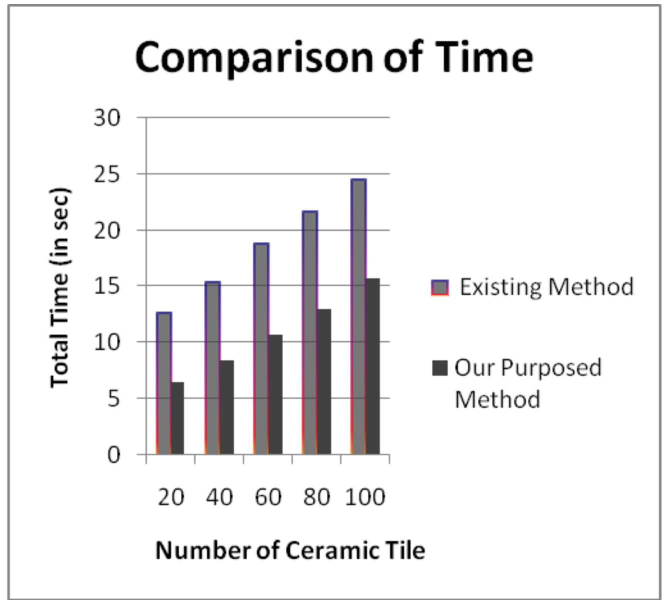


Figure 8: Time comparison chart for Corner detection

VI. CONCLUSION AND FUTURE SCOPE

In this paper, the detection of the corner defect from the image of square ceramic tiles. We use Upgraded Automated Quality Maintaining Machine (UAQMM) for finding corner defect from the square ceramic tiles. Our proposed algorithm is successful to increase the efficiency rate and reduced the total computational time for corner defect detection from the images of the ceramic tiles. Thus our proposed algorithm is helpful for maintaining the quality in the ceramic tile industry. Future work of corner defect detection from the rectangle and other geometrical shapes of ceramic tiles and reduce the total computational time.

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