RICE AGE IDENTIFICATION USING HYBRID GRAPH CUT AND KNN CLASSIFIER

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Abstract

There are many well-established techniques in the assessment of ageing of rice such as electronic devices, sensors, biosensors or high end instruments to study the different chemical components, specificity, sensitivity, accuracy, and reusable issues. In order to overcome such issues, an alternate technique or method needs to be developed which can replace the human intervention to avoid the experimental errors through analyzing the surface structure rather than the chemical method. Among the different changes that occurred during the ageing process, the internal structure is also an important phenomenon because of the starch modification with several factors like temperature, moisture content and storage period. Hence, the objective of the study concentrates on analyzing the structural changes to assess the age of rice through the enhanced normalized cut segmentation technique and KNN classifier

Keywords: *Ageing, Food, GLCM, Grain, Normalized Cut, Fuzzy.*

1. Introduction

Rice is the principal and basic food consumed by the majority of the world's population. It also impacts on economy and livelihood of billions of people. A total of 944.9 million tons of rice is produced yearly in the world. The projected area for the production is 186.36 million hectares. 4.41 tons Rice is the principal basic food consumed by the majority of the world's population. The scientific name of Rice is 'Oryza sativa L.' and it belongs to the Graminae family.

Almost half of the world consumes this food. Moreover, it is the income source of the people who work in the fields. In India almost 70% of Indians consume this as their primary food. It covers 43% of overall food grain production and 53% of cereal production per hectare (Wanjari et.al 2006).

India stands second in producing rice yearly. India produces 168.50 million tons of rice yearly and is about 2.57 tons per hectare. However, the current production level is to be increased by 2 million tons each year to fulfill the food needs of the growing population and to achieve food security in the country. There is a need of 120 million tons of rice to feed the upcoming increasing population by 2020. In India, many states have their contribution to rice production. Furthermore, Karnataka is one of the primary rice-growing states of India. It is in fourth place in the production. The central regions in the Karnataka where the rice is produced are Raichur, Koppal, Haveri, Dharwad, Mysore, Hassan, Chitradurga, and Uttara Kannada (Bhagirath et.al 2017).

We require technology to study the chemical components, sample preparation, specificity, sensitivity, accuracy, and reusable issues. To overcome these issues, we propose to develop an alternate technique which can replace the human intervention to minimize the experimental errors by analyzing the surface structure rather than the usual chemical method.

The objective of the study concentrates on analyzing the structural changes to assess the age of rice through enhanced Normalized Cut segmentation technique and KNN classifier. Here enhanced means Normalized Cut and Fuzzy are combined as a hybrid technique used for the segmentation of the rice grain image. Though there are many well established techniques such as electronic devices, sensors, biosensors or high-end instruments to study the different chemical components, sample preparation, specificity, sensitivity, accuracy, and reusable issues, in order to overcome such issues, an alternate technique or method need to be developed which can replace the human intervention to avoid the experimental errors through analyzing the surface structure rather than the chemical method.

2. Literature Survey

Ageing, mainly corresponds to the biochemical changes that happen during rice grain storage. If freshly cropped paddy is milled, the rice offers a white gruel when cooked. Under suitable storage conditions, these properties decrease within weeks and the grains do not tend to stick on to one another when cooked. Ageing may also lead to a progressive change in amylose content and transformations in protein, lipid, and materials formed from enzyme activities during storage.

The conventional ageing of rice takes a comparatively long time, just about 4–6 months. This ageing process also needs more space for the storage of paddy, leading to a high cost of operation. Moreover, paddy undergoing ageing is vulnerable to the spoiling from insects, micro-organisms and rodents. Appropriate methods including accelerated ageing techniques are being explored to decrease the ageing time and cost of operation while, in the meantime, to preserve the rice properties such as texture and appearance similar to those acquired by the predictable ageing process. The ageing process brings a progressive change in Amylose content and changes in protein, lipid, and ingredients shaped from the activities of enzyme throughout storage. The biochemical changes occur during the storage of the rice grain. We can usually see that new milled rice gives pasty gruel when cooked but after some weeks or months, grains do not incline to observe to one another when they cooked.

3. Proposed Framework

3.1 Data Collection and Pre-Processing

We have collected 40 Sona masoori rice grains as sample images for our experiment. Sassen containing mainly of ethyl-ester and rhodarate are used for pre-processing. Sassen is diluted with water in which rice grains are dipped for 2 hours. Then they are horizontally cut. Later they are scanned using microscope. Images have starred in respective directories. The data used for experiment consisted of 40 images among which 28 images corresponding to new rice class 12 images corresponding to old rice class. Now the rice grain images are ready for the experiment.

