Review on Classification of Wheat Grain Using Machine Algorithms

Meesha Punn, Nidhi Bhalla

Abstract - In this paper we have conducted a systematic review of the machine vision algorithms used in identification of class of quality of wheat grain. We have found that not much work has been done on Indian variety of wheat in terms of identification of its class using machine algorithm.

Index Terms - Classification, Computer Vision System, Image Processing, Grading, Quality, SVM, Wheat

1.Introduction

India is the second largest producer of wheat in the world after China. Determining the quality of wheat is critical. Specifying the quality of wheat manually requires an expert judgement and is time consuming. Sometimes the variety of wheat looks so similar that differentiating them becomes a very tedious task when carried out manually. To overcome this problem, machine algorithms can be used to classify wheat according to its quality.

Machine algorithms are incorporated by using machine vision. Machine vision is widely used in the field of agriculture for identifying the varieties of various food crops and for identifying their quality as well. A machine vision system (MVS) provides an alternative to the manual inspection of biological products. Machine vision system incorporates the use of digital images. These images are obtained with the help of digital camera and are then stored in the computer for future work. In a Machine Vision System, the camera acts as an eye and the computer acts as the brain.

Meesha Punn is currently pursuing masters degree program in Computer Science in Punjab Technical University, Punjab India. E-mail:meesha990@yahoo.in
Nidhi Bhalla is currently working as Assistant Professor in Swami Vivekanand Institute of Engineering and Technology, Punjab, India.

Digital images stored in the computer are processed by Image processing algorithms extract the features from the digital images and use them to generate pattern. These patterns are input to the machine algorithms based on which the objects are classified into their respective classes. Such machine algorithms used for classifying objects are referred to as pattern classifiers.

2. Image processing for quality measurement of wheat

Image processing is being increasingly applied in the very sensitive area seed analysis. It is also an excellent instrument for making tests and doing monitoring and classification in a number of other industrial production areas. Image processing applied to wheat seeds' quality classification contributes in achieving fast and accurate operation.

The only drawback of machine vision system [10] is that its results are influenced by the quality of the image captured by the camera and accuracy of machine algorithm(s).

3. A review of Methodology

The methodology for classification of wheat grains incorporates the following steps:

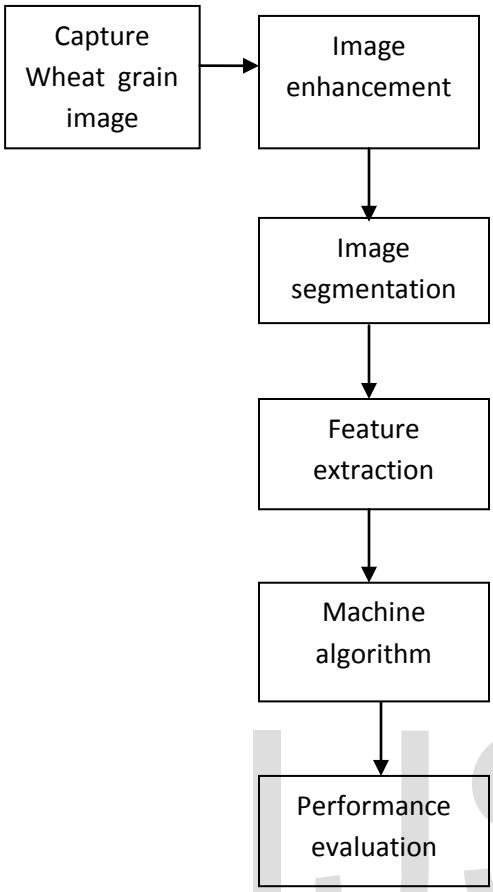

Fig 1. Procedure for wheat grain identification

3.1 Image Acquisition

The first step for the classification of wheat using machine algorithms is to acquire the images of wheat. The images are acquired using a digital camera and are stored in the computer in the form of digital images.

3.2 Image Scaling

Image scaling is the process of resizing the images. Increasing the size of the image makes the image soft. Reducing the size of the image enhances the smoothness and sharpness of the image.

