Journal of Advances in Computer Research
Quarterly pISSN: 2345-606x eISSN: 2345-6078
Sari Branch, Islamic Azad University, Sari, I.R.Iran
(Vol. 7, No. 2, May 2016), Pages: 41-52
www.jacr.iausari.ac.ir

To Present Method for Rice Variety Identification with Fuzzy-imperialist Competitive Algorithm

Zeinab Faraji, Farhad Ramezani✉**, Homayun Motameni**
Department of Computer Engineering, Sari Branch, Islamic Azad University, Sari, Iran
zeinab.faraji84@gmail.com; farhad.ramezani@iausari.ac.ir; motameni@iausari.ac.ir

Received: 2015/02/22; Accepted: 2015/09/19

Abstract

Digital image processing in recent decades has made considerable progress in theoretical and practical aspects. Nowadays, machine vision techniques have important application in the field of agriculture. One of these applications is detection of different varieties of rice from the bulk sample of rice image. These techniques also have high speed, accuracy and reliability. Texture feature selection is one of the important characteristics used in pattern recognition. The better feature selection of a feature set usually results in better performance in a classification problem. In This work we try to extract features by using co_occurrence matrix and select the best feature set for classification of rice varieties based on image of bulk samples using hybrid algorithm which is called "fuzzy_ imperialist competition" and then classify the best features using support vector machine(SVM). Results of the proposed method showed, the classification accuracy is improved to 96/79%. The feature set which is selected by the fuzzy-Ica provides the better classification performance compared to that obtained by Imperialist competition algorithm.

Keywords: *Fuzzy-Imperialist Competition Algorithm, Texture Feature, Co_Occurrence Matrix, Support Vector Machine*

1. Introduction

Digital image processing has made considerable progress in theoretical and practical aspects in recent decades. One of the applications of digital image processing is in agriculture and food industry. people's request for providing high-quality products of rice, caused researchers to use image processing techniques on the rice images to improve precision and speed of identification of rice varieties. In This work we try to extract features with co-occurrence matrix and select the best feature set for classification of rice varieties based on image of bulk samples using hybrid algorithm which is called “fuzzy_ imperialist competition” and then classify the best features by using support vector machine(SVM).

faraji et al., [1] used SVM to classify rice samples on RGB model. First they extracted 44 texture features in each RGB channel such as: red, green and blue. Then they combined features in two channel (blue and green) that had best classification rate and classified rice samples with 88 features. Also they used from Gabor filter in preprocessing level and then extract feature and classify them that increase accuracy rate. Liu [2] used color and shape features to classify the rice grains by neural network. Verma [3] developed a neural network to classify three varieties of Indian rice based on a feature set containing six morphological features with accuracy ranging from 90 to 95% . Pabamalie et al., [4] extracted color features from rice varieties images and used neural network, to classify these features. Akhlaghian Tab et al. [5] first selected best features using KNN algorithm, then classified the ten selected features in five variety of Iranian rice, by support vector machine. In the same year, Mousavi Rad et al. [6] extracted 11 texture features of bulk sample of Iranian rice using co-occurrence matrix in four angles (0, 45, 90, 135) and then used imperialist competitive algorithm to selected the best features. Finally they classified rice samples with the 21 selected features using SVM with accuracy of 95.14%. Akhlaghian Tab et al. [7] used neural network to evaluate six morphological features to classify rice image. Mousavi rad et al., [8] selected 12 textural features from rice grain, then they used backward and forward algorithm to select the best features. They classified selected features by 3-layers neural network and made a comparison between the recognition result of support vector machine and neural network classifiers. Also Mousavi rad et al. [10] compared the classification based on the best features which were selected from imperialist competition algorithm with other methods were discussed above. Mousavi rad et al. (2011) [11] extracted the best colored textural features of rice and classified rice variety using a neural network. In the same year Mousavi rad et al. [12] classified rice samples by using morphological features and support vector machine. In a same work, Mousavi rad et al. [13] proposed a new method for detection of rice variety which uses morphological characteristics. First they extracted 18 morphological features from rice grain and selected six best features, then compared result of error rate in branch and bound, SFS, SBS and plus-1-takeaway-r algorithm. Haralick et al. [15] describes some easily computable textural feature based on gray tone spatial dependencies, and illustrates their application in category identification tasks of three different kinds of image data .they used two kind of decision rules one for a piecewise linear decision rules and another rules for a min-max decision rules. Alam et al, [16] try to optimize the numerical computation of the Haralick texture features which are used in many different applications. They made an attempt to optimize the code using a divide & conquer strategy where individual processors calculated the co-occurrence matrix and communicated with other processors by sending respective results. After the final co-occurrence matrix was formed, they attempted to optimize the feature calculations by eliminating redundancies from the code. With these optimizations in the co-occurrence construction step and in the feature calculation step, the overall runtime was reduced by 58% in case of two worker processors.

