# Categorization of Tiles Using Image Processing

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***Abstract***

*Manufacturing industries are among the strongly motivated industries to use high precision and high accuracy inspection systems with low installation and at the same time maintaining cost and as well as the possibilities for reduction in time consumption and efforts that they representin the industry. This project aims to improve the ceramic tile factories classification of their products in terms of their size measuring investigation. The objective of this exploration is to use an image processing algorithm to compute the length of our considered object i.e. ceramic tiles. A visual inspection system for ceramic tiles is appointed to evaluate the suggested algorithm in a real experimental environment. The outcome shows that the maximum error in length measurement is very nominal. The Blob algorithm could be used for image detection and identifying the sides of the ceramic tiles. Automation of the error detection focus at reduction in manual involvement of the process and a significant reduction in the time allotted for assessment of the ceramic tiles and their grading.*

***Keywords***—Visual Inspection, Machine Vision,Dimension Measurement, Quality Control

## I. INTRODUCTION

The ceramic tiles fabrication process has now been completely automated with the peculiarity in the final stage of production concerned with visual assessment. This automated categorization method helps us to gather knowledge about the pattern of defect within a very little time and also to decide about the recovery process so that the defected tiles may not be merged with the fresh tiles just obtained. This paper is concerned with the complication of automatic assessment of ceramic tiles using computer vision. It must be noted that detection of defect or error in textured surfaces is a vital area of automatic industrial assessment that has been largely overlooked by the recent wave of research in machine vision applications. Humans are capable to discover such defects without any prior knowledge of the defect free pattern. Defects are viewed as in-homogeneities in regularity and in orientation fields. Two pronounced but conceptually related proposal are presented. The 1st one defines structural defects as regions of sudden falling regularity, the 2nd one as perturbations in the dominant orientation. Both methods are general in the senses that each of them is suitable to a variety of patterns and defects. Human judgment as we know that is also influenced by expectations and initialinformation. However, we can say that this problem is not determined to structural defects. In many detection tasks for instance, edge detection, there is a moderate transition from presence to absence. While on the other hand, in “crystal clear” cases most inexperienced observers agree that the defect is present, even if they are not able to identify the structure. Such task that require examining is of course tedious and time taking, subjective and exorbitant but it is based on a long experience and can make use of the huge admiration and recognition abilities of the human mind.The defect detection function induces that the whole surface of each and every tile must be imaged and analyzed. The goal of the assessment is to produce a statistical investigation of the production batches. Such that all batches of tiles will be imaged separately without any sampling task. The image acquisition acquired directly on line, in the current time i.e. real time. The image analysis algorithm must be quick enough to follow the manufacturing rate. Objective of this paper is to create a visual system that is efficient for detecting the surface defects for the fired ceramic tiles. That ensure that the products are free from faults for the classifying process. Classifying process must be effectively, objectively and repeatedly, with rapidness and minimal costs. It must have the capability to adopt autonomously to changes in materials. The techniques used range from Blob, Crack, Pin-hole and Spot detectors algorithms for plain, textures tiles. This therefore decreases the number of faulty tiles. The presented assessment procedures have been executed and tested on a number of ceramic tiles using synthetic and real faults. The outcome suggested that the performance is sufficient to provide a basis for a viable commercial visual assessment system which we will see it in the next sections.

## II. BACKGROUND

In this we study the sorting system in the ceramic tiles industries from relying on the human which detects the faults manually upon his experience and abilities which varies from person to person to the automated system relying on the computer vision. That affect mainly in the categorization or sorting function which is also done by human in the industry. People may workefficiently for short\ periods of time and many discrete operators are involved in inspecting the same batch of tiles. Continuity over time is not assured and may result in overall poor quality, which may cause customers to protest or even to reject the batch. Miss-sorting is kept at low level. Isolating different kinds of faults in tiles images. Automated sorting systems would bring many number of benefits to the overall sector with major economic advantages, also assure product quality, increase in plant efficiency and decrease fixed and periodic investments.