3.3 Image Enhancement

Image enhancement deals with modifying the image so as to improve the image. It improves the quality of image by removing noise and blurring from the image. Image enhancement is done to get better understanding of the image.

3.4 Image Segmentation

Image segmentation refers to the process of dividing a digital image into various segments. The purpose of segmentation is to present the image in more simplified presentation so that it is easy to analyze the image and get the segments of interest. Image segmentation gives a meaning to the image.

3.5 Feature selection

Selecting features deals with choosing relevant subset of features form large set of features to carry the task of classification. While classification of wheat, identification, extraction and selection of appropriate features is of great importance. This is so because selecting the wrong features can deviate the classification process from its correct path. The features can be used in combination with other features in order to obtain the better accuracy of the machine learning algorithms[1]. Employment of correct number of features offers better results. Employing more features can deteriorate the performance of the machine algorithm and increase computational cost[7]. Correct number and selection of features leads to computational accuracy of machine algorithm.

Morpological Features	Area
	Perimeter
	Maximum Feret's Diameter
	Circularity
	Solidity
	R Factor
	Aspect Ratio
	Convexity
	Concavity

	Rectangularity
	Roundness
	Compactness
	Length
	Width
	Major Axis Length
	Minor Axis Length
Textural Features	Mean
	Standard Deviation
Color Features	Hue
	Saturation
	intensity

Table 1. Features extracted for Machine Algorithms

Feature selection using SFS algorithm

Sequential Forward Selection algorithm incorporates a criterion function based on scatter matrix[13]. It chooses feature that has a larger value in the criterion function and adds that function to vector function[1].

Feature selection using UTA algorithm

UTA algorithm calculates the average of feature in all instances. This selected feature is replaced by calculated mean value in all input vectors. Then the trained network is tested with the new features and total feature's error is calculated [3].

3.6 Implementing machine algorithms: A Review

Different machine algorithms have been implemented till date using different features of grains. An algorithm was developed taking into account morphological features to classify Canada Western Red Spring(CWRS) wheat, Canada Western Amber durum(CWAD) wheat, barley, oats and rye [4]. Another classification model was developed by combining two or three feature sets(morphological, color, textural) for classification of Canada Western Red Spring(CWRS) wheat, Canada Western Amber durum(CWAD) wheat, barley, oats and rye [5]. Different values of accuracy was achieved using different pair of feature sets. Later, a Digital Image Analysis (DIA) algorithm was developed to classify Canada Western Red Spring(CWRS) wheat, Canada Western Amber durum(CWAD) wheat, barley, oats and rye [6] using textural features of individual wheat grains. Textural features were obtained using different color band combinations to identify the color band combination that classifies the wheat grains with maximum accuracy [6].

A comparison of three machine learning classifiers [8], namely Artificial Neural Network (ANN), Support Vector Machine (SVM)[12] and Random Forest (RF) was done [9]. The comparison showed that RF took longer time than SVM but has an advantage that it is easy to use. This is so because it requires only one variable to be set by the user. ANN produced results between RF and SVM. It required the highest calculation times among the three classifiers. ANN was considered as the least favorable classifier. Conversely, SVM emerged as the best classifier. It showed good performance and robustness. The calculations were done faster and took less calculation time than ANN. Burges et al., 1998 stated that Support Vector Machine (SVM) is a set of linear classifier that provides higher values of classification accuracy as compared to other classifiers used such as multilayer perceptron neural networks [14].

Another study employed ANN classifier for classification of wheat using two features, morphology and color [2]. It was concluded that morphological features were better than color features in classifying wheat. But, only morphological features were not sufficient in wheat classification so a combination of both was used.

3.7 Performance Evaluation

After the implementation of machine algorithms, the performance of classifiers is evaluated and the results are obtained.

4. Agricultural procedure (Grading and marking) Act, 1937 (AGMARK STANDARDS). Quality measurement of wheat grains

Agricultural Produce (Grading & Marking) Act, 1937 is also referred as AGMARK Standards [17]. It provides standards of various agricultural commodities. Grading provides description of the quality of the wheat seeds. The grading standard deals with the following:

Foreign Matter : It comprises of dust, , lumps of earth, stones, chaff, stem or straw, non edible seeds.

Other Food Grains : Edible foodgrains except wheat.