Since the elimination of redundant features and selection of the appropriate features have major role in enhancing the detection rate, in this paper, we tried to obtain the best feature set to classify the four variety of rice, by optimizing imperialist competitive algorithm using fuzzy logic. At first we extract 44 features from co-occurrence matrix (same as [5]) and then, select the 24 best features using proposed method “fuzzy_ica” algorithm and finally classify selected features with multi class SVM.

The aim of our purposed method is achieving the best classification rate of bulk samples of four kind of Iranian rice.

The main advantage of propose method is selection of the best feature set for classification.

Schema of the proposed method is shown in Figure 1.

Figure 1. Schema of the proposed method

The rest of this paper is organized as follows:

In Section 2 first we review briefly feature extraction using co-occurrence matrix, second we propose our method and describe it in detail. In Section 3, the classification using support vector machine is presented. In section 4 the results of the implementation of this paper is presented. Conclusions are made in section 5.

2. Proposed Method

A co_occurrence matrix is a square matrix that elements represent the relative frequency occurrence of pair gray values within a certain distance and determined direction. The Grey Level Co-occurrence Matrix defined by Haralick is a square matrix G of order N, where the (i, j)th entry of G represents the number of occasions a pixel with intensity i is adjacent to a pixel with intensity j. The normalized co-occurrence matrix is obtained by dividing each element of G by the total number of co-occurrence pairs in G. The adjacency can be defined to take place in each of the four directions (horizontal, vertical, left and right diagonal) as shown in figure2. The Haralick texture features [16] are calculated for each of these directions of adjacency.

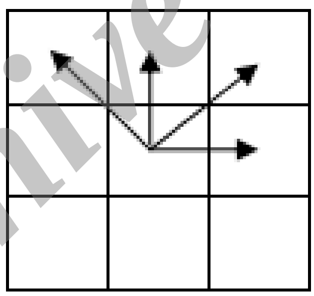

Figure 2. The four directions of adjacency for calculating the Haralick texture features

The texture features are calculated by averaging over the four directional co-occurrence matrices. To extend these concepts to n-dimensional Euclidean space, we precisely define gray scale images in n-dimensional space and the above mentioned directions of adjacency in n-dimensional images. Image of rice varieties using in this paper is show in figure 3[5, 6].

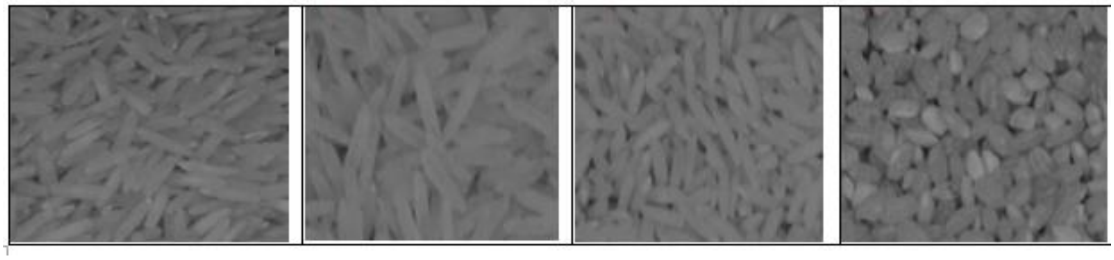

Figure 3. Image of rice varieties (left to right: Fajr, Hashemi, Mahali, Gerde)