## III. LITERATURE SURVEY

[1] H.M. Elbehiery ; A.A. Hefnawy ; M.T. Elewa "Quality control enhancement via nondestructive testing for green Ceramic Tiles "

Quality control in the ceramic tile production is quite difficult and labor intensive so it is performed in a real harsh industrial environment with noise,temperature and humidity. It can be categorized into color analysis, dimension verification, and surface fault detection which is the centered purpose of our research. Fault detection is based on the judgement of human employee operators while most of the other production activities are automated. So, our work is a quality control magnification by executing a non-destructive testing for the green ceramic tiles using proximity ultrasonic sensors that enables on-line process control, which is a test configuration for the green ceramic tiles. Ultrasonic testing is utilized for integrity validation of composite materials. Design launchedover here in the research is the minimal cost on-line measurement system using proximity ultrasonic transducer root on the TOFD technique, which is one of the non-destructive testing techniques till now. Time of flight diffraction is quickly gaining attention as a powerful stand-aloneassessment technique that can simultaneously detect and size fault. This paper, presents the solution of an experimental investigation for a non-destructive test on real green ceramic tiles including productionfaults which will be described in the research.

[2] Yao Zhang ; Xiaoya Liu "Extract Characteristic of High Reflect Rate Surface Texture Using Wavelet Transformation"

Against the difficulty of drawing out the color aberration of high-reflect-rate ceramic tile surface texture, author came up with an excitingly amazing way of utilizing wavelet transformation to pull out the image texture features. Basically, the way is suggesting to use  dimension wavelet decomposition on each and every passage of the image and pull out energy characteristic from every detailed sub-graph. This energy signal mixes the message of color and feature. Computes samples' color histogram statistics as the critical data for doing categorization. At the end, utilizing Minimum Distance Classifier to rank the samples. According to the experiment conducted, compare the currently existing method which mostly uses the color histogram distribution, this procedure can show greater message of color distribution in space. Experiment signifies that this particular method can get a goodcategorized result.

[3] Yun Feng Li ; Xi Xi Han ; Sheng Yang Li "Non-contact dimension measurement of mechanical parts based on image processing"

Shedding light at the problems that mechanical parts are bulk produced in industrial manufacturing, and the workload of traditional manual computation is heavy, the computation efficiency is low. Contact computation system that rely on image processing and machine vision technology is introduced. The hardware of the computationarrangementcontainsillumiation source, optics, camera and PC, the computation system acquire transmitted illumination to shed light on the contour feature of mechanical parts. Preprocessing is initiallyexecuted to the captured image by the software of the computation system, then threshold sectionalization and the edge contour extraction are performed; At last, in order to ameliorate the detection precision of the geometric elements, a method to locate the center of circles accurately is adopted, which based on Hough transform algorithm. The results show the validity of the method and the feasibility of the algorithm in the system, it amelioratethe efficiency of the computation system and understands the non-contact online measurement of mechanical parts.

[4] Min Li ; Wei-Wei Zhang ; Biao Ma "The measurement system of hardware's shape and dimension based on image processing method."

Image measurement technology applies the digital image processing technology for precision measurement. As Compared to traditional ways of measurement, image measurement technology has advantages of high accuracy, large dynamic range, non-contact and flexibility, so, it is very suitable for a number of on-site uses, and it has large applications and practical value. In this paper, key technologies of image measurement technology were improved to raise the measurement accuracy and speed. Two-dimensional median filter was used to filter image noise and enhance filtering speed. Edge extraction algorithm based on eight-direction Sobel operator overcame the edge fracture problem. Hough transform based on graphics geometric characteristics was applied to detect the edge of the geometric primitives. Finally, curve was fitted by least squares on edge of pixel points, and its geometric dimensions were gained. The measurement results of standard gauge blocks and measuring needles reaches sub-pixel accuracy and proves the efficiency of the method proposed in this paper.

[5] Xie Chi ; Liu Ying ; Liu Nian ; Yang Fu ; Tang Xiaoji "Capturing and processing for large dimension measurement of large transformers"

The CCD sensor is the important part of the automatic measurement system with high accuracy of direct pointing. Because the target of measurement system is the complicated silicon-steel sheet with no more than 0.5 mm thickness for the large transformer, the routine projection aiming cannot work easily for the complicated figure. For the measurement of large transformers' silicon-steel sheet, a new aiming method with

CCD sensor is developed. In this method, the system's aiming mechanism is the special CCD sensor, and the conventional aiming line is supposed as the virtual line and the center of CCD sensor's picture is regarded as original of coordinate. The complicated images of large transformers' silicon-steel sheet are captured fast by the CCD sensor and by image processing, and we can determine the edge, then the image can be processed as well as automatically by the error correction, so the aiming velocity and the accuracy are increased. At the same time, all the operations, such as image capture, image processing and control signal sending, are integrated in one operation environment, and the error correction calculation for the CCD sensor with fast aim is completed by computers automatically. The capturing and signal processing for large dimension measurement is very useful to the modern manufacturing industry and application. The image signal processing error correction method for CCD camerawork can overcome the artificial pointing error in the conventional method.

