AUTOMATIC SEED CLASSIFICATION BY MULTI-LAYER NEURAL NETWORK WITH SPATIAL-FEATURE EXTRACTION

4 authors:

Suseendran G.
VELS INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS), CHENNAI.
149 PUBLICATIONS   870 CITATIONS

SEE PROFILE

Chandrasekaran Ekambaram
Veltech .Rangarajan Dr.Sakunthala R&D Institute of Science and technologe, Avadi, …
39 PUBLICATIONS   154 CITATIONS

SEE PROFILE

Akila D.
Saveetha College of Liberal Arts and Sciences
112 PUBLICATIONS   489 CITATIONS

SEE PROFILE

Balaganesh Duraisamy
Berlin School of Business and Innovation, Berlin, Germany.,
67 PUBLICATIONS   261 CITATIONS

SEE PROFILE

AUTOMATIC SEED CLASSIFICATION BY MULTI-LAYER NEURAL NETWORK WITH SPATIAL-FEATURE EXTRACTION

G. Suseendran[1], E. Chandrasekaran[2], D. Akila[3], D. Balaganesh[4]

[1]Assistant Professor,Department of Information Technology,School of Computing Sciences
Vels Institute of Science, Technology& Advanced Studies (VISTAS), Chennai
[2]Professor, Department of Mathematics, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology , Chennai
[3]Associate Professor, Department of Information Technology, School of Computing Sciences,
Vels Institute of Science, Technology &Advanced Studies (VISTAS), Chennai
[4]Dean Faculty of Computer Science and Multimedia, Lincoln University College, Malaysia

Email : suseendar_1234@yahoo.co.in,e_chandrasekaran@yahoo.com, akiindia@yahoo.com ,
balaganesh@lincoln.edu.my

Abstract

Now a day's research works on agriculture field have been widely implemented and it is the department that shows rapid growth. This improved growth has shaken its hands to technology for extreme growth. Man, free system for food processing unit like classification based on variety, quality and other aspects. This paper expresses about seed classification based on multiple feature extraction and minimum distance classifier. Feature extraction is associated with spatial, color, shape, texture and statistical features. We have used rice, corn and wheat for this classification process. Too many features have been extracted. Optimum morphological features are extracted for database creation. Training and classification by Means of Multi-Layer Perceptron neural network and Neuro-fuzzy neural network. Matlab tool have been used for entire process.

Keywords: Classification, rice, wheat, corn, feature extraction, Multi-layer perceptron neural network, Neuro-Fuzzy classification.

INTRODUCTION

In the field of agriculture and technology application of machine vision is considered to be very important one. Mainly for monitoring seed germination, plant growth rate analysis, weed growth analysis, plant health monitoring, irrigation for plant, classification of fruits, vegetable and seed varieties. Seed form a basis for agriculture process. Coming to seed categories there are many seeds available in market that belongs to same or different classes or may belong to different species on same class. Even agricultural land, weather and water supply will determine seed category. Additional knowledge have been gain through seed classification and analysis. Visual inspection of seed for classification is very tedious process and consumes a lot of time. Thus in order to increase the efficiency of work. Here we have used two different machine learning technique i.e. MLP neural network and neuro-fuzzy classifier.

Our proposed system work flow will be like the first step is to acquire images of the seeds that is going to be classified. Then multiple preprocessing has been carried out on the image by which image could be converted to a stable format for further processing. This preprocessing includes gray scale conversion, resizing, binary conversion, denoising and enhancement. Then comes connected component analysis for analyzing individual grain properties of all the grains placed in the image. Some features of seed has been extracted by connected component analysis and more number of features are calculated using some derivations and formulas. All the features extracted are trained with MLP-neural network and finally classification is carried out with Neuro-Fuzzy Classifier.

Related work

Early days seed classification have been carried out with the help of human beings which consumed a lot of time. And later many researchers worked out on seed classification process through image recognition system. Some of them are as given below.

Classification of chickpea varieties with different performance of supervised and unsupervised neural network has been proposed by kaka, Piroz and Jam. They concluded that accuracy of classification with unsupervised method s high when compared with supervised classification method. Morphological features of chickpeas are taken in consideration for classification.