2.1. feature extraction: co-occurrence matrix

Using the normalized GLCM, similar to [5-6] the following textural features are extracted

1. Maximum Probability

$$Max(pij) \qquad (1)$$

2. Correlation: this shows how a pixel is correlated to its neighbor over the entire image.

$$\sum_{i=1}^{k}\sum_{j=1}^{k}(i-j)^2\left(p_{ij}\right) \qquad (2)$$

3. Contrast: this measures contrast between a pixel and its neighbor

$$\sum_{i=1}^{k}\sum_{j=1}^{k}(i-j)^2\left(p_{ij}\right) \qquad (3)$$

4. Uniformity(Energy)

$$\sum_{i=1}^{k}\sum_{j=1}^{k}(p_{ij})^2 \qquad (4)$$

5. Entropy: this measures randomness of a GLCM element.

$$\sum_{i=1}^{k}\sum_{j=1}^{k}(p_{ij})\log(p_{ij}) \qquad (5)$$

6. Homogeneity: this measures the closeness of the distribution of elements in the GLCM.

$$\sum_{i=1}^{k}\sum_{j=1}^{k}\frac{p_{ij}}{1+|i-j|} \qquad (6)$$

7. Dissimilarity

$$\sum_{i=1}^{k}\sum_{j=1}^{k}p_{ij}\,|i-j| \qquad (7)$$

8. Mean

$$\mu_i \sum_{i=1}^{k}\sum_{j=1}^{k} i(p_{ij}) \quad (8)$$

$$\mu_j \sum_{i=1}^{k}\sum_{j=1}^{k} j(p_{ij}) \quad (9)$$

9. Cluster shade (CS) and cluster prominence (CP): CS and CP are measure the skewness of the matrix, in other words the lock of symmetry. When CS and CP are high, the image is not symmetric. In addition, when CP is low, there is a peak in the co-occurrence matrix around the mean value. For the image, this means that there is a little variation in gray scales.

$$cs = \sum_{i=1}^{k}\sum_{j=1}^{k}((i-\mu_i)+(j-\mu_j))^3(p_{ij}) \quad (10)$$

$$cp = \sum_{i=1}^{k}\sum_{j=1}^{k}((i-\mu_i)+(j-\mu_j))^4(p_{ij}) \quad (11)$$

So, 44 features (11 features × 4 orientations) are extracted. After completing the feature extraction step, outputs are normalized to the range of 0 to 1.

2.2. Propose method: Fuzzy – ICA Algorithm

Imperialist competitive algorithm is a new method in evolutionary computation field, which is found optimal solutions of optimization problems. In recent years, ICA has emerged as a new, evolutionary algorithm, and it has been applied to obtain optimal solutions in various applications. The algorithm begins with a random initial population and objective function which is computed for them. The most powerful countries are selected as imperialists and the other are colonies. Next, competition between imperialists takes place to obtain more colonies. The best imperialist has greater chances of possessing the most colonies. To improve the convergence velocity and precision of ICA in the colonies division step, the standard imperialist competition algorithm was modified as follow: ICA is incorporated to the fuzzy logic controller and is called fuzzy-ica. In our scheme, the proposed method steps are described as below:

Steps 1: generate an initial population

In ICA algorithm, each solution is shown by an array named “country”. In an N dimensional optimization problem, a country is an 1*N array. This array is defined by

$$country = \left[p_1, p_2, \cdots p_j \right] \quad (12)$$

Steps 2: calculate cost function value

The cost function is evaluated for each colony as follows:

The cost value of a country is defined as the classification accuracy of the country. KNN was chosen to compute the cost value of a country. The cost function is determined as follows [6]:

$$\cos t = \frac{number.of.correctly.classified.samples}{total.number.of.samples} \qquad (13)$$

The algorithm starts randomly with Npop initial countries in the population size, and the best of them, Nimp, is chosen as the imperialist. The remaining population Ncol will be the colonies each of which belongs to an empire. The colonies are distributed among imperialists based on the “fuzzy logic”.

Step 3: sort the initial population according to objective function value.
Step 4: select the imperialist state.
Step 5: calculate colonies for each imperialists.
In this paper for calculating the colony of every imperialism, first, we calculate the cost of every imperialist and then we use FIS with features as below:

1. Name = ica_evalfis
2. Type = mamdani
3. Version = 2.0
4. Number of Inputs = 3
5. Number of Outputs = 1
6. Number of Rules = 18
7. And Method = min
8. Or Method = max
9. Imp Method = min
10. Aggregation Method = max
11. Defuzzification Method = mom

Our FIS is designed with 3 inputs and 1 output as below:
Input 1: number of colony [0 180].
Input 2: cost of colony [0.75 0.85].
Input 3: number of imperialist [1 20].
Output: number of colony for each imperialist [5 15].
if number of exist colony is among 0-180 and cost of i(th) colony is among 0.75 0.85 and number of exist imperialist is among 0-20 then calculate number of colony for i(th) imperialist among [5 15].

Membership functions Diagram for each input and output are shown in figure 4.