## IV. DESIGN METHODOLOGY

The block diagram of the methodology is shown in Figure below. It's components of a raspberry pi microcontroller, WIFI, SD card, pi camera and power supply.

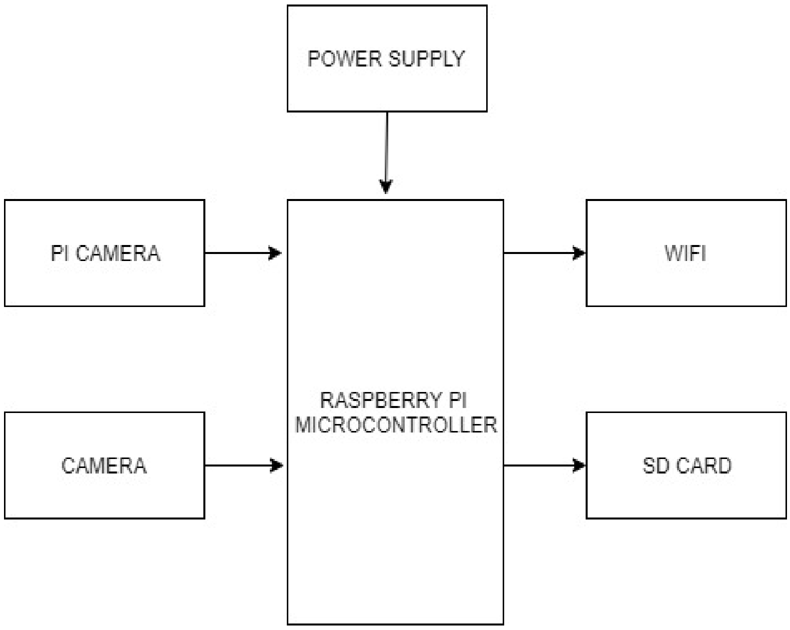


**Fig1.Block Diagram of the system**

The hardware components required for the above system is explained below:

- Raspberry Pi Microcontroller
- Pi camera
- WIFI
- SD card
- Power supply
- Keyboard.

*A. Raspberry PiMicrocontroller*

Raspberry Pi Model, 512 Mb with a black plastic case: The Raspberry Pi is a low cost, credit-card sized computer that can be plugged into a computer monitor or TV, and it uses a standard keyboard and mouse. It can interact with the outside world, and can be used in real time applications. The board is the central module of the whole embedded image capturing and processing system as given in figure. Tools are available for Python as the programming language, with support for others like BBC BASIC (via the RISC OS image or the "Brandy Basic" clone for Linux)& C.
Hardware:
Initially sales were of the Model B, with Model A following in early 2013. Model A has only one USB port and no Ethernet controller, and will cost less than the Model B which has two USB ports and a 10/100 Ethernet controller.
Although the Model A doesn't have an 8P8C (RJ45) Ethernet port, yet it can connect to a network by using an external usersupplied USB Ethernet or a Wi-Fi adapter. On the model B the Ethernet port is provided through a built-in USB Ethernet adapter. As typical of modern computers, generic USB keyboards and mice are compatible with the Raspberry Pi.
The Raspberry Pi does not have a real-time clock, so the OS must use a network time server, or ask

the user for time information at boot time to get access to time and date for file time and date stamping. Also, a real-time clock (such as the DS1307) with battery backup may be added via the I²C interface.
Hardware accelerated video encoding became available on 24 August 2012 after it became known that the existing license also covered encoding. However, yet there is no stable software support for hardware H.264 encoding.
The Raspberry Pi Foundation has released two additional codec’s that can be bought separately, MPEG-2 and Microsoft's VC-1. Also it was announced that the Pi will support CEC, to enable it to be controlled with the television's remote control.
A revision 2.0 board was announced on 5 September 2012, with a number of minor corrections and improvements. On 15 October 2012, it was announced that all new Raspberry Pi model B's would be fitted with 512 MB instead of256 MBRAM.
USB hub: A USB hub is a device which expands a single Universal Serial Bus (USB) port into several ports so that there are more ports available to connect devices to a host system. USB hubs are mostly built into equipment such as computers, keyboards, monitors, or printers. When such a device has many USB ports, they all usually branch from one or two internal USB hubs rather than each port having independent USB circuitry. Physically separate USB hubs are avialable in a wide variety of form factors: from external boxes (looking similar to an Ethernet or network hub) connectible with a long cable, to small designs that can be directly plugged into a USB port.

