Classification of Milled Rice Using Image Processing

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Abstract— Classification of different types of rice is carried out in this study using metaheuristic classification approaches.13 different rice samples are considered. Images of milled rice are acquired using a computer vision system. Feature Extraction methods are used to extract fifty seven features including five shape and size features, forty eight color features and four texture features from color images of individual rice samples. Four different metaheuristic classification techniques including Artificial Neural Network, Support Vector Machine, Decision Tree and Bayesian Network are utilized to classify milled rice samples. Results indicated that Artificial Neural Network had the highest classification accuracy (92.307 %) followed by Support Vector Machine (90.384 %), Bayesian Network (82.692 %) and Decision Tree (59.615 %), had the higher accuracy, respectively.

Index Terms— Artificial neural network, Bayesian Network,Decision Tree, Classification, Computer Vision, Metaheuristic techniques, Rice, Support vector machine,

1 Introduction

Rice (Oryza Sativa) is the staple food for about one half of the world's population. The rice samples of different varieties can vary in appearance. Specialists traditionally identify grains manually based on their appearance. However Manual inspection is time consuming. In addition, the result of this method may be not reliable. Finding a particular type of rice among variety of rice samples is still a challenging task. Physical parameters that are obtained from each rice samples including color, size & shape and texture are quality indices distinguish rice among bulk of rice samples.

In the present work a digital imaging approach has been devised in order to investigate different types of characteristics to identify the rice varieties. In the developed system, first, images of 13 different types of rice samples are captured using camera. After image segmentation, the primary 57 feature vectors are created based on some shape and size, color and texture features. To have a high classification accuracy, it is necessary to prepare a proper input vector for the classifiers. For this purpose, the primary extracted features are subjected to a correlation based feature selection procedure to reject the inferior features.

Finally, the best classifier is selected by examining four commonly used metaheuristic approaches. In order to determine the best classifier, rice samples are examined for each classifier method.

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2. Related Works

Various existing systems for classification of rice varieties investigated by many researchers and their findings are as follows. Xiai Chen et al. (2012)[1] proposed a machine vision system for rice quality detection. The Least Squares Support Vector Machines (LS-SVM) was applied for the classification of head rice and broken rice. Genetic algorithm was used to optimize the parameters values of LS-SVM. HarpreetKaur et al.(2013)[9] proposedmachine algorithm to grade (Premium, Grade A, Grade B and Grade C) the rice kernels using Multi-Class SVM. The SVM classify accurately more than 86%. However the major drawback of SVMs is that, they were originally developed to solve binary classification problems. Multi-class classifiers are typically constructed by combining several binary classifiers.

B.K. Yadavet al. (2001)[18] proposed a system to Monitor milling quality of rice. Digital image analysis was used to determine the head rice yield (HRY), representing the proportion by weight of milled kernels with three quarters or more of their original length, and the whiteness of milled rice. Characteristic dimension ratio (CDR) defined as the ratio of the sum of a particular dimensional feature of all head rice kernels to that of all kernels comprising head and broken rice in the sample. HRY and CDR were found to be related by power functions

. Chong-Yaw Wee et al.(2009) proposed an efficient method to Sort the rice grains using Zernike moments. Rice sorting method is based on the ZM feature extractor and neural network classifier.

The objective is to develop a computervision-based system combined with appropriate metaheuristic algorithms to classify rice based on the product visual features.

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3 Methodology

The following Methodology diagram gives a detailed description of the Rice classification.

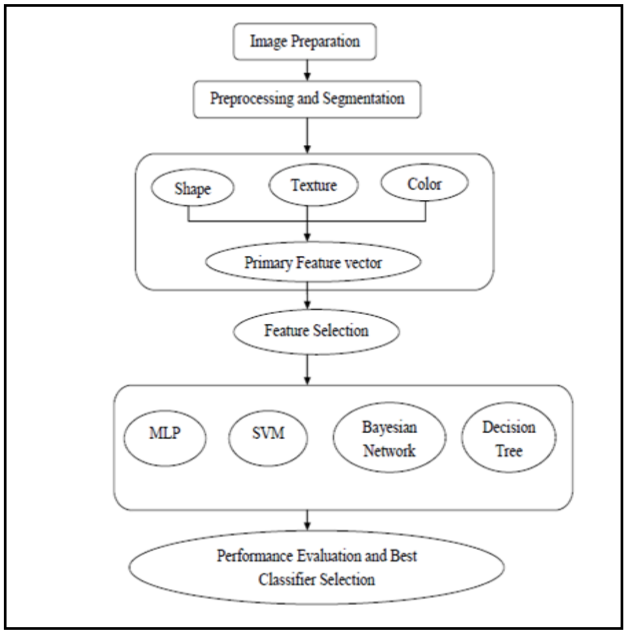

Fig 1. Methodology Diagram of Rice Classification.