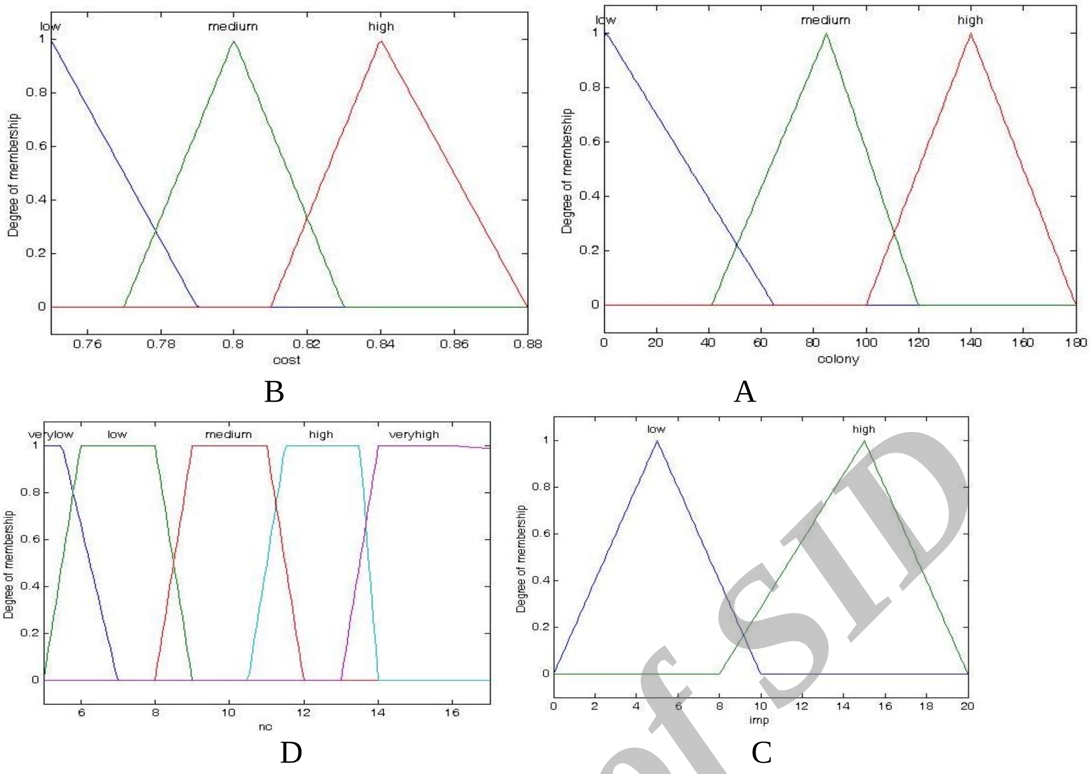

Figure 4. A: membership functions Diagram for input1, B: membership functions Diagram for input2, C: membership functions Diagram for input3 and D: membership functions Diagram for output

In this paper we had used MOM (mean of max) Method for defuzzification.

Step 6: Assimilation

In this paper assimilation step similar to the original version of imperialist competition algorithm operates on continues problems. Imperialist countries start by improving their colonies. Move colonies toward their imperialist state based on Euclidean distance.

Step 7: Revolution

The revolution increases the exploration of the algorithm and prevents the early convergence of countries to local minimum. In each iteration, for every colony a random number which is varying between 0 and one is generated. Then this value is compared with probability of revolution rate. If random number is lower than probability revolution rate, the revolution is performed. The new colony will be replaced with previous colony while its cost is improved.

Step 8: run imperialistic competition.

Step 9: remove the weakest empire.

Step 10: inspect the number of imperialist: if it is 1 then go to step 6.

Figure 5 shows the comparison of the proposed method with two other methods in calculating colony for each empire.

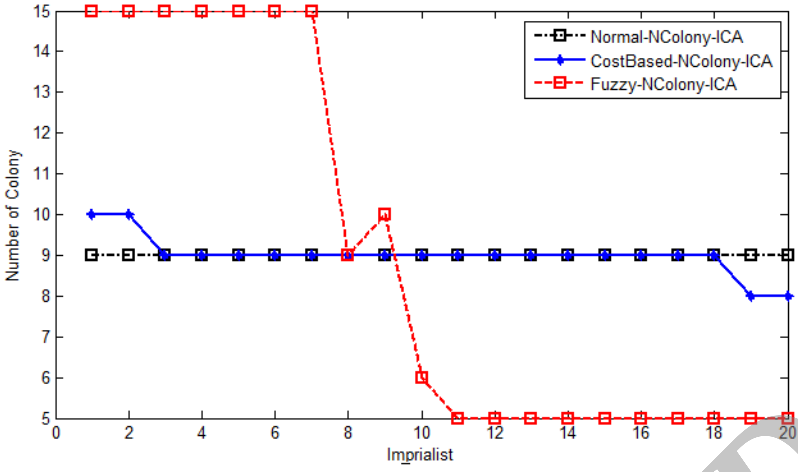

Figure 5. The comparison of proposed method with two other methods in calculating colony for each imperialist

This division for colony, increased identification rate of rice sample from 90/92 to 96/79. The pseudo code of the proposed algorithm is shown in fuzzy_ica Algorithm.

Table 1. The pseudo code of the proposed algorithm

```
fuzzy_ica Algorithm
Generate an initial population
Calculate the cost function for initial population
Sort initial population based on the cost function values
Select imperialist state
Divide colonies among imperialist using fuzzy min-max
while number of empire is among low and high do
    select i^th empire
    while cost of empire is  among low, medium and high do
      while number of colony is among low, medium and high do
         move colony to each empire using FIS ( if then rules)
      {
         if number of  exist colony among 0-180   then
             if cost of i^th colony among 0.75 0.85  then
                 if number of exist imperialist among 0-20 then
                     Calculate number of colony for i^th imperialist among [5 15].
                 end if
             end if
         end if
        }
    else Break
      End while
         Calculate cost function value for new population
         Compare and select the best one
     End while
All colonies based on their cost function
Check cost of all colonies in each empire
```

```
 If there is a colony which has lower cost than its imperialist then
  Exchange the position of the colony and the imperialist
 End if
Update the position of the ith empire
Calculate total cost of empire
Fined the weakest empire
Give one of its colony to the winner empire
Check the number of colony in each empire
 If there is an empire without colony then
  Remove the empire and gives its imperialist to the best empire
 End if
End while
```