Other Wheat :wheat would be divided into two classes (1) Durum or Macaroni [15] wheat and (2) vulgare or common wheat [16].

Damaged Grains : Grains that are internally damaged or discoloured, damaged and discolouration materially affecting the quality.

Slightly Damaged Grains : Grains that are superficially damaged or discoloured, damaged and discolouration not materially affecting the quality.

Immature, Shriveled and Broken Grains : Immature and shrivelled grains are those that are not properly developed, Broken grains are pieces of whole grains.

Weevilled Grains : Grains that are partially or wholly bored or eaten by weevils or other grain insects.

Grade Designation	Foreign matter (% by wt.)	Other food grains (% by wt.)	Other wheats (% by wt.)	Damaged grains (% by wt.)	Slightly damaged grains (% by wt.)	Immature shrivelled and Broken Grains (% by wt.)	Weevilled Grains (% by wt.)
I	1.0	1.6	5.0	1.0	2.0	2.0	1.0
II	1.0	3.0	15.0	2.0	4.0	4.0	3.0
III	1.0	6.0	20.0	4.0	6.0	10.0	6.0
IV	1.0	8.0	20.0	5.0	10.0	10.0	10.0

Table 2 List of Quality Parameters for Wheat Grain Classification

5. Conclusion

The classification accuracy varies differently for different classifiers. Also, the accuracy varies differently for same classifier employing different set of feature values. A single feature alone may not be enough for proper classification of wheat so a combination of two or more features can be used to obtained better classification of wheat. Employing large number of feature values does not improve the performance of machine algorithm. It increases the computational cost and may also decrease the accuracy of machine classifier. Choosing the correct features results in better accuracy of machine classifier. After comparison of various machine learning algorithms it was concluded that SVM emerged as the best

classifier. It showed good performance and robustness and took less computational time as compared to other machine learning algorithms.

References

[1] F.Guevara-Hernandez and J. Gomez-Gil 2011 "A machine vision system for classification of wheat and barley grain kernels".
[2] A.Arefi, A.Modarres Motlagh and R. Farrokhi Teimourlou 2011 "Wheat class identification using computer vision system and artificial neural networks".
[3] Alireza Pazoki and Zohreh Pazoki, 2011 "Classification system for rain fed wheat cultivars using artificial neural network".
[4] Majumdar, S. and D.S. Jayas. 2000a. "Classification of cereal grains using machine vision. I. Morphology models."
[5] Majumdar, S. and D.S. Jayas. 2000b. "Classification of cereal grains using machine vision. II. Color models".
[6] Majumdar, S. and D.S. Jayas. 2000c. "Classification of cereal grains using machine vision. III. Texture models".
[7] Majumdar, S. and D.S. Jayas. 2000d. "Classification of cereal grains using machine vision. IV. Combined morphology, color, and texture models".
[8] Francisco Pereira, Tom Mitchell, Matthew Botvinivick, 2008 "Machine learning classifiers and fMRI: A tutorial overview".
[9] I. Nitze, U. Schulthess, H. Asche, 2012 "Comparison of machine learning algorithms Random Forest, Artificial Neural Network and Support Vector Machine to maximum likelihood for supervised crop type classification".
[10] Narendra V G, Hareesh K S, 2010 "Quality inspection and grading of agricultural and food products by computer vision- A review".
[11] Sanjivani Shantaiya, Mrs.Uzma Ansari, 2010 "Identification Of Food Grains And Its Quality Using Pattern Classification".
[12] William S Noble, 2006 "What is a support vector machine, Nature Biotechnology".
[13] Theodoridis S, Koutroumbas K, 20006 "Pattern recognition".
[14] Burges, C. J. C. "A tutorial on support vector machines for pattern recognition".
[15] B S Tyagi, Jag Shoran, Gyanendra Singh, R K Gupta and B Mishra, 2008. "Breeding durum wheat genotypes for better grain yield, pasta quality and resistance."
[16] Dharam Pal, Sanjay Kumar, 2009. " Genetic analysis of forage yield and other traits in barley (*Hordeum vulgare* L.)"
[17] http://agmarknet.nic.in/Wheat_manual.htm