4 Materials and Methods

4.1 Image Acquisition

The image acquisition was carried out with a SAMSUNG mobile camera. The camera was mounted on a fix stand. The software development and the image processing were carried out on a personal computer (2.2 GHz i3 processor with a 4 GB of RAM). A desk lamp with fluorescent light source was used in all experiments for lighting the area to be photographed. A light beam from a desk lamp was directed on seeds to avoid formation of shadows.

A black surface was used as a background. Images were taken by spreading the seeds on the black background. The fluorescent bulb was switched on for few minutes before taking photographs for stability. The camera was white balanced according to the light source. Seeds were placed in random orientation at variety of position inside the field view. Rice was arranged in non-touching pattern and images were acquired and stored for later analysis.

4.2 Image preprocessing and segmentation

Image preprocessing operations were executed to prepare the images before feature extraction. In order to separate rice from the background, a global threshold method was applied on the images using OTSU's segmentation method. OTSU's method selects the threshold value k that maximizes the value of G based on the following formula

$$G = P_j\,(I_j - I_T)^2 + P_b(I_b - I_T)^2 \qquad (1)$$

Where ,

P_j = proportion of the pixels of milled rice,
P_b = proportion of pixels of background,
I_j = mean gray value of milled rice,
I_b = mean gray value of background,
I_T = mean gray value of whole image.

4.3 Feature extraction

Totally, 57 features are extracted for each rice. 5 for size and shape, 4 for texture and 48 for color information.

4.3.1 Shape and Size Features

F1-Major axis length.
F2-Aspect Ratio
F3-Equivalent diameter
F4-Perimeter
F5-Area

4.3.2 Texture Features

F6-Contrast
F7-Energy
F8-Correlation
F9-Homogeneity

4.3.3 Color features

Color features in RGB space
Mean

$$\mu = [\textstyle\sum_{x=0}^{x=z-1} h(x)]/z \qquad (2)$$

F10 – mean of R
F11 – mean of G
F12 – mean of B
F13 – mean of (R+G+B)
F14 – mean of (R+G+B)/3
F15 – mean of RGB/(R+G+B)
F16 – mean of R+G
F17 – mean of G+B
F18 – mean of R+B

Variance

$$\sigma = [\textstyle\sum_{x=0}^{x=z-1}(h(x) - \mu)2]/z \qquad (3)$$

F19 – variance of R
F20 – variance of G
F21 – variance of B
F22 – variance of (R+G+B)
F23 – variance of (R+G+B)/3
F24 – variance of RGB/(R+G+B)
F25 – variance of R+G
F26 – variance of G+B
F27 – variance of R+B

Skewness

$$S = [\textstyle\sum_{x=0}^{x=z-1}(h(x) - \mu)3]/z\sigma^3 \qquad (4)$$

F28 – skewness of R

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F29 – skewness of G
F30 – skewness of B
F31 – skewness of (R+G+B)
F32 – skewness of (R+G+B)/3
F33 – skewness of RGB/(R+G+B)
F34 – skewness of R+G
F35 – skewness of G+B
F36 – skewness of R+B

Kurtosis

$$K= [\sum_{x=0}^{x=z-1}(h(x) - \mu)4]/z\sigma 4 \quad (5)$$

F37– kurtosis of R
F38 – kurtosis of G
F39 – kurtosis of B
F40 – kurtosis of (R+G+B)
F41 – kurtosis of (R+G+B)/3
F42 – kurtosis of RGB/(R+G+B)
F43 – kurtosis of R+G
F44 – kurtosis of G+B
F45 – kurtosis of R+B

Color Features in HSV Space
Mean

$$\mu_1= [\sum_{x=0}^{x=z-1}(h(x))]/z \quad (6)$$

F46 – mean of H
F47 – mean of S
F48 – mean of V

Color features in L*a*b* space
Mean

$$\mu_2=[\sum_{x=0}^{x=z-1}(h(x))]/z \quad (7)$$

F49 – mean of L
F50 – mean of a
F51 – mean of b

Color Features in YCbCrColor Map
Mean

$$\mu_3= [\sum_{x=0}^{x=z-1}(h(x))]/z \quad (8)$$

F52 – mean of Y
F53 – mean of Cb
F54 – mean of Cr

Color Features in NTSC System
Mean

$$\mu_4= [\sum_{x=0}^{x=z-1}(h(x))]/z \quad (9)$$

F55 – mean of Yi
F56 – mean of I
F57 – mean of Q

4.4 Feature selection

Best First procedure was chosen as the search algorithm. The mentioned algorithm was implemented on the extracted features of milled rice using CfsSubsetEval attribute evaluator in WEKA software.