Brinkkemper computed shape and size features for classification. Also, it has been followed by statistical   analysis of the databases with QDA (Quadratic Discriminant Analysis) and stochastic Neighbor Embedding system. This system helped for seven different seed varieties.

Shantaiya and Ansaria proposed a system for rice variety classification with neural network system with the help of colour and morphological features. And this system gives about 84% of accuracy. Chen et al [3] proposed a classification system for China corn varieties with five types with an accuracy of 90%. Guevara-Hernandez and Gomez-Gil [4] classified wheat and barley kernels with KNN based on colour, texture and morphological feature and discriminant analysis which shown 90% accuracy. P. Zapotoczny [5] proposed a system to classify 11 varieties of wheat with 90-95% accuracy, classification is made through geometric feature with the help of Meta Multi Class Classifier. Morphological and color feature of rangeland seed species resulted in % accuracy was proposed by Anvarkhah et al [6]. Pandey et al [7] combined CBIR (content Based Image

Retrieval) for recognition of seeds and classification with ANN and Euclidean distance. Resulted with 95% on ANN and 84.4% on Euclidean distance classifier. Pazoki [8] introduced MLP neural network and Neuro-Fuzzy methods for classification of five different corn seed varieties with accuracies of 94% for MLP neural network and 96% for Neuro- Fuzzy Neural Network.

METHODOLOGY
This paper explains about the classification of seed variety based on various feature extracted from the seed image.

Grain Data and Image acquisition
Grains considered in this work for classification are rice, corn and wheat. These common grains used for house hold purpose. For image acquisition, grains are spread on a dark surface and images are captured through a high-quality digital camera with 5Mega pixel quality. These images are used for further processing and classification. Classification is done using MATLAB2013b. Complete process is as follows
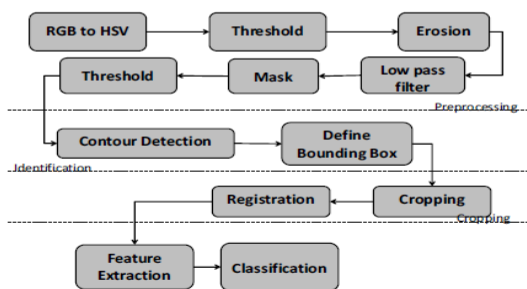

Fig. 1. Process of benchmarking

Fig. 2. Original input image of corn seeds

Gray scale conversion
Input image is converted from three planes (RGB image) to single plane image (Gray scale image). Input images obtained from MRI scans are in RGB format, which increases computation time, storage space, and complexity of coding. Hence Color conversion of input bio-medical image is performed. The color conversion is performed by taking average value of red, green and blue pixel values or by taking weighted sum of RGB pixels, e.g.: 0.4R + 0.39G + 0.21B.

Fig. 3. Gray scale converted input corn image

Image resizing
Image scaling refers to resizing of an image i.e. increasing or decreasing total count of pixels of the image. It also refers to

varying the size of rows and columns to change the overall image matrix size.Biomedical image processing needs images of fixed size to perform segmentation and analyze uniform results. Here, the paper performs scaling operation by simple method of nearest neighbor interpolation and decimation process.

Image enhancement
Image enhancement refers to increasing the visual quality of an image. Enhancement can be done through many processes like histogram equalization, Histogram stretching, image sharpening and many more process. Here we have used image adjustment with 0.5 threshold function for image enhancement.

Binary conversion
Final preprocessing step is binary conversion. Image binarization in is the processing of converting 8 bit pixel to logical value corresponding to the pixel present there. This process reduces the complexity of calculating morphological feature parameters. And this binary conversion is done with 0.3 as threshold in order to convert maximum data logical '0'.
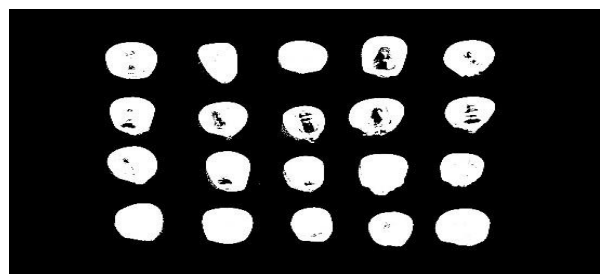