3. Experiments

To show the performance of proposed fuzzy-ICA based feature selection algorithm, we compared it with ICA based feature selection. The results showed that the best performance is achieved when parameters are tuned as shown as follows:

- Number of population: 200
- Number of imperialist: 20
- Max Decades: 200
- Revolution rate: 0.3
- Zeta: 0.1

Totally, 24 features were selected as the superior ones, the selected features are:

1. Maximum probability at direction 0, 90 and 135 deg.
2. Homogeneity at direction 90 deg.
3. Correlation at direction 0, 45, and 90 deg.
4. Uniformity at direction 0, and 90 deg.
5. Dissimilarity at direction 0, 45 and 135 deg.
6. Contrast at 45, 90, and 135 deg.
7. Entropy at direction 90 deg.
8. I_{mean} at direction 0, 45, 90 and 135 deg.
9. j_{mean} at direction 90 and 135 deg.
10. Cluster performance at direction 0, and 90 deg.

4. Classification: Support Vector Machine

A Support Vector Machine is a new supervised learning method that is used for classification and regression. SVM is a discriminative classifier formally defined by a separating hyper plane. The basic idea behind this technique is that two classes are linearly separable. Actually, there are more than one hyper plane for satisfying this condition, and one of them is chosen as classifier on the basis of the margin it creates between the two classes. Support vectors are points that are on maximum margin hyper plane. SVMs can be used for classifying data that is not linearly separable. The data space is transformed using kernel function into a higher dimensional space where classes become linearly separable. In this paper we use leave one out of cross validation multi class _SVM with Quadratic kernel function.

The obtained results indicate the high performance of the proposed algorithm to find superior features leads to high classification accuracy. The comparison of the results of proposed method with other methods is shown in table 2.

Table 2. Comparison result of proposed method with other methods

Kind Of Rice	All feature Genetic algorithm[5]	Ica[5]	All feature [4]	Color features (green +blue channels) [1]	Fuzzy_Ica Color features	Fuzzy-Ica
Fajr	89.12	90.01	88.89	96.65	97.37	98.68
Gerde	84.62	83.88	100	96.77	97.85	100
Hashemi	98.89	98.89	94.44	94.87	92.03	93.59
Mahali	—	—	93.33	97.44	98.72	94.87
Total accuracy	**90.87**	**90.92**	**94.16**	**96.28**	**96.49**	**96.79**

Results show that using fuzzy_ica to feature selection improves rate accuracy of rice variety. The implementation of this paper is done by using MATLAB (2012 a) on dataset [5, 6].

5. Conclusion and Future Work

In this paper, a new optimal feature selection technique based on hybrid imperialist competition algorithm was proposed. The performance of our proposed method was evaluated in classification of bulk rice samples. In this method we used fuzzy logic to calculate number of colony for each empire. Using fuzzy logic to divide colony for each empire makes a better performance than the boltzman action selection strategy which considers all possible actions during the exploration. It may choose the worst performing action to assign colonies to imperialist. Since the fuzzy set adapts to the action selection strategy to adjust its rules in order to avoid possible fault of worst imperialist selection.

In future work we try to use fuzzy logic in other steps of ICA algorithm such as assimilation step to improve accuracy of this algorithm in feature selection. Also we try to use fuzzy logic in classification step.

References

[1] Z. faraji, F. ramezani, H. motameni, " , To Present Method for Rice Variety Identification with color texture features," The Second National Conference on Computer Science, Information Technology. Iran, Tehran, February, 2015,[In Persian].