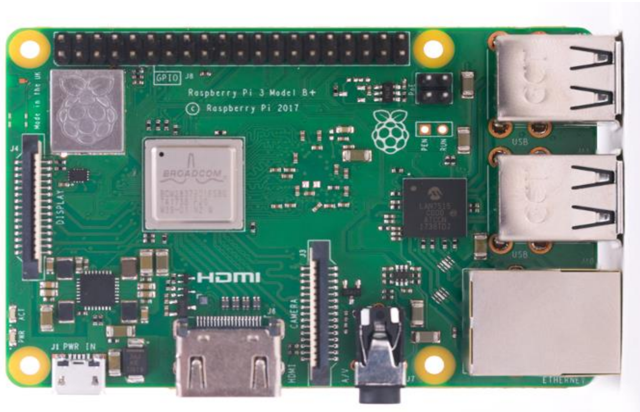


***Fig2. Raspberry pi***

*B. Pi camera*

The Raspberry Pi camera module is used to take high-definition video, as well as stills. It’s easy to use for beginners, but has plenty to offer advanced users if one is looking to expand ones knowledge. There are lots of examples of people using it for time-lapse, slow-motion and other video modifications. You can also use the libraries bundled with the camera to create effects.

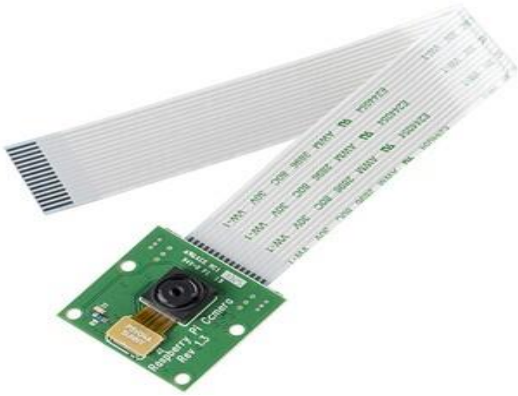

**Fig3. Pi camera**

*C. WIFI*

Wi-Fi is a popular wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections. A common misconception is that the term Wi-Fi stands for "wireless fidelity," but this is not the case. Wi-Fi is simply a trademarked phrase that means IEEE 802.11x.

*D. SD card*

The SD card is aessential part of the Raspberry Pi, it provides the initial storage for the Operating System and files. Storage can be expanded through many types of USB connected peripherals. A 32 GB SD card is used for our Project.

**Fig4. SD Card**

Secure Digital (SD) is a nonvolatile memory used extensively in portable devices, like mobile phones, digital cameras, GPS navigation devices, handheld consoles, and tablet computers. It is from a family of solid-state storage media. The Secure Digital standard was introduced in August 1999 as an improvement over Multimedia Cards (MMC). The Secure Digital standard is maintained by the SD

Association (SDA). The Secure Digital format has four card families available in three different form factors. The four families being the original Standard-Capacity (SDSC), the High-Capacity (SDHC), the extended-Capacity (SDXC), and the SDIO, that combines the input/output functions with data storage. The three form factors are the original size, the mini size, and the micro size. Electrically passive adapters allows a smaller card to fit and function in a device built for a larger card.

*E. Power Supply*

Raspberry Pi can work with or without the main connection by using power bank that can be connected to Pi using an USB cable. The unit uses a Micro USB connection to power itself (as only the power pins are connected – so it will not transfer data over this connection). A standard modern phone charger with a micro- USB connector will work, if it produces at least 700mA at 5 volts. Check the power supply's ratings carefully. If unsure what to use one can use a range of other power sources (assuming that they are able to provide enough current ~700mA):

- Computer's USB Port or powered USB hub (which will depend on power output)
- Special wall sockets with USB ports
- Mobile Phone Backup Battery (will depend on power output) (in theory – it needs to be confirmed).

To use the above, we need a USB A 'male' to USB micro 'male' cable - these are often shipped as data cables.

*F. Keyboard*

Any standard USB keyboard and mouse works with Raspberry Pi. Wireless keyboards and mice will work if it is already paired. For keyboard layout configuration options checkraspi-config.

