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Rice Crack Detection without De-Husking Using Image Processing Techniques

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***Abstract*— In this paper, an algorithm is proposed to analyze quality of paddy without de-husking using image processing techniques. This system eliminates manual process of quality asses of rice granules which is laborious, inefficient and time consuming. To analyze quality of paddy, X ray image of few paddy samples are considered for processing. Quality of paddy is analyzed by detecting possible cracks in paddy samples by automation. On the acquired X ray image of paddy, image processing operations such as de-noising, edge detection, dilation, segmentation and Hough line detection are performed to analyze its quality. Condition of paddy determines its quality and price.**

***Index Terms*— Counting, Edge detection, Hough line, Segmentation, X-ray image**

I. INTRODUCTION

India is the second largest country in the production of rice. India contributes about 20% for world rice production. Processing of paddy to rice takes many stages like harvesting, classification, packaging, transport, processing, preservation and selling, etc. There is a possibility of paddy getting damaged in any of these stages. Humidity in paddy should be 7- 14% at room temperature for good quality of paddy. Rapid change in the temperature of the atmosphere also affects the physical state of the paddy. Before processing, quality of paddy is examined in the industry. Quality of paddy is an important factor to decide its price as crack in paddy decreases its quality. Paddy husk is a thick layer around rice kernel due to which rice cracks are not visible to naked eyes. The current method of crack detection in paddy is done by manually de-husking, and examining kernels under light. This method is laborious, time consuming and subjective. Automation of the process makes the system more efficient**.** While processing the rice about 14% loss occurs due to breakage of rice kernels. To reduce this loss an automatic sys-tem is implemented. 'jaya' variety of paddy is considered for experiments in this paper.

II. LITERATURE SURVEY

Liu Guangrong [1] proposed a method to find the chalk degree of rice. The rice image has been extracted from background with an optimal threshold value. After the extraction, chalk has been defined through contrast-ribbon approximation. The chalk has been extracted from the rice. Chalk degree is defined by calculating area ratio of chalk and the whole rice. Then chalky area ratio and chalky grain rate are calculated. After this automatic detection of rice chalk degree has been realized.

Dollawat Ngampak and Punpiti Piamsanga [2] proposed a method to evaluate the broken rice grains. In this method, a grain image is converted into grayscale, passed to Gaussian filter to eliminate noises and enhance the edge contrast of broken rice using morphological opening. Then the image is filtered by Otsu 'method and features are extracted. Major axis length and minor axis length, which are maximum length and maximum width of each rice grain, respectively, are extracted to classify broken grains according to the features extracted.

Mahale et.al, [3] proposed a method to sort rice based on quality by grading and evaluating the of rice grains on the basis of grain size and shape using image processing tech-niques. Specifically edge detection algorithm is used to find out the region of boundaries of each grain. Depending on the morphological measures rice is classified.

C Karunakaran, et.al, [4] proposed a method to sort the infested wheat kernels by acquiring the x ray images at different stages of wheat life using neural networks using the non-parametric classifier and BPNN.

There are recent works on counting, sorting and detecting damaged rice grains. In this paper number paddy in an image is calculated and cracks in the paddy are detected using image processing techniques.

III. PROBLEM DEFINATION

The objective of the paper is to develop an automated system using image processing techniques to count amount of paddy and detect cracks in paddy without de-husking and hence to asses quality of rice grain. This system would contribute in improving the automation in rice milling industries.

IV. METHODOLOGY

To detect cracks in the paddy, a system is developed by acquiring x-ray image of rice and processing the image with steps as shown in figure 1.

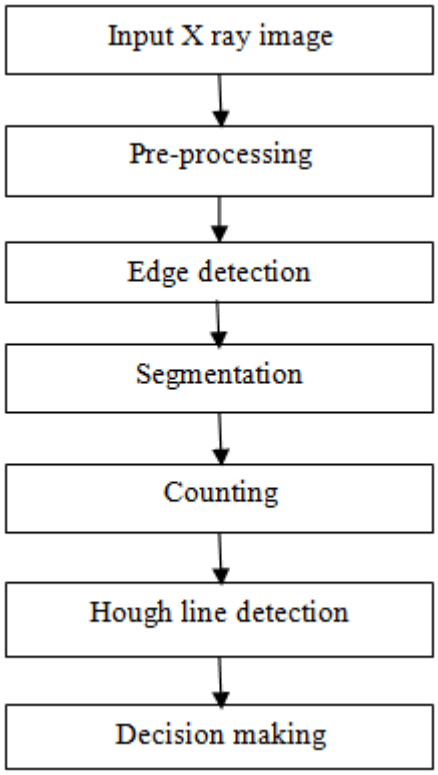

Figure 1 Flow chart of the algorithm developed.

