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Maize Grain Classification System using Neural Network

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Abstract: This presents a system for automated classification of maize grain varieties using Artificial Neural Network. Maize Grain is the most important food crop in Myanmar. This system can classify the types of maize grain such as Butter Corn, Sweet Corn, Kalar Corn, Shan Corn. An input image of maize grain is acquired firstly by using a digital camera. The image is segmented by using threshold function and is needed to perform image processing techniques such as converting gray scale, resizing and changing to binary image. To remove the noise of an image the median filter has been used. The important features of the image are needed to be extracted according to morphological features. The seven important morphological feature extracted from images were used as input for developed ANN. This system is implemented by using MATLAB programming language.

Keywords: - Maize grain, Artificial Neural Network, Threshold Function, Feature Extraction, median filter

1. INTRODUCTION

Grains are the prime crop for our country's peasants to increase their agricultural income. Maize grain is one of the most important cereal crops. The automation level of testing grain quality is low and most work is done by manpower. Although most of the maize produced around the world is used for animal feed, its use for human consumption and the manufacture of industrial products have grown rapidly in recent decades. The process of manual classification of maize grains is slow, has low reproducibility, and possesses a degree of subjectivity hard to quantify, both in its commercial as well as in its technological implications. In the present grain-handling system, grain type and quality are rapidly assessed by visual inspection. This evaluation process is tedious and time consuming. The decision-making capabilities of a grain inspector can be seriously affected by physical condition such as fatigue and eyesight, mental state caused by biases and work pressure, and working conditions such as improper lighting, climate, etc. Hence, these tasks require automation and develop imaging systems that can be helpful to identify maize grain [1].

Artificial neural networks (ANN) is a mathematical tool, which tries to represent low-level intelligence in natural organisms and it is a flexible structure, capable of making a non-linear mapping between input and output spaces. This method can be trained with numerical sample data concerning only inputs and corresponding outputs, they have promise in solving the problems of agriculture, especially grain identification. The inputs to the ANN can be given in terms of data obtained from digital images, which provide quantitative estimate of morphological features of grain and offer scope to bring objectivity in the process of identification [2]. Fortuna pointed a neural network is constructed by highly interconnected processing units (nodes or neurons) which perform simple mathematical operations Lippmann summarized neural networks are characterized by their topologies, weight vectors and activation functions which are used in the hidden layers and output layer. So the standard classification of maize grain is one of the most important factors that farmers interested in. To implement this system, artificial neural network is applied. Backpropogation neural networks are useful for various types of pattern recognition system. MATLAB software, like any other computer vision software, implements the use of training patterns or the training sets to test the performance of a specific geometric pattern recognition approach, is mainly applied. It is simple to understand and it works well for practical problems. A basic machine vision system used in agricultural applications for classification of various maize grains consists of a digital camera, and computer software for capturing, classification, sorting, analyzing and processing the image.

The morphological features of grains are heritable characters and play an important role in wheat variety recognition. In the current grain grading systems, grain type and quality are inspected through visual assessment by experts and trained inspectors which is subjective, and tedious. Computer vision system offers an objective and quantitative method for estimation of morphological parameters and quality of agricultural products to obtain quick and more reliable results. Image processing based on morphology, colour and textural features of grains is necessary for different applications in the grain industry including assessing grain quality and discrimination of wheat classes [3]. Various grading systems have been reported in literatures which use different morphological features for the classification of different cereal grains and cultivars.

In grain classification process, several techniques such as statistical, artificial neural networks and fuzzy logic have been used. Classification performances of different neural network topology were compared by using morphological features of Canada Western Amber Durum (CWAD) wheat, Canada Western Red Spring (CWRS) wheat, oats, rye and barley [4].

This paper is organized as follows: related works of the system are described in section two. In section three, result and discussion is explained. Finally, in section five, the paper has been concluded.

2. MATERIALS AND METHODS

Overall five steps including image acquisition, pre-processing operations, feature extraction, neural network and classification were performed to classify maize grains [fig. 1]. Maize grains classification steps are explained in following;

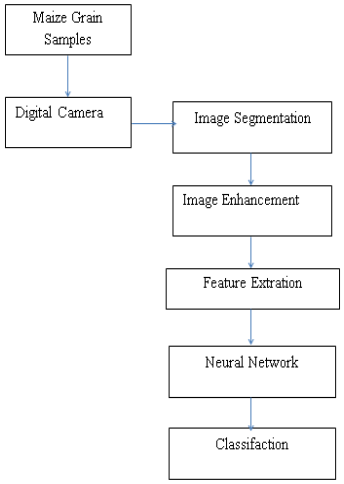

Fig. 1. Flowchart of maize grains classification process.

