Automatic Grain Quality detection and Grading using Image Processing

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***Abstract*— The grain quality checking scenario in this age and day, grain type and quality are identified manually by visual inspection which is tedious and not accurate. There is need for the growth of fast, accurate and objective system for quality determination of food grains. An automated system which uses digital Image Processing allows a much wider range of algorithms to be applied to the input data Rice grading sorts rice and assign into its classes or grade. The grading of rice plays important role in the determination of rice quality method applied in the rice production industry and its subsequent price in the market. Grain quality evaluation is done manually but it is relative, time consuming, may be varying results and costly. To compensate for this lack in the quality checking system image processing techniques is the can be used as an alternative for grain quality analysis. The paper presents a solution of grading and evaluation of rice grains on the basis of grain size and shape and also estimates the purity and impurity content by measuring the percentage of impurities. Then finally viewing the impurity content and the size of the grain it is characterized into a category of grade type using image processing techniques.**

Keywords: ***Grain quality, Grain Type Identification, Color features, Geometric feature, Morphological operations,***

1. Introduction

Rice supplies of vitamins and minerals. It is good in nutrition values, low in fat and has no additives. It constitutes of food for the 80% of the population around the world. It provides energy and low glycaemic index is present. India is the one of the largest producers of rice in the world, therefore enforcing the use of rice grain standards is important to ensure that farmers get paid maximum value for their grain according to the quality of the grain. The analysis of grain type, grading and their quality features are performed manually by skilled people. These methods are in danger to many issues such as, it is highly subjective, influenced by human factors and working conditions that results in inconsistency in results. Also, the rate of cleaning and recovery of salvages is limited. Non-destructive quality evaluation of food products for various parameters defines quality of these product as manhandling of grains often takes place during carrying or transportation from one place to another(e.g. size, shape, colour, texture, external defects, etc.) and then is calculated with the help of image processing without affecting physical structure of food products. The automation level for testing quality of grain is low and most work is done by manpower. The workload is so much that it will lead to workers fatigue and need them to have sample testing experience. And it also the testing is expensive and time consuming. With the development of import and export trade this situation is difficult to deal with. During grain handling operations, types of grain and their quality known is better as at several stages before the next operation can be determined and performed. In the present grain handling system, grain type and quality are rapidly inspected by visual inspection. This analysis process is difficult and time consuming. There isn't such method to identify inferior quality grains in the market. This has become a serious problem for the consumers as they should get the worth of their money. The farmers are affected by this manual selection. Therefore, it is required to explore the possibility of using technology for a suitable solution. The accuracy of is different from person to person to check quality and it also depends on working stress, persuasion and loyalty for traders and also the knowledge and experience of inspectors are required to accurately perform this evaluation process.

2. Motivation

Quality of grains is an important requirement for today's market, to protect the consumers from substandard products. The government imposes price control for essential commodities in order to protect the consumers from black marketing and inflated prices. As a result, some traders unethically release sub-standard products to the consumer market. Because of such practices there are so many inferior quality grains arriving to the market day by day. These grains consist of several impurities like stones, damaged seeds, more broken granules etc. This is often seen today in rice trade where rice of low quality is sold.

3. Objectives

1) The Objective of this work is to develop a real-time application capable of classifying the given grain type and its quality and grade in case of rice as per the definition.

2) To do so we capture the grain image from the digital camera. Store them in the database. Read an image from the database, preprocess the image. Perform segmentation in order to extract the ROI i.e. each individual grain from the image sample.

3) Extract the color and the geometrical feature from each ROI, store the extracted features in feature vector for training.

4) Finally, test the system by giving different type of grain images as input.

4. Problem Statement:

The aim of the project is to design a quality analysis system using its color geometrical features, which classifies the quality of the grain and grade for Rice.

For quality analysis of rice, we have considered three quality of rice namely basmati, broken and boiled rice, and each can be categorized into three grades, i.e. Grade1, Grade2 and Grade3.

5. Literature Review

Computer vision and image processing are non-destructive, accurate and reliable methods to achieve target of grading. Grain grading and specification system assures that a particular lot of grain meets the required set standards customer. In many countries grading of grain depends on four main properties; (I) test weight (ii) moisture contents (iii) broken foreign material or the percentage fragments example broken corn foreign materials (iv) damaged kernels (i.e. total and heat damaged).