V. INPUT IMAGE

X ray image of paddy is acquired with digital Dental X ray machine placing a paddy samples against the sensor. X rays are passed through the paddy samples with an exposure time of 4.6 milliseconds. Digital X ray machine used in experiments is MyRay RXAC. It is designed with non-variable voltage and current parameters of 70kVp and 08mA respectively.

VI. PREPROCESSING

a. De-noising

The acquired image is filtered with the median filter. Median filter is used to smoothen the image. With the median filter the sharp or high intensity variation of the pixel values are brought down to nearby neighbor pixel value. A window of size 3×3 is set and all the pixel values P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8 and p_9 in the window are replaced by the median value of the window are shown in figure (2).

P_1	P_2	P_3
P_4	P_5	P_6
P_7	P_8	P_9

Figure 2 A 3x3 window for median filter.

To get the median value over all the pixel values of the window.

- All the pixel values are arranged in ascending order.
- Middle value of pixels is selected and replaced all the other pixel values by this selected value.
- If there are even numbers of pixels then the average of the middle two pixels is computed and all other pixel values are replaced by the median value.

b. Background suppression

To remove the noise and sharpen the image, a threshold is set to reduce the risk of background edge detection which is out of interest. After subjected to mean filtering, background of image is suppressed with a threshold value of 15 to decide the pixel intensities. Rice kernel in the image is enhanced by suppressing the background. By thresholding the pixel values cracks in rice kernels are made intense.

c. Dilation

Dilation filter or maximum filter is used to expand the foreground pixel values. Dilation process fills dark spots in the image there by eliminating pepper noise. A 5x5 window is considered and all the pixel values under the window are replaced by the maximum pixel. A pixel value for dilation is calculated by the equation (1)

$$\hat{f}(x,y) = \max_{(s,t)\in S_{x,y}} \{g(s,t)\} \qquad (1)$$

Where f(x, y) is the replaceable pixel value and g(s, t) is represents the pixel values to be replaced under the window.

VII. EDGE DETECTION

After de-noising and background suppression edges are extracted using canny edge detection.

The algorithm of canny edge detection works in following 5 steps.

- Smoothing: removes noise with the help of Gaussian filter which gives the blurring effect.
- Finding gradients: The edges should be marked where the gradients of the image has large magnitudes using partial derivatives.

$$Magnitude, M(x,y) = \sqrt{g_x{}^2 + g_y{}^2} \qquad (2)$$

$$Angle, \alpha(x,y) = \tan^{-1}\left[\frac{g_y}{g_x}\right] \qquad (3)$$

Where g_x and g_y are horizontal and vertical gradients respectively.

- Non-maximum suppression: Only local maxima should be marked as edges.
- Double Thresholding: A higher and a lower threshold values are set. The pixel values crossing thresholds are marked as edges and connecting edges respectively.
- Edge tracking by hysteresis: Final edges are determined by suppressing all edges that are not connected to a very certain edge.

By canny edge detection algorithm edges of the image will be more predominant.

VIII. SEGMENTAION

The image is segmented by flooded watershed algorithm. In the algorithm background and foreground are subtracted from the image to get the unknown region. Then the unknown region and background region is subtracted from the image to emphasize foreground region of image. In the algorithm, the gray level values of the pixels in image represent peaks and valleys. The lowest valley is the *absolute minimum*. Peaks of regions vary from one to other. Peaks of all the regions are made equal to highest peak by constructing dams. These dams separate one region from the other.

By applying the watershed algorithm to the rice image, each of the rice kernels is separated from other kernels and individually indentified. Each rice kernel is considered as a region, segmented and identified.

IX. COUNTING

After segmentation, number of rice kernels in the image is counted. Using the concept of contours on segmented image, bounding box is drawn around each of the rice kernel which is recognized as object to count.