Algorithm 1:

Step 1: *Input Original Image*

Step 2: *Compute parameters a, b and c*

Step3: *Fuzzification of Image*

Step 4: *Relationship Modification*

Step 5: *De-Fuzzification*

Step 6: *Enhanced Image as output*

3.2 Segmentation of Rice Pre-processed Image using Fuzzy and Graph Cut

We have combined the fuzzy- based rule (Zadeh et al. 1994) with the graph cut method to achieve the image segmentation (Mondal et al. 2012). For our experiment, the microscopic rice images are used to test the algorithm. This plotting explains the internal structure of the rice. Every element in an array corresponds to the level of brightness in the grey level. Its fuzzy notation is as follows:

$$X = \cup\left\{\mu\left(x_{i,j}\right)\right\} = \left\{\frac{\mu_{i,j}}{x_{i,j}\, i} = 1, 2, \ldots, M \text{ and } j = 1, 2, \ldots, N\right\} \qquad (1)$$

Here $\mu\left(x_{i,j}\right)$ represents the level of brightness processed using the grey level intensity of the $(i, j)\,th$ pixel.

Fuzzification: The member function of a fuzzy set plots all the elements of the set into a set of real numbers ranges in [0, 1]. The relationship function of a gray level image is a function which shown as follows (Srivastava *et al.*2014).

$$\mu\left(x_{i,j}\right)=\begin{cases} o \; for \; x_{ij} \le a \\ \dfrac{x_{ij}-a}{(b-a)(c-a)} \; for \; a \le x_{ij} \le c \\ 1-\dfrac{\left(x_{ij}-c\right)^2}{(c-b)(c-a)} \; for \; b \le x_{ij} \le c \\ 1 \; for \; x_{ij} \ge c \end{cases} \quad (2)$$

In the above equation x_{ij} defines the intensity of an image and represents the parameters a, b, c which determine the outline of the function.

De-fuzzification: In order to achieve enhancement of contrast additional adaptive and further effectively and to escape over-enhancement or under-enhancement, modified fuzzy contrast improvement, de-fuzzification is used, which converts the membership value $\mu\left(x_{i,j}\right)$ to a grey level value by the following formula,

$$x_{ij}=\begin{cases} L_{min}, \mu\left(x_{i,j}\right)=0 \\ L_{min}+\dfrac{L_{min}-L_{max}}{c-a}\sqrt{\mu\left(x_{i,j}\right)(b-a)(c-a)}, \quad 0<\mu\left(x_{i,j}\right)\le\dfrac{(b-a)}{(c-a)} \\ L_{min}+\dfrac{L_{min}-L_{max}}{c-a}\sqrt{(c-a-1-\mu\left(x_{i,j}\right)(b-a)(c-a)}, \dfrac{(b-a)}{(c-a)}<\mu\left(x_{i,j}\right)<1 \\ L_{max}, \mu\left(x_{i,j}\right)=1 \end{cases} \quad (3)$$

PPV, Sensitivity and coefficient of dice similarity

Both PPV and Sensitivity are the parameters which measured the outcomes of segmentation by computing the True Positive TP_n, False Positive FP_n and False Negative FN_n voxels. These are defined mathematically as follows.

$$PPV=\frac{TP_n}{TP_n+FP_n} \quad (4)$$

$$S=\frac{TP_n}{TP_n+FN_n} \quad (5)$$

Dice coefficient is another parameter that compares segment of test data (Berkeley) and segment of ground-truth (manual segmentation), denoted by D. These two segments are represented by two sub-sets A and B respectively. Then the dice coefficient is defines as,

$$D=\frac{2|A\Lambda B|}{|A+B|} \quad (6)$$

Where the symbol $|.|$ represents the function defining the segmented area.

Algorithm 2:

Step 1: *Input enhanced image*

Step2: *Brightness, Color and Texture features extraction of an image*

Step 3: *Compute intermediate matrices*

Step 4: *Fuzzification*

Step 5: *Interference Engine*

Step 6: *De-Fuzzification*

Step 7: *Segmented Image*

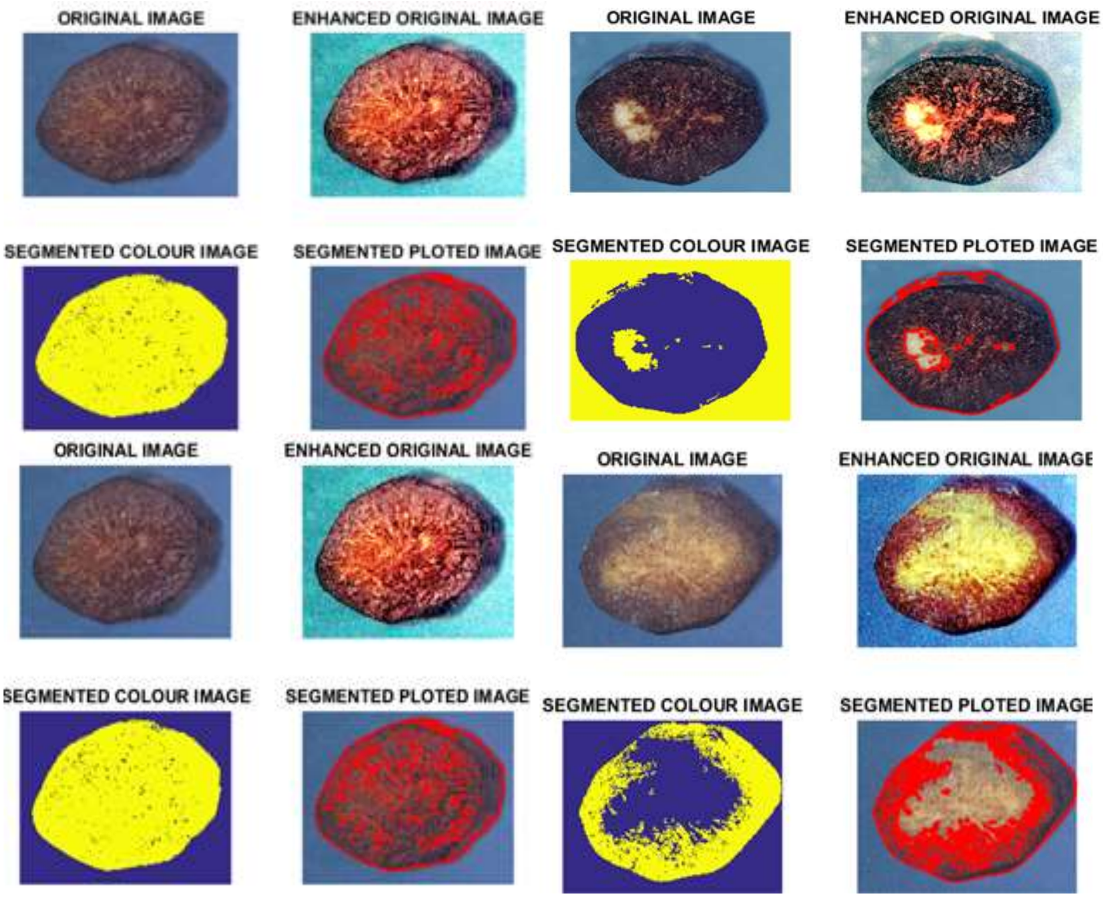

Figure 1 Enhancement, Segmentation and Plotted Image

TABLE 1: True Segmentation Rate

Segmented Image	*Evaluation*	*Accuracy*
	S	0.94 ±0.04
	PPV	0.96 ±0.04
	D	0.92 ±0.06
	S	0.95 ±0.03
	PPV	0.93 ±0.05
	D	0.91 ±0.06
	S	0.97 ±0.06
	PPV	0.93 ±0.04
	D	0.92 ±0.06
	S	0.93 ±0.02
	PPV	0.94 ±0.04
	D	0.96 ±0.06

Feature Extraction

The Gray Level Co-occurrence Matrix (GLCM) (Maohanaiah *et al.* 2013) and connected texture feature computations are image analysis methods. Given an image consists of pixels, all with an intensity, the GLCM is a tabulation of how often different combinations of gray levels co-occur in an image. Texture feature calculations use the contents of the GLCM to provide a measure of the difference in intensity at the pixel of interest. Echo view offers a GLCM Texture Feature operative that produces an implicit variable that corresponds to a particular texture computation on a single beam echogram. We have used the GLCM method to pull out the features of the segmented image. To end with, a feature map has produced for the segmented images. This computation uses only the values Entropy, Contrast, Energy, Correlation, Homogeneity, Prominence and Shade in the GLCM.

TABLE 2 : Statistical information of an image using GLCM

Statistic	*Explanation*
Contrast	Computes the local variations in the GLCM.
Correlation	Computes the combined probability occurrence between the specific pair of pixels.
Energy	Computes the sum of squared elements in GLC matrix.