Fig.4. Binary converted input corn image

Connected component analysis
CC analysis includes grouping connected data i.e. pixel together in order to analyze individual objects. This works by scanning an image from top to bottom analyzing each pixel to group connected and similar pixels to form groups. Since input is a binary image this process groups all '1's together. Thus, we will get each grain as an object.
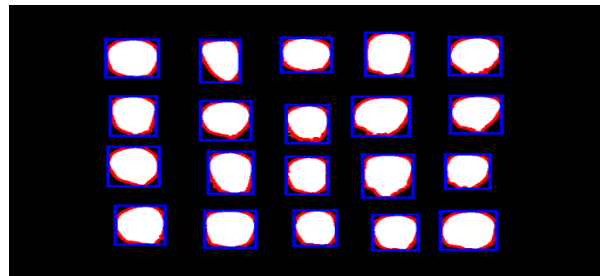

Fig. 5. Result of connected component analysis with bounding box representing individual grain
Follows area open function to eliminate broken grain and dusts. Also, this acts a filter to eliminate unwanted objects from the image.

Features extracted from the grain image
Area refers to number of whitepixel '1' present in each object. It refers to number of pixels representing each seed. Major Axis Length (MAL)is Length of the seed which refers to the longest line connecting either side of the seed. Minor Axis Length (mAL) is the width of the seed which refers to the shortest line connecting either side of the seed.Eccentricityrefers to the ratio of MAL and Foci of the seed data.

$$ECC_{seed} = \frac{AL_{major}}{f_{seed}} \ ...(1)$$

Convex area is theTotal number of pixels that covers the convex hull is convex area of the object.Filled area is theArea of seed

covered with '0'. Equivalent diameter refers to diameter of seed is calculated assuming seed area to be a circle.Solidityis the ratio between seed area to its convex or concave area.

$$S_{seed} = \frac{A_{seed}}{A_{convex}}.........(2)$$

Extent is the ratio between area of seed to the area of its bounding box.Perimeteris the number of pixels connected to form the border of the seed. Convex ratio refers to the ratio between difference of convex area and seed area to the convex area.

$$CXR_{seed} = A_{convex} - A_{seed} ......(3)$$

Circularity is the ratio between seed area and its perimeter.Ellipse ratio is the ratio between seed area and the product of MAL and mAL.

$$ER_{seed} = \frac{A_{seed}}{AL_{major} + AL_{minor}}...(4)$$

Circle Ratiois the ratio between seed area and MAL.Compactness is the ratio between seed area and mAL.Aspect ratiois the ratio between MAL and mAL.

$$Aspect_{seed} = \frac{AL_{major}}{AL_{minor}}.........(5)$$

Roundness is the ratio between perimeter and seed area.There are four major shape factors

- Ratio between MAL power of two to seed area
- Ratio between seed area to MAL power of three.
- Ratio between seed area to the mean of MAL power two
- Ratio between seed area to the product of mean MAL power two and mean mAL power two.

Elongation:Ratio between mAL and MAL

$$Aspect_{seed} = \frac{AL_{minor}}{AL_{major}}.........(6)$$

Mean, Median, Standard Deviation, Covariance, Skewness, Kurtosis, Moment has been calculated for the gray scale image. All the above features are calculated for multiple set of input images of grains and database is formed. Thus, the same process is followed for query image.

Finally, Euclidian distance classifier has been used for classification with the above features

Artificial Neural Networks
ANN is a mathematical tool that has flexible structure and a non-linear mapping between input and output spaces can be made with this, also low-level intelligence in natural organism can be represented with ANN. For seed type classification Neuro-fuzzy network and Multi- Layer perceptron Network has been used.