Contours are drawn around individual rice kernels. Centroid of the contour is calculated by equation (4)

$$C_x = \frac{M_{10}}{M_{00}} \qquad C_y = \frac{M_{01}}{M_{00}} \qquad (4)$$

Where (C_x , C_y) is centroid of a closed contours and M_{00}, M_{01} and M_{10} are moments of contour.

Area of each enclosed region is calculated. Minimum rectangular box is drawn around each region which is called bounding box. Length and width of the bounding box is calculated which gives the length and thickness of the rice respectively. Number of bounding box in the image is calculated which gives the count of rice kernels in the image.

X. HOUGH LINE TRANSFORM

Features of cracks on the rice kernel are similar to thin lines. Hence Hough line detection algorithm is employed to detect cracks on the rice kernel. The algorithm for detecting straight lines can be divided into the following steps:

- Edge detection, e.g. using the canny edge detector.
- Mapping of edge points (x, y) to the Hough space and storage in an accumulator (r, ɵ).
- Where ‘r’ gives perpendicular distance between origin and line. Ɵ is slope of line ranges from [0, 180]
- Interpretation of the accumulator to yield lines of infinite length.
- Conversion of infinite lines to finite lines.

XI. RESULTS

Experimental results of the proposed algorithm by taking X-ray image of paddy samples as input are shown below.

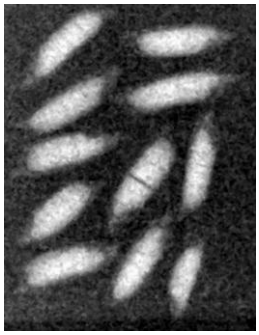

Figure 3 Input X ray image of paddy samples

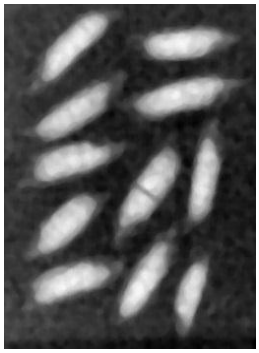

Figure 4 After applying median filter to input image

Figure 5 Resultant image after background suppression

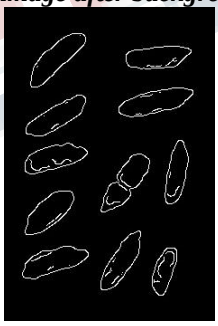

Figure 6 After applying canny edge detection to the pre-processed image

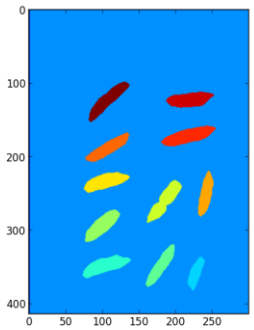

Figure 7 Image obtained after segmented image

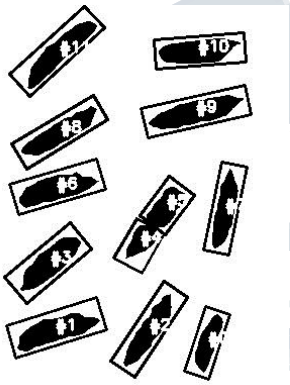

Figure 8 Bounding box applied to the each of the rice kernel for counting.

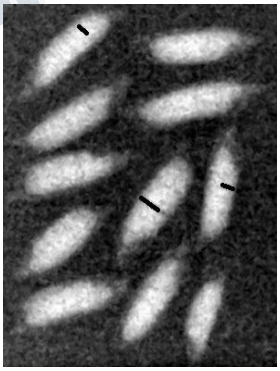

Figure 9 The resultant image of the algorithm showing cracks on the rice kernels with Hough lines.

XII. ACKNOWLEDGEMENTS

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XIII. CONCLUSION

In rice milling industries, equality of paddy is assessed manually by de-husking. This process is subjective, time consuming and laborious. To overcome these limitations,

this paper proposes an image processing technique to assess the quality of paddy automatically. This automated process is more efficient and economical to rice milling industries. Dental X-ray machine is used to acquire images of rice kernel as it emerges less radiation thereby preventing any possible damages to rice kernel.

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