This paper is focused on providing a better approach for identification of different types of grains and rice quality based on color and geometrical features using Probabilistic neural network and image processing concepts. Tests on the system for the test sets show accuracy of 98% and total success rate of quality analysis and grading of rice is 90% and 92% respectively [1].

The other paper has a technique that takes into account the physical properties of grain devised from an image-based method to classify whole and broken grain. A novel image processing technique was adopted for morphological feature extraction followed by ANFIS model building for discrimination of grains. The classification accuracy for the test images were >98.6%, which comparatively better than standard SVM and KNN classifier (<95%). Moreover, the proposed ANFIS classification results seem to be more reliable than the results obtained from SVM and KNN, since it deals with uncertainty in output [2].

In this paper the proposed system consists of the following steps: a) Acquiring quality images, b) Binarization, c) removal of noise, d) Calculating the number of black bunches of pixels. In this paper, an effective method to detect the good quality wheat is designed. In this method after detecting grains a percentage of impurity present is calculated and it is observed that it gives approximately 95% accuracy. Also, it is fast, less memory consumable and cost effective. In the up gradation of this method, a grading of wheat grains can be done on the basis of grain size. [15]

6. Methodology

The schematic workflow of the proposed system-based grading of rice grains is given in this section. Subsequently, the steps involved in the technique are detailed in the following subsections.

a) Sample Preparation: The rice grain samples can be taken in a scattered arrangement for imaging. These arrangements are important which is likely due to the fact that the grain characterization method employs the visual attributes of grains obtained from image-processing techniques. Thus, the heaped grain images might attain certain disadvantages e.g., boundaries of grains not completely visible and distinguishable and noise appearing more prominent than the boundaries if grains are overlapping with each other. Hence, we use distinctly scattered 100 rice grain images with some impurities.

b) Imaging System and Image Acquisition: The first step in this system is to acquire a digital image. This can be achieved by using a digital camera. Proper illumination plays a very important role in order to obtain a good image. This can lead to distortion of object features in the image. Determination of an ideal illumination source is not easy and depends on the nature of the task. Here we capture the images of different food grains using a digitized phone camera. The camera used here has a resolution of 13MP. The images are captured under natural light avoiding the direct sunlight for proper illumination. We maintain a uniform background which is white in color. The grains are spread on a white sheet randomly. Although we place them randomly, we must make sure that they are not in contact with other, i.e. non-touching fashion. The images were captured and stored in JPEG format automatically.

c) Image Preprocessing: Preprocessing is one of the important steps for the enhancement of quality of the captured image. The preprocessing methods use a small neighborhood of a pixel in an image, to get a new brightness value in the output image. Gaussian filter was used for image smoothening. A threshold was set in order to eliminate background. Then the grayscale image was binarized. Once the image is binarized morphological operations were performed, first we used erosion operation to eliminate the shadow of the grains, this was followed by dilation to enhance the image after the erosion and improve the boundary sharpness

- **Image Filtering**: Images are often corrupted due to the variation in illumination, intensity or may have poor contrast and can't be used directly. Filtering helps to transform pixel intensity values to reveal certain image characteristics: 1) Enhancement: helps to improve the contrast of the image 2) Smoothing: Remove the noise from the image. Gaussian Filter: Gaussian smoothing is very effective for removing Gaussian noise.
- **Background Elimination:** Background elimination which is also called as Foreground Detection, is a technique in the fields of Image processing wherein an image's foreground is extracted for further processing, i.e. Object Recognition. Usually the images region of interest is a part of image foreground. Here we check the intensity of each pixel of the image with a precalculated value, and the pixel values falling with this range are set to zero.
- **Binarization:** Binarization of an image is a process representing an image using only two different pixel values. It is generally performed by classifying a gray scale image into two groups of pixels based on certain threshold value. Those pixel values greater than or equal to the threshold is set to a particular grey value and those below the threshold to another grey value. The quality of the binary image is much dependent on how appropriately the threshold for binarization are chosen or how fairly the pixels are classified into two groups of pixels. If $f(x, y) > T$ then $f(x, y) = 0$ else $f(x, y) = 255$ where T is a threshold value.

- **Morphological Operations:** Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. Morphological techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels.

  Erosion and Dilation: Erosion and dilation are the most basic morphological operations in image processing.

