Abstract
India is the second largest producer of wheat in the world. Specifying the quality of wheat manually is very time consuming and requires an expert judgment. The aim of this proposal is to suggest algorithm for quality analysis of wheat using image processing techniques. With the help of image processing techniques, an automated software system can be made to avoid the human inspection and related drawbacks. Analysis and Classification of wheat is done visually and manually by human inspectors. Images of wheat grains are captured using digital camera and thresholding is performed. Edges of wheat kernels will be detected by canny edge detection. Following this step, morphological and color features of wheat are extracted from these images. For classification and grading SVM and Naïve based classifiers will be used. Digital Image processing can classify the wheat grains with speed and accuracy.
1. Introduction

Grain’s Quality is an important requirement for today’s market, to protect the consumers from substandard products. Wheat is the very important and widely grown food crop in the world. India is the second largest producer of wheat in the world. Determining the quality of wheat is important. Determining the quality of wheat manually is time consuming and requires an expert judgment. Sometimes, the variety of wheat looks so similar that differentiating them becomes a very tedious task when carried out manually. To overcome this problem, different algorithms can be used to classify wheat according to its quality. Grain grading system assures that a particular lot of grain meets the required set standards customer. In many countries grading of grain depends on some properties; test weight, moisture contents, broken foreign material or the percentage fragments example broken corn foreign materials, damaged kernels. These grains consists of several impurities like stones, weed seeds, chaff, damaged seeds, more broken granules etc. [1] This is often seen today in wheat trade where wheat in low quality is sold without being noticed. However, there is no suitable method to identify these lower quality grains in the market. Therefore, this has become a critical issue for both the consumer and the government. Therefore, it is required to explore the possibility of using technology for a suitable solution. The accuracy of quality checking by using human inspection method is varied from person to person according to the inspectors’ physical circumstances such as working stress, persuasion and loyalty for traders. Also, the knowledge and experience of inspectors are required to accurately perform this evaluation process. In recent years, image processing techniques has been widely used in determination of shape, color, texture and size of agricultural products. Manual measurement techniques have been replaced by image processing technique. These systems are flexible in application and they can be used in process lines instead of human inspection. The present study showed that the images of wheat under UV light can be used in separation of healthy and damaged ones automatically with using suitable algorithm. However there is still need to use different imaging techniques to reach more accurate results. Digital images stored in the computer are processed by Image processing algorithms. They extract the features from the digital images and use them to generate pattern. These patterns are input to the classifiers based on which the objects are classified into their respective classes.

2. Literature Survey

Studies have been carried on classification and grading of various grains using image processing and machine algorithms. These studies have used different classifiers and have performed feature extraction for determining the quality of grains. Some studies extracted two classes of features while others extracted one classes of features. Studies performed on different food grains. The work is also performed on wheat grains for classification and grading purpose by extracting one or two feature type. If there is overlap of grains, some classifiers are not able to classify correctly and in this case the accuracy decreases.

- Alireza Khoshroo et.al.[2] studied the classification of four Irani wheat cultivars. Ten morphological features were extracted from images using image processing techniques. Feature selection was conducted to reduce the redundancy in the morphological feature set. The Discriminate Analysis was used for this purpose. Then, the Artificial Neural Network (MLP) was used for classification of wheat cultivars. Overall classification accuracy of...
85.72% was obtained for classification of wheat cultivars. A. Arefi et al. [3] proposed a system to identify 4 wheat varieties (zarin, sardariRasad, Parvareshi). Morphological features (area, four factors of shape) and color features (average, variance, skewness, kurtosis of images in RGB) were extracted. Artificial Neural Network was used for classification of wheat types. The overall success classification rate was 95.86%.

- Alireza Pazoki et al. [4] classified Six Rain fed wheat cultivars (Sardari, Sardari 39, Zardak, Azar2, ABR1, Ohadi). 6 colors, 11 morphological features and 4 shape factors were extracted. UTA method was used for feature selection. The extracted features were feed to ANN (MLP) for classification of Rain fed wheat cultivars. Accuracy average for classification of rain fed wheat grains cultivars computed 86.48% and after application of feature selection with UTA algorithm accuracy increased to 87.22%.

- F. Guevara-Hernandez et al. [5] studied classification of wheat and barley grain kernels. 21 morphological, 6 color and 72 textural features were extracted. Object classification was accomplished by means of discriminated analysis (DA) and K-nearest neighbors (K-NN) algorithms.

- Harpreet Kaur, et al., [6] proposed a algorithm to grade (Premium, Grade A, Grade B and Grade C) the rice kernels. Maximum Variance method was applied to extract the rice kernels from background i.e. for segmentation purpose. Ten geometric features are extracted to determine the percentage of broken rice, head rice and brewers in rice samples. Multi-Class SVM is used to classify the rice kernel by examining the Shape, Chalkiness and Percentage of Broken (Head Rice, Broken) kernels. Here, the accuracy for classification of rice by using SVM is 86%.

- Jose D Guzman et al. [7], Classification of Phillipines rice grains using Multilayer ANN. Thirteen shape features of grain were extracted and fed to Multilayer ANN. The overall accuracy of classification was 70%.