Multi-Layer Perceptron (MLP) network
More number of artificial neurons linked together forms an Artificial Neural Network. They are linked together Which follows some specific architecture. Transforming inputs to a meaningful output is the main objective of this neural network. Similar to other neural networks MLP neural network has a input layer and an output layer and one or more hidden layer in between them in which each layer is composed of multiple neurons. The smallest unite that constitutes the artificial neural network is the Artificial neuron. Training algorithms like back propagation are used for training the network. Goal of each and every training algorithm is to adjust the weights and biases to reduce global errors. In this research work we used a MLP neural network with 5 hidden layers and with 29 neurons at input that resembles 29 features extracted.
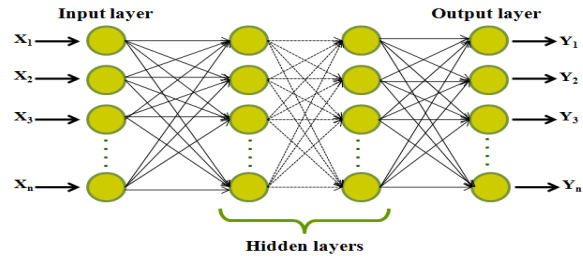

**Fig. 6. Multilayer perceptron neural network**

Neuro-Fuzzy classification network: Classification problem has been faced by many different systems. Neural networks, Fuzzy and neuro fuzzy systems are widely used as classifiers in some areas of computational intelligence. Artificial neural network and fuzzy logic combines to form Neuro-Fuzzy system in the field of artificial intelligence. In this system some criterion optimization is done by choosing some membership function to design the fuzzy system. Initially the fuzzy system structure is specified after where some parameters are free to change which will be determined according to the input-output pairs[15].

RESULT ANALYSIS
In Figure 6. Output of various stages of preprocessing is shown. Those are input image, gray scale image, enhanced image, binary image, binary image filtered with area open function.
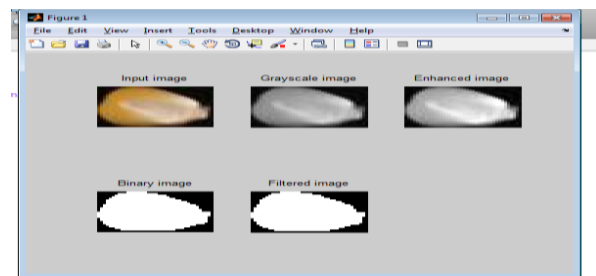
**Fig. 7. Output of various stages of image preprocessing**
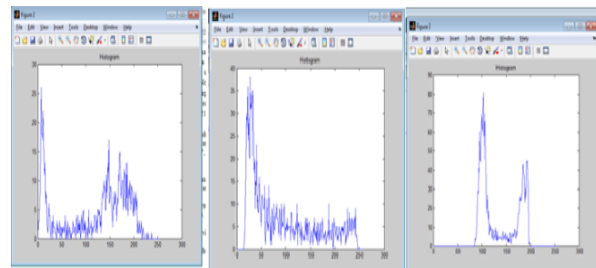
Fig. 8. Histogram of corn, wheat and Rice respectively

Fig.7 shows the variation of peak related to various seed varieties. These values are related to the variation of neighbor pixels. And we can see both pattern and peak variation in the above figures.Here X axis represents the event whose frequency have to be count. And Y axis represents the frequency.

For wheat the maximum peak is in the range of 35-40 Hz. Average frequency lies in the range of 12-18 Hz. For Rice maximum peak lies in the range of 70-80 Hz. Average frequency lies in the range of 30-40 Hz. And for corn maximum peak lies in the range of 45-50 Hz. Average frequency lies in the range of 15-20 Hz Hz.

Table 1. Features of seed extracted

S.no	Parameter	Value
1.	Aspectratio	1.5382
2.	Seed Area	736
3.	Convex Area	758
4.	Equivalent Diameter	30.6122
5.	Eccentricity	0.7598
6.	Extent	0.7548
7.	Filled Area	736
8.	CMAL	38.3265
9.	COV	1.0702e+07
10.	Solidity	0.9709
11.	Circular ratio	9.4021
12.	Circularity	0.2064
13.	Minor axis length	24.9171
14.	Compactness	15.2204
15.	Convexratio	0.0290
16.	perimeter	1.0584e+02
17.	Ellipseratio	0.2453
18.	Elongation	0.6501
19.	Round	15.2204
20.	Roundnessratio	0.8256
21.	StandardDeviation	24.4131
22.	Shapefactor1	1.9958
23.	Shapefactor2	0.0130
24.	Shapefactor3	6.2963
25.	Shapefactor4	0.0405
26.	kurtosis	1.4747
27.	mean	1.3722e+02
28.	median	181
29.	moment	3.3230e+15
30.	Skewness	0.9530
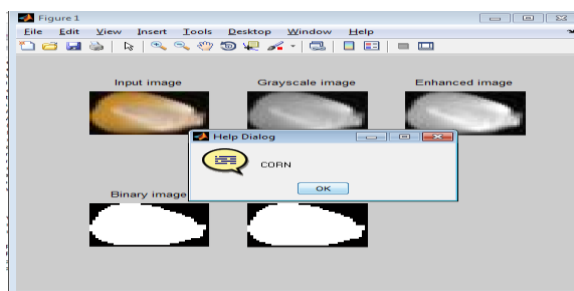
Fig. 9. Classified result