  Erosion: Erosion removes small-scale details from a binary image but simultaneously reduces the size of regions of interest, to 0. In a binary image, if any of the pixels is set to 0, the output pixel is set to 0. Dilation: Dilation has the opposite effect to erosion, it adds a layer of pixels to both the inner and outer boundaries of regions. The holes enclosed by a single region and gaps between different regions become smaller, and small intrusions into boundaries of a region are filled in. The value of the output pixel is the maximum value of all the pixels in the input pixel's neighborhood. In a binary image, if any of the pixels is set to the value 1, the output pixel is set to 1.

d) **Image Segmentation**: The aim of image segmentation is to cluster pixels into salient image regions. Image segmentation is an essential preliminary step in most automatic pictorial pattern recognition and scene analysis problem. Here we perform the segmentation using Component Labeling. Once the image is binarized, we perform labeling of connected components. By using labels and the similarity of grey level values, grains are segmented.

e) **Feature Extraction:** In this process some qualitative information is being extracted from the objects to be analyzed in the image. These extracted attributes are called features and a pattern is defined as a vector of such features. The various features that could be extracted are color features, geometrical features and texture features.

(1) **Color Features:** Color features play a vital role in the classification process. We have extracted three color features from the captured image, i.e. the mean values of the RGB colors. The mean values of red, green and blue colors are extracted from the image.

(2) **Geometrical Features:** The geometric parameters give us the basic information regarding the size and shape of the grains.

1)Area: This parameter refers to the number of pixels in the region, i.e. the pixels with level "1".
2)MajorAxisLenght: Length of the major axis of the ellipse with the same second order normalized central moment of the object.
3)MinorAxisLenght: Length of the minor axis of the ellipse with the same second order normalized central moment of the object.
4) Centroid: The centroid function returns the x, y-coordinates of the centroid of a polyshape.

f) **Percentage Purity Calculation and Grading:**

1)Purity Calculation: A fixed number of rice grains (i. e 100) samples were taken. Edge detection is used to find the boundaries of objects and hence, the impurities are detected and counted. For final calculations, the overall percentage purity of the sampled rice was displayed.

2)Grading of Rice Samples: By using inbuilt region properties in MATLAB, the area of the overall image as well as specific area of each rice grain is determined. As the grading criteria depends on the size of the rice grain, the total area estimation is used for determining the broken rice and the grading is done accordingly.

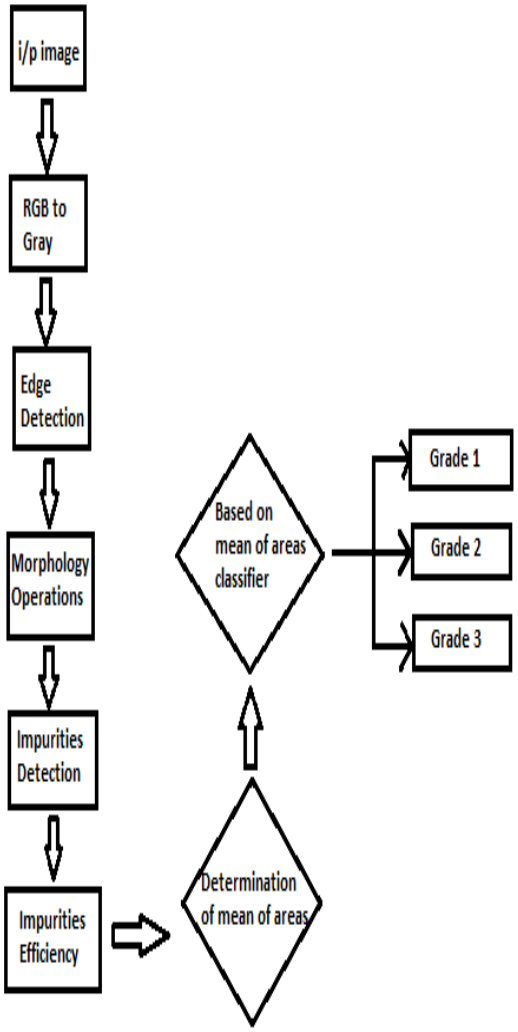

Fig 6.1 Flowchart of system

7. Results:

Fig 7.1 Input Image

Fig 7.2 Binary conversion output.