- Bhavesh B. Prajapati et al. [8] proposed an algorithm for quality analysis of Indian Basmati Rice using Image processing techniques. Artificial Neural Network was used for quality analysis of Basmati rice.

- Megha R. Siddagangappa et al. [9] introduced an automated system used for grain type identification and analysis of rice quality (i.e. Basmati, Boiled and Delhi) and grade (i.e. grade 1, grade 2, and grade 3) using Probabilistic Neural Network. Color and geometrical features were extracted and fed to PNN. Grading of rice was done according to size of grain and presence of impurities. The accuracy for grain type identification is 98% and for grading 90.92%.

- L. Zhao et al. [10] identified six varieties of rice (ey7954, syz3, xs11, xy5968, xy9308, z903). Fourteen morphological and 7 color features were extracted. DA, Principal component analysis (PCA) are used for feature selection. Classification of rice is done by Neural Network. M.A. Shahin et al. [11] proposed an image analysis based approach for measuring seed size.

- Nandini Sidnal et al. [12], identified the unknown grain types, impurities and its quality. The morphological and color features are presented to the neural network for identification of grain types, impurities.

- Sanjivani Shantaiya et al. [13] given an approach to perform texture and morphological based retrieval on a quantity of food grain images. Median filter is used for smoothing.
Nine color, textural, morphological features are extracted and given to Discriminate Analysis (DA) and then classified using ANN.

- Hannu Rautio et al. [14] determined average grain size using morphological and textural analysis. Mathematical morphology was used as preprocessing method, with grayscale erosion. Feature extraction was implemented with first and second-order statistics. Classification was performed with k-NN and minimum distance classifiers using leave-out method.

- Meesha Punn et al. [15] classified wheat grains using machine algorithms (Neural Network (LM), Support Vector Machine (OVR)). Thresholding is used for image segmentation. The accuracy for classification using NN was 94.5% and 86.8% by using SVM.

- Rubi Kambo et al. [16] classified the varieties of Basmati rice using Principal Component Analysis. Morphological features were extracted and thresholding is used for image segmentation. Different varieties of Basmati rice were detected using PCA.

- N.S. Visen et al. [17] proposed an algorithm to process color images of bulk grain samples of five grain types, namely barley, wheat, oat, rye, and durum wheat. The proposed algorithms were used to extract 150 color and textural features. A back propagation neural network-based classifier was developed to identify the grain types. The color and textural features were given to the neural network for training purposes. The network was trained and then used to identify the unknown grain types. Classification accuracies of over 98% were obtained for all grain types.

3. Classification and grading of wheat grain

The general steps of classification and grading include preprocessing, segmentation, feature extraction, classification and so on. The preprocessing technology consists of smoothing and histogram equalization. The feature extracted is color, morphological and textural features. In classification step, Support Vector Machine (SVM) classifier and Naive Bayes classifier are used.

3.1 Image pre-processing

In order to get wheat seed features accurately, wheat seed images are preprocessed through grayscale, enhancement, smoothing (denoising), and binarization. First the image will be converted into gray scale image [0,256] and the image will be pre-processed using a smoothing filter (median filter) that included operations which can enhance and smooth images, accentuating image edges and remove noise from an image. [6]

Averaging, Gaussian filters are the filtering types used in noise reducing techniques in which their operation causes the image smoothing. In [1][6], smoothing is done using Median Filters. Median filtering is very broadly used in digital imaging because it conserve the edges of the image during noise removal. Speckle noise and salt and pepper noise are which with, median filters are particularly effective. Using median filter the noise in the input gray color image is removed. To get a new brightness value in the output image. In [9] the Gaussian filter for image smoothing is applied.

3.2 Segmentation

Image segmentation subdivides an image into different parts or objects. The image is usually subdivided until the objects of interest are isolated from their background. There are generally two approaches for segmentation algorithms. One is based on the discontinuity of gray level values; the other is based on the similarity of the gray-level values. [1] [13] Segmentation is attained by three
techniques such as Edge segmentation, Region segmentation and Thresholding. Maximum variance method is used to segment the image into foreground and background regions [6]. In [9] performed the segmentation using Component Labeling. Once the image is binarized, they performed labeling of connected components. By using labels and the similarity of grey level values, grains are segmented. In [1][15] performed segmentation through adaptive thresholding and detection of edges through canny and sobel edge detection[1].

3.2.1 Thresholding
Thresholding can be done in terms of global or local thresholding. Usually local thresholding is been favored if the background illumination is not even [13]. Thresholding is a technique based based on absorption of light in their surfaces to characterize the regions of the image. Threshold is to separate the regions in an image with respect to the objects, which is to be analyzed. This separation is based on the dissimilarity of intensity between the object pixels and the background pixels. From a grayscale image, thresholding can be used to create binary images by turning all pixels below some threshold to zero and all pixels about that threshold to one[15]. Here to perform thresholding, adaptive thresholding technique is implemented. Once properly separated the necessary pixels, set them with a determined value to identify them (i.e. we can assign them a value of 0(black), 255(white) or any value that suits our needs) [1].