4. Results and Discussion

Experimental Setup: For fulfillment of proposed system manually, Rice images are classified into two classes, namely old and new. New rice class maintains 28, and Old rice class maintains 12 grayscale preprocessed images having 40 total samples for this experiment. After applying preprocessing techniques, images have starred in respective directories. Then they are processed under the segmentation process using Graph Cut and Fuzzy. After this GLCM feature has extracted from segmented images and feature map has generated. Feature map has classified using KNN classifier (Gongde *et al.* 2003), and results have recorded.
Depending on the portion of the red plots, we can decide the whitish portion of the microscopic rice image. We have used MATLAB 2016a as a programming tool for our experimentation.

Evaluation Protocol: *True positive rate (Recall):* Sensitivity (SN) is computed by dividing the number of true positive predictions by the overall number of positives. Recall (REC) is another name used for sensitivity and also called as True Positive Rate (TPR). The finest sensitivity value is 1.0, whereas the worst value is 0.0. The following are the formula to compute different True Positive Rates.
Consequently, probably a true positive rate and a false negative rate. The dissimilarity matters for the reason that, it highlights that, both numbers have a numerator and a denominator.
Accuracy: The accuracy can be computed as the percentage of accurately classified instances $(TP + TN)/(TP + TN + FP + FN)$. Where TP, TN, FN, FP and TN represents, the number of true positives, true negatives, false positives and false negatives correspondingly.

$$Accuracy = \frac{True\ Positives + True\ Negatives}{All\ Samples}$$

Percent Error Formula: It is the difference between a calculated value and theoretical value, divided by the theoretical value, multiplied by 100%. Whereas keeping the sign for error, the computation is the experimental or else computed value minus the theoretical value, divided by the theoretical value and later multiplied by 100%.

TABLE 3 : Comparative result of using various classifiers on rice image dataset

Classifier	Result	
	Accuracy	Error
Fine-KNN (Proposed)	97.5	2.5
Weighted-KNN	95	5
Medium-KNN	87.5	12.3
Cosine-KNN	92.5	7.5

$$Percentage\ Error = \frac{Experimental\ Value - Theoretical\ Value}{Theoretical\ Value} * 100$$

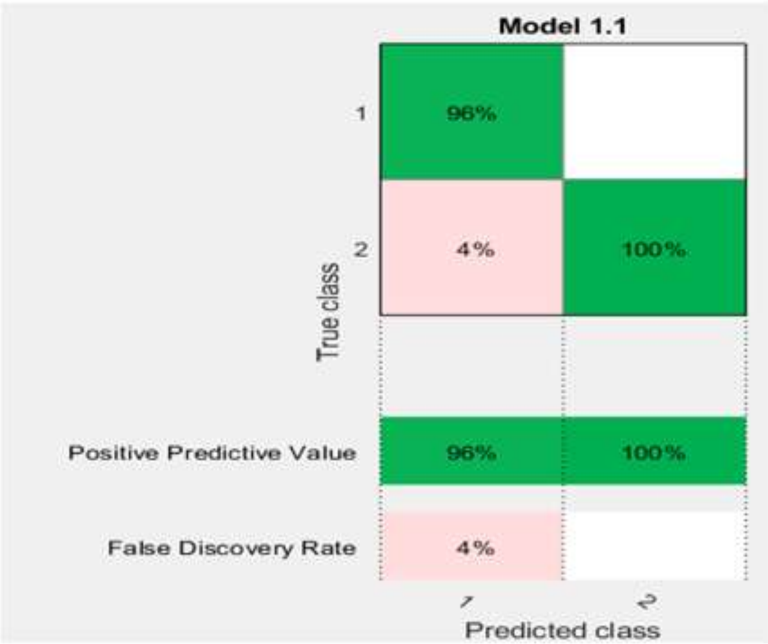

Figure 2 Accuracy using proposed model

5. Conclusion

Though we have required technology to study the chemical components, sample preparation, specificity, sensitivity, accuracy and reusable issues to overcome these issues, we should develop an alternate technique which can replace the human intervention to minimize the experimental errors by analyzing the surface structure rather than the usual chemical method. The ageing process of rice undergoes many different changes during its process. The starch modification in the internal structure with many factors like moisture content, period of storage and temperature. Therefore, all the objectives of the study concentrate on analyzing the changes in the structure to find the exact age of rice through fuzzy and graph cut segmentation technique. Hence, the proposed segmentation technique delivers proficient results for microscopic rice images. In future, we can automate the process of detecting the ageing process of different types of rice grains.

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