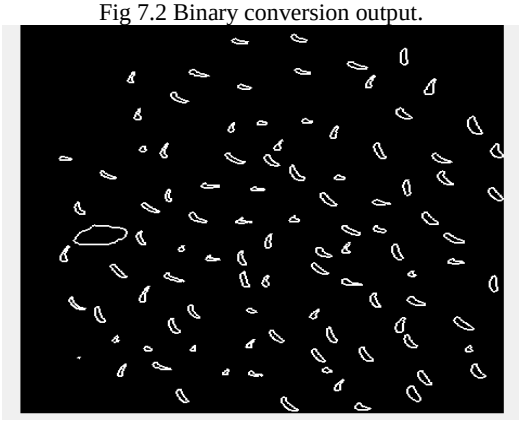

Fig 7.3 Edge Detection output.

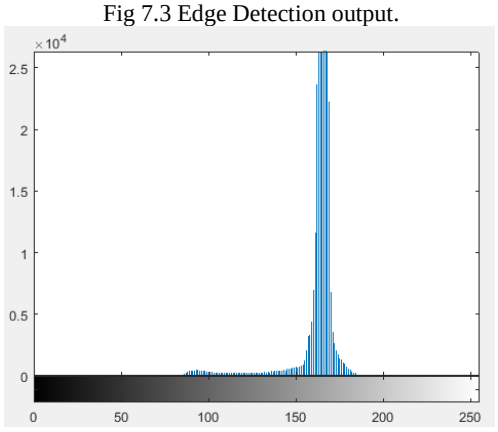

Fig 7.4 Histogram equalization for binarized and edge detected output.

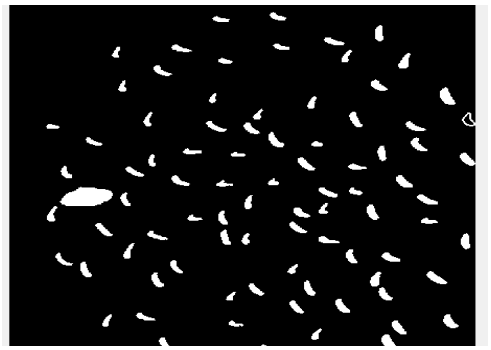

Fig 7.5 Area detection using imfill operation.

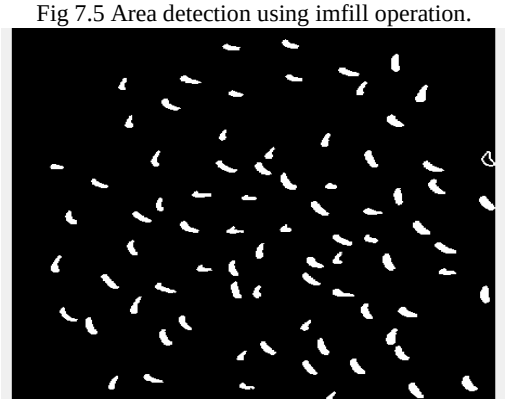

Fig 7.6 Filter to remove impurities

8. Specifications

- **Hardware requirements:**

1. Camera with 13MP or higher
2. 1GB of RAM (Laptop)

- **Software requirements:**

3. MATLAB 7 or higher version
4. Windows Operating system, as implementation is in MATLAB.

9. Applications and Uses

1) This method is used in rice mills to check the quality of grain.
2) The method of edge detection provides the grade of the grain when it is to categorized.
3) wholesalers purchasing grains use this method for insurance of the quality of grain being purchased.
4) Used oil milling industries to avoid extra filtrations. The purer the oil grains the less polluted the extracted oil is. Hence reducing cost of filtering for pollutants.
5) Grain quality detection is very important when it comes to wheat as only then moisture, ash and protein content of the wheat can be tested. If impurities are present it hampers the composition and results of these tests.
6) Is the initial process for a farinograph which measures the dough and gluten properties of the wheat grain.

10. Conclusions

Food and health being an important part of lives, this project contributes to the society by ensuring the quality and purity of the food gains which directly affects millions of people. The quality analysis

part of the project was almost 99% accurate. The computing time is particularly less in this algorithm as we use the non-touching grains criterion only. The overall speed of the algorithm is less as compared to other studies as it uses only a few main basic attributes of the grain for its quality analysis and grading. The quality of grain detection was not only successfully completed using Image Processing but the features like morphication, dilation, erosion and edge detection provides a strong platform for further processing and holds true promise for advancements in the same field were studied successfully.

11. Future Scope:

We further intend to apply this approach to various food grains and also classify the various grains accordingly. Also, various infections on food grains like fissures can also be identified further. A few more features can be added in the existing system to increase its accuracy and speed.

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