2.1 Maize Grain Samples

In this study, identification of four Maize Grains were carried out. Butter corn, Kachin corn, Kalar corn, and Shan corn are maize grains widely grow in Myanmar. Fig.2 show the maize grain samples;

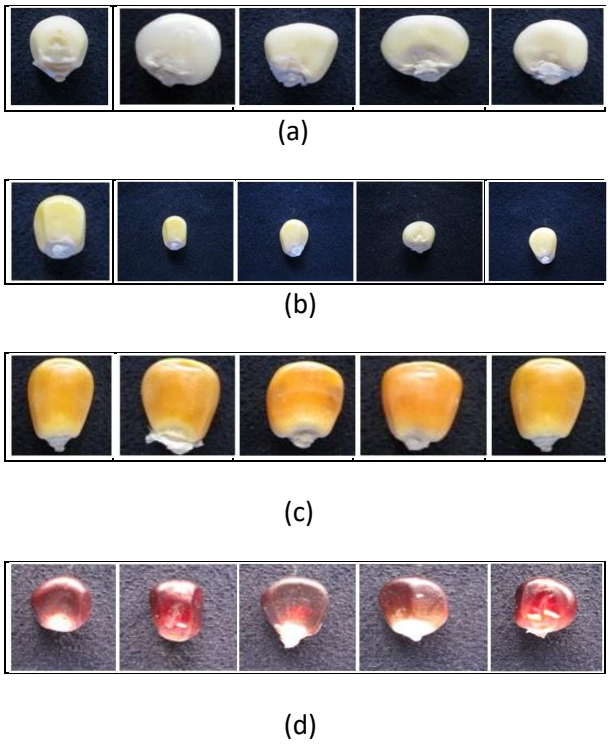

Fig. 2. Sample of Maize Grains: (a) Butter Corn, (b) Kachin Corn, (c) Kalar Corn, (d) Shan Corn

2.2 Image Acquisition

An image capturing system was designed to take some standard pictures from the samples. Resolution 640 x 480 pixels of Nikon camera are used as image acquisition devices. In this system, off-line image acquisition is used and the images are *.jpg format.

2.3 Pre-Processing

In the pre-processing step, changing colour space, resizing, median filter and morphological feature extraction are performed.

1) Changing Color: The color is changed from RGB into Grayscale image and Grayscale image was converted to binary image.

2) Resizing: The black and white image is resized into 108x 108 pixels to get a uniform size of maize grain image.

3) Median Filter: The median filter is a best known to remove salt and pepper noise in image processing. Median filter techniques abound in many image processing applications. Median filter has tend to blur sharp edges, destroy lines and other fine image detail .

2.4 Feature Extraction

The morphological features were extracted from images of maize grain varieties. Geometry related features including area, perimeter and major and minor axis lengths were measured from the binary images [5]. The below equation (1) and (2) are area and equivalent diameter.

Area: It was the number of pixels inside and including the image boundary.

$$\text{Area} = \iint_R dxdy \quad (1)$$

Perimeter: It was the total number of pixels around the Boundary of each region in the image.

Bounding Box: It was the smallest rectangle containing the region.

Length: It was the length of the rectangle bounding the image.

Width: It was the width of the rectangle bounding the image.

Equivalent Diameter: It was the diameter of a circle with the same area as the image region.

$$\text{Equadial} = \text{sqrt}(4\text{xArea}/\text{pi}) \quad (2)$$

Convex Area: It was the number of pixels in the smallest Convex polygon that can contain the image region

2.5 Intelligent Classification

Classifying Four maize grains was done using artificial neural network (ANN) based on morphological features using Neuron Solutions software. A multi-layer perception (MLP) network which is commonly used to classify objects was designed. MLPs often have one or more hidden layers of linear or non-linear neurons followed by an output layer.

Several layers of neurons with nonlinear transfer functions allow the network to learn nonlinear and linear relationships between input and output vectors. Based on trial and error method, networks with one or two hidden layers with different number of neurons for hidden layers were developed. Number of neurons in output layer was four and the number of neurons in input layer was equal to number of input features. In the developed MLP models, the tangent sigmoid which is a non-linear transfer function was used for hidden layers. 60% of all samples were used for training the network to adjust the network weights. 15% of samples were used for validating the structure of network and remaining samples (25%) were used for evaluating the network in the testing step. In total, the training was performed 3 times and continued to minimize the mean squared error (MSE) between targets and outputs.