In Figure 8. Final classification of grain variety is shown. Classification has been done among three grain varieties namely Wheat, Rice and corn. Various features have been extracted for classification purpose and extracted features are shown in figure 7. Then classification done by MLP neural network.

CONCLUSION

Finally grain images have been classified with multiple features like spatial, color, texture, morphological and statistical features extracted using multiple formulations. And classification is done through Multi-Layer Perceptron neural network and neuro-fuzzy network. Through this method we have classified three grains and an accuracy of 97% has been achieved. Further this method can be enhanced to spectral feature extraction and including in classification.

REFERENCES
1. N. Pandey, S. Krishna and S. Sharma, "Automatic Seed Classification by Shape and Color Features using Machine Vision Technology", International Journal of Computer Applications Technology and Research, Vol. 2, Issue 2, 2013, pp. 208 – 213.
2. Melchinger, Albrecht E., et al. "In vivo haploid induction in maize: identification of haploid seeds by their oil content." Crop Science54.4 (2014): 1497-1504.
3. N. Vapnik, "The nature of statistical learning theory," New York: Springer Verlag, 1995.
4. Smelser, A., M. Blanco, T. Lubberstedt, A. Schechert, A. Vanous, and C. Gardner, 2015: Weighing in on a method to discriminate maize haploid from hybrid seed. Plant Breed. 134, 283—285.
5. Chaikam V, Boddupalli MP (2012). Double Haploid Technology in Maize Breeding: Theory and Practise. CIMMYT, Mexico, pp. 20-23.
6. Katerina NOVOTNA, Jan VRBA'" New Methods For Treatment Of Atherosclerosis" in Proceedings of IEEE International Conference on Image Processing, 2008.
7. Sree Hari Rao, Senior Member, IEEE, and M. Naresh Kumar," Novel Approaches for Predicting Risk Factors of Atherosclerosis" in ieee journal of biomedical and health informatics, vol. 17, no. 1, January 2013.
8. Gang Liu, Li Yao, Xiaojie Zhao," Optimization of Image Preprocessing for Diffusion Tensor Magnetic Resonance Imaging" in proceedings of IEEE 2010 Sixth International Conference on Natural Computation (ICNC 2010).
9. Olivier salvado, claudiahillenbrand, shaoxiangzhang, and david. Wilson" Method To Correct Intensity Inhomogeneity In Mr Images For Atherosclerosis Characterization", in IEEE transactions on medical imaging, vol. 25, no. 5, may 2006
10. Suhas.S, C R Venugopal," MRI Image preprocessing and Noise removal technique using linear and nonlinear filters", in 2017 International Conference on Electrical, Electronics, Communication, Computer and Optimization Techniques (ICEECCOT)
11. Comaniciu and P. Meer, "Mean shift: A robust approach toward feature space analysis," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 24, no. 5, pp. 1-18, 2002.
12. Pazoki, A.R. and Z. Pazoki, 2011. Classification system for rain fed wheat grain cultivars using artificial neural network. African J. Biotechnol., 10(41):8031-8038.
13. G.Suseendran, E.Chandrasekaran "Interference Reduction Technique in Mobile Adhoc Networks Using Mathematical Prediction Filters, International Journal of Computer Applications, Vol. 60(6), December 2012. pp-9-16
14. Vo, Nam Xuan, Trung Quang Vo, Ha Thi Song Nguyen, and Thuy Van Ha. "The Economic Evaluation in Vaccines - A Systematic Review in Vietnam Situation." Systematic Reviews in Pharmacy 9.1 (2018), 1-5. Print. doi:10.5530/srp.2018.1.1