5. CLASSIFICATION

Classification categorizes detected objects into predefined classes by using suitable method that compares the image patterns with the target patterns. Four different metaheuristic techniques were evaluated using WEKA software.

1. Artificial Neural Networks(ANN)
2. Support Vector Machine(SVM)
3. Bayesian Networks(BN)
4. Decision Tree(DT)

5.1 Artificial Neural Networks

An ANN consists of a sequence of layers, each layer consists of a set of neurons. All neurons of every layer are linked by weighted connections to all neurons on the preceding and succeeding layers. One of the most common types of artificial neural network for classification purposes is Multilayer perceptron (MLP). A multilayer perceptron (MLP) is a feed forward artificial neural network model that maps sets of input data onto a set of appropriate outputs.

5.2 Support Vector Machine

A support vector machine model is a representation of the samples as points in space, separated by a clear boundary. The optimal boundary is known as hyper-plane. The vectors situated near the hyper plane are called supporting vectors. If the space is not linearly separable a kernel function may be used to solve the problem.

5.3 Bayesian Network

A Bayesian network is a graphical structure that allows us to represent and reason about an uncertain domain. The nodes in a Bayesian network represent a set of random variables, $X = X_1,..X_i ,...X_n$, from the domain. A set of directed arcs (or links) connects pairs of nodes, $X_i \rightarrow X_j$, representing the direct dependencies between variables. The strength of the relationship between variables is quantified by conditional probability distributions associated with each node.

5.4 Decision Tree

A Decision Tree is a flow-chart-like structure. Each internal (non-leaf) node denotes a test on an attribute. Each branch represents the outcome of a test. Each leaf (or terminal) node holds a class label. The topmost node in a tree is the root node. A classification tree or a decision tree is an example of a multistage decision process. Instead of using the complete set of features jointly to make a decision, different subsets of features are used at different levels of the tree.

6. RESULTS AND DISCUSSION

6.1 Data base

The rice data set was collected from various rice mills. 13 different types of rice samples are taken. Variety of rices are given below.

1. Samba rice
2. Ponni rice
3. Ambai 16
4. AST 16

5. IR20
6. Black Raw rice
7. Doppi
8. Cumin samba
9. Deluxe ponni
10. Idly rice
11. Basmati rice
12. White Raw rice
13. Chellaponni

6.2 Results

Artificial Neural Network (ANN)

MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H 5 function is selected as the best function for rice classification. The accuracy of the developed classifier is 92.307%. The high accuracy of the neural network topology indicates the suitability of the selected features.

Support Vector Machine (SVM)

SupportVectorPolyKernel -E 1.0 -C 250007functionis selected as the best function for rice classification. The accuracy of the developed classifier is 90.38%.

Bayesian Network (BN)

NaiveBayes function is selected as the best function for rice classification. The accuracy of the developed classifier is 82.69%.

Decision Tree (DT)

J48 -C 0.25 -M 2function is selected as the best function for rice classification. The accuracy of the developed classifier is 59.615%.

6.3 Performance evaluation

The performance of the utilized rice classification was evaluated by forming a Confusion Matrix (CM) and computing the statistical parameters such as Sensitivity (Se), Specificity (Sp), Classification Accuracy (Ac) and Root Mean Squared Error (RMSE).

The performance comparison of the classifiers based on the statistical parameters is given in Table 1.

TABLE 1.
PERFORMANCE COMPARISON

Classifier	Ac (%)	Se (%)	Sp (%)	RMSE (%)
MLP	92.307	94	92.3	0.0912
SVM	90.384	91.4	90.4	0.2493
BN	82.692	85.3	82.7	0.1631
DT	59.615	60.4	59.6	0.2507

7 Conclusion

It can be observed that the system is showing that four different classification techniques were utilized to classify rice samples. Performance evaluation of the classifiers indicated that MLP neural network was the best classifier with an accuracy of 92.31 %. After the MLP, Support Vector Machines with kernel function, Bayesian Network with Naivebayes and Decision Tree with J48 algorithm had the higher accuracy, respectively.

Comparison of classification matrices obtained from metaheuristic techniques showed that these approaches were quite efficient in classifying milled rice grains based on the defining features.

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