3.3 Edge Detection Techniques
Edge detection is based on detection of edges by different edge operators. Discontinuities in color, grey level, texture, etc. are detected by edge operators. The Sobel operator is more sensitive to the diagonal edge is than to the horizontal and vertical edges. On the contrary, Prewitt operator is more sensitive to horizontal and vertical edges. For comparison of performance, two different edge detection techniques namely Sobel edge detector and Canny edge detector are used [1][13]. Edges are also been detected by applying Laplacian of Gaussian filter [13].

3.4 Feature Extraction
Extraction of quantitative information from segmented images is dealt with Feature Extraction. [1]. 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. Grains can be analysed and classified based on the parameters like length, width, length to width ratio, broken/fragment grains and damaged grains, discolored grains [8]. The various features that could be extracted are color features, morphological features and texture features [9].

3.4.1 Color Feature Extraction
An RGB image, sometimes referred as a true color image, is stored as an m-by-n-by-3 data array that defines red, green and blue color components for each individual pixel. The mean value of R (Rm), the mean value of G (Gm), the mean value of B (Bm)[4][9][12]the mean value of H (Hm), the mean value of S (Sm) and the mean value of V (Vm) were calculated in an image [4][13].

3.4.2 Morphological Feature Extraction
Morphology is identified as one of the most effective features that can be useful in discriminating different objects. Morphology denotes visual and shape characteristics of an object. Based on these characteristics, Recognition of wheat grains was carried out [2].Area, perimeter and major and minor axis lengths were measured from the binary images [4][9][12]. From these parameters following features are calculated. Aspect ratio, Equivalent diameter, Convex area, Compactness.
The other morphological features that can be calculated are Convex area, Eccentricity[9], Aspect Ratio, Rectangular Aspect Ratio[13], Volume, Roundness ratio, percentage of broken grain[15] etc.

### 3.5 Classification (Grading)

There are various classifiers used for wheat granules classification and grading such as SVM (Support Vector Machine), Neural Network, KNN, PNN etc. The classification approach is mainly based on the guess that the digital image under consideration depicts one or more features, and these features correspond to one of the several dissimilar and exclusive classes. The two phases that are in use for classification algorithms are training and testing. In the training phase, properties of the image features are separated and, based on these, a exclusive explanation of each classification category. In the testing phase, image features are classified by using the feature space partitions[9].

The grading is determined using Back propagation neural network based on the extracted features from the rice samples [1]. Multilayer perceptron (MLP) network consists of an input layer, output layer and one or more hidden layers. Multiple neurons are included in each layer. An artificial neuron is the smallest unit that constitutes the artificial neural network[4]. The Support Vector Machine help to grade and classify rice kernels accurately (better than 86%) and that too at a small cost [6]. The PNN was used for Identification of different kinds of grains i.e. analysis of rice quality (Basmati, boiled, Delhi rice) [9].

A neural network was used to classify the rice seed [13]. The comparison between Neural Network and SVM was used for classification and grading of wheat granules [15]. Here for classification and grading of wheat granules Naïve Bayes classifier is used. SVM is better than MLP and ANN classifier because of its complexity of training, flexibility, classification accuracy and complexity.

- The SVM is a machine learning algorithm used for solving classification problems
- SVM implements regular complexity control
- SVM is popular because
- It is easy to use
- It frequently has good performance
- The same algorithm solves various problems with little tuning.

### 4. Performance Analysis of Classification and grading of wheat grains

Following table shows the features extracted, methods used for preprocessing, segmentation, various classifiers used for classification and the accuracy rate of classification and grading of wheat granules studied by different authors and researchers.

**Table 4.1: Performance Analysis**

<table>
<thead>
<tr>
<th>Reference No.</th>
<th>Purpose</th>
<th>Feature Extracted</th>
<th>Methods Used</th>
<th>Classifier</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Classification Problem</td>
<td>Features Used</td>
<td>Preprocessing Techniques</td>
<td>Classification Algorithms</td>
<td>Accuracy</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td>Alireza Pazoki and Zohreh Pazoki [4]</td>
<td>Classification of rain fed wheat grain cultivars(Sardari,Sardari39,Zardak,Azar2,ABR1,Ohadi)</td>
<td>Morphological, Color and textural features</td>
<td>By using UTA method for feature extraction</td>
<td>ANN (Multilayer Perceptron)</td>
<td>86.58</td>
</tr>
<tr>
<td>JoseD Guzman, Engelbert K. Peralta [7]</td>
<td>Classification of Philippines rice grains</td>
<td>Morphological features</td>
<td></td>
<td>Multilayer NN</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>For Grading-Size of grain kernel, presence of impurities</td>
<td></td>
<td>92</td>
</tr>
</tbody>
</table>
5. Conclusion

Different methods and techniques which were provided by various authors for classification and grading of grains are included. Different methodologies were proposed, various features were extracted earlier for the classification and grading of wheat and other grains with the help of image processing. The accuracy of classification varies differently for different classifiers. The accuracy also varies for different set of features but using same classifier. For better classification and grading two or more features can be extracted.

References

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