## V. METHODS

*A. Image acquisition and capturing image acquisition.*

Image acquisition is the process of obtaining a digitized image from real world. Each step in the acquisition process might introduce random changes into the values of pixels in the image which is known as noise. An image of ceramic tile is captured and stored in computer for processing. We intended to create images that are most suitable for the human visual perception object detection and target recognition. We used principles of Image processing and morphological operations on the captured images. Hence, we get new images that contain the surface defect only to make easier for detecting process and classification operation.

*B. Image Capturing*

The ceramic tiles images are captured through the camera held on the line production at the industry. The image captured will convert to another kinds of images (Binary or Gray scale) to be suitable for the various defect detection algorithms used for different types of defects. Different methods used are Edge detection, Morphology operations, Noise reduction, smoothing process, and intensity adjustment. The effects of unequal lighting and space sensitivity of the TV camera CCD are corrected analyzing a sample tile made of white Plexiglas whose image has been previously divided in 8x8 sectors. This representsa compromise between spatial resolution distribution and computing time.

*C. Edge detection*

An edge may be considered as a boundary between two dissimilar regions in an image. These may be different surfaces of the object, or a boundary between light and shadow falling on a single surface. An edge is easy to locate since differences in pixel values between regions are relatively easy to calculate by considering gradients. Many edge extraction techniques can be broken into two phases: • Finding pixels in the image where edges are likely to occur by looking for discontinuities in gradients.

• Linking these edge points to produce descriptions of edges in terms of lines curves etc. Thresholdingproduces a segmentation that yields all the pixels that belong to the object or objects of interest in an image. Another way is to find those pixels that belong to the borders of the objects. Applying the Defect Detection Process: Pre-processing operations are applied to the reference image, stored in the computer to compare with test image.

### *D. Expected Output*

As described in the previous section Blob algorithm, and spot detection algorithms used independently also as post-processing stages to our other techniques. It is an accurate approach but is computationally demanding. We apply these algorithms on a several number of tiles, which are plain tiles and textured tiles. In addition, these algorithms are applied on a dozen of tiles images. These tiles images have the same kind of defect whereas the operating conditions (speed of the line, vibrations etc.) were similar to real conditions i.e. for logistic reasons to see if the algorithm gives the same result or not.

### *E. Working*

This project aims at creating visual inspection system that's capable of measuring the dimensions of ceramic tiles.This system's working starts with a power supply which provides power to pi camera and keyboard. The pi camera module is a portable light weight camera that supports Raspberry pi, captures the image of incoming tile.Keyboard is used to provide standard size of tiles. Here we provide two standard dimensions that are 2cm X 2cm and 2cm X 1cm.The captured image is verified whether it is correct or not.If not then the image is captured again.If the captured image is correct, then these inputs are given to Raspberry pi microcontroller.Based on the input values and algorithm used microcontroller measures length, breadth, and thickness of the ceramic tile. The microcontroller used then sends signals as output to the interfaced computer through WIFI. If the current tile is faulty, then it sends an error signal on the computer screen. Fault occurs if the dimension of the tile does not matches with the standard dimensions provided as input. In this way design flow occurs.

## VI. RESULT

It is required to find the dimensions and measurement of ceramic tiles when used. Because a wrong ceramic tile would not be proper fit when used. We need a proper dimension of the tile to fit it in the desired position. A camera is used for image capturing which can be used to find whether tile is faulty or not. A good and well dimensioned tile would be used after the operations are performed. We are using raspberry pi as a main controller which controls all operations. Inputs through keyboard like for selecting measurement dimensions, length, breadth and thickness of the ceramic tile. If tiles are not in the proper dimensions, then error message will be display on the screen.

## VII. CONCLUSION AND FUTURE WORK

This paper is concerned with the problem of detection of the surface defects on the fired ceramic tiles using the image processing operations. By implementing this technique we can develop a change in the ceramic tiles industries from depending on humans which detects defects manually to the automated system depending on the computer vision. People can work effectively for short periods and many operators are involved in checking the same batch of tiles. Continuity over time is not guaranteed and may result in overall bad quality, which may cause customers dissatisfaction or even to reject the batch. We success in differentiating different kinds of defect in ceramic tiles images. Automated sorting systems would bring numerous benefits to the entire sector with major economic advantages, also guarantee product quality, increase plant efficiency and reduce investments. The continuous measurement of surface defects gives line production operators to optimize temperature, speed and other operating parameters.

ISSN: 2233-7857 IJFGCN

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ISSN: 2233-7857 IJFGCN