To classify maize grains based on morphological features, artificial neural networks were used. ANN was trained using 20 samples and validated by 5 samples. Network evaluation was done using testing data (14 samples). Seven morphological features were used as input data. The best ANN was determined based on trial and error method. The number of hidden layers and the number of neurons in hidden layers are important factors in developing a MLP. Results showed that the developed MLP with one hidden layer in this study could successfully recognize most maize grains. When the number of hidden layer was increased from one to two layers, the MLP's performance did not improve, this can be due to over fitting problem in which the MLP memorize the input patterns. Therefore, ANN architecture with one hidden layer was selected for further investigation.

To find the optimum number of neurons in the hidden layers, trial and error method was used. Mean squared error (MSE) of test data was used for comparing MLP models with different number of neurons in hidden layer. The best model was selected based on the minimum value of MSE. The performance of different MLP models is presented [Fig 3.]. Trends of network MSE with number of neurons in hidden layer shows a decreasing pattern up to 10 neurons and increasing pattern for MSE after 10 neurons. Then to prevent overtraining, the best number of neurons in the hidden layer is 10. Hence the best topology of ANN was obtained as 7-10-4.

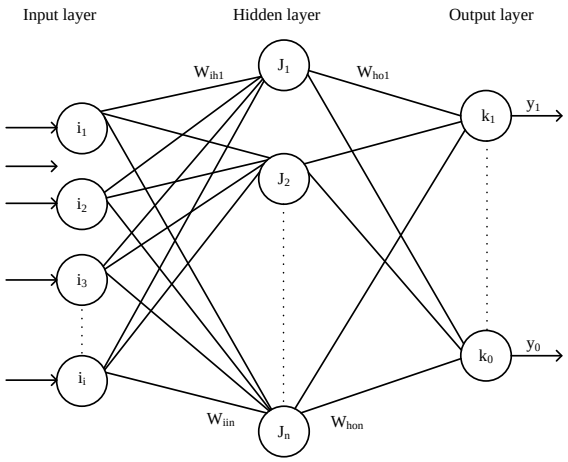

Figure 3:ANNtopology: xi is the xth input feature; ii is the ith input node; ji is the jth hidden layer; ki is the kth output layer neuron and yi is the yth output; wij is weight between input and hidden layers and who is weight between hidden and output layers.

3. RESULTS AND DISCUSSIONS

Morphological features were computed from individual kernel images using image processing techniques. Some of morphological features were highly correlated with another and they did not contribute significantly to the morphology model.

Confusion matrix and classification accuracy of ANN classifier are presented in table 1 and table 2, respectively. The overall accuracy of maize grain identification was 86.25%. The acceptable classification accuracies were obtained for 'Butter Corn', 'Kachin Corn' and 'Kalar Corn' (Table. 4). 'Butter Corn' and 'Kachin Corn' grains were classified with the highest accuracy and the lowest classification accuracy was obtained for 'Kalar Corn' and 'Shan Corn' grains. It may be because there were several morphological features that were able to make a significant difference between 'Butter Corn' and 'Kachin' with other grains (Table 4). For this reason, ANN was able to detect them with high accuracy. Whereas, a significant difference was not observed between 'Kalar Corn' and 'Shan Corn' grains for robust features.

Overall, the results show the developed computer vision system can identify wheat cultivars satisfactorily. Although the morphological features were not suitable for describing 'Kalar Corn' grain. Further studies must be explored for finding suitable features such as, colour, texture, wavelet and Fourier transform for improving classification accuracy of 'Kalar Corn' grain.

Table 1. Confusion matrix of ANN classifier for grain identification

Output/ Desired	Butter Corn	Kachin Corn	Kalar Corn	Shan Corn
Butter Corn	20	4	3	4
Kachin Corn	0	16	0	0
Kalar Corn	0	0	17	0
Shan Corn	0	0	0	16

Table 2. The ANN classification accuracy for grain identification

Maize Grain	Accuracy
Butter Corn	100
Kachin Corn	80
Kalar Corn	85
Shan Corn	80
Average	86.25

4. CONCLUSION

This paper described the basic approaches, techniques, and applications of artificial neural networks as a start of the development of comprehensive recognition systems. Artificial neural network method are proves better. It gives the best classification accuracy of 86.25% In this paper, the developed system is maize grains classification system that gives the great effect on the consumers, merchants and farmers in Myanmar. So, the system is able to classify the various types of particular maize grains. But the system can classify only one seed a time.

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