[2] Z. Liu, F. Cheng, Y. Ying, and X. Rao" ,Identification of rice seed varieties using neural network," Journal of Zhejiang University. Science .B, vol. 6, p. 1095, 2005.

[3] Verma, B. "Image processing techniques for grading & classification of rice". International conferences on computer and communication technology. India, 2010.

[4] L. Pabamalie and H. Premaratne, "An intelligent rice quality classifier," International Journal of Internet Technology and Secured Transactions, vol. 3, pp. 386-406, 2011.

[5] F. Akhlaghian Tab. S.J. . Mousavirad, K. Mollazade, "Identification of Rice Varieties Using Co-occurence Matrix Features of Bulk Samples and Support Vector Machine," presented at the 20th Iranian Conference on Electrical Engineering, University of Tehran, Tehran, Iran, 2012.

[6] S.J. Mousavi Rad, F. Akhlaghian Tab, K. Mollazade, " Application of Imperialist Competition Algorithm for Feature Selection: A Case Study On Rice Classification", International Journal of Computer Application, Vol. 40, No.16, 2012.

[7] F.Akhlaghian Tab. S.J. Mousavirad, K. Mollazade, "Real Time Identification of Rice Varieties Using Texture Features Based on Classifier Fusion Method," in the 16th CSI International Symposium on Artificial Intelligence and Signal Processing, Shiraz University, Iran, 2012.

[8] S.J. Mousavi Rad, F.Akhlaghian Tab, K.Mollazade, "Comparison of Neural Networks and Support Vector Machines using Texture features on Rice classification", The first conferences on computer and information technology, Tabriz University, Iran, 2011,[In Persian].

[9] S.J. Mousavirad, H. Ebrahimpour, Feature selection using modified Imperialist Competitive Algorithm, International Conference on Computer and Knowledge Engineering, Ferdowsi University of Mashhad, Mashhad, Iran, 2013.

[10] S. J. MousaviRad,F. Akhlaghian Tab, K. Mollazade, "Classification of rice varieties using optimal color and texture features and BP Neural Network," presented at the The 7th Iranian Conference on Machine Vision and Image Processing, Iran University of Science and Technology, 2011.

[11] S.J. Mousavi Rad, F. Akhlaghian Tab, K. Mollazade," Classification of rice varieties using morphological features and support vector machines",20th National Food science & industries congress, Sharif University, Iran,2011.

[12] S.J. Mousavi Rad, KH. rezaei, K. Nasri, "A new method for identification of rice iranian rice kernel varieties using optimal morphological features and an ensemble classifier by image processing", Majlesi Journal of Multimedia Processing, Vol. 1, No. 3, 2012.

[13] S.J. Mousavi Rad, F. Akhlaghian Tab, K. Mollazade, " Design of an Expert System for Rice Kernel Identification using Optimal Morphological Features and Back Propagation Neural Network" ,International Journal of Applied Informatics Systems, Vol. 3, No. 2012.

[14] S.J. Mousavi Rad, F. Akhlaghian Tab, "Design of an expert system for rice purity detection using combination of texture features of bulk samples", "Iranian journal of machine vision and image processing",2012.

[15] R. M. Haralick, K. Shanmugam, I. Dinstein, " Textural Features for image classification", IEEE transactions on systems, man and cybernetics vol.smc-3, No.6, pp.610-621,1973.

[16] F. I. Alam, R. U. Faruqui, "Optimized Calculations of Haralick Texture Features", European Journal of Scientific Research, Vol. 50 No. 4, pp. 543-553, 2011.

[17] N. VG, H. K S. " Quality inspection and Grading of Agricultural and food product by computer vision," international journal of computer applications, vol. 2,pp43-65, 2010

[18] H. K, Baljitsingh. "classification and grading rice using multi-class SVM," international journal of scientific and research publications, vol.3 ,2013.

[19] J. singhaulakh, Dr.v.k. banga. "percentage purity of rice samples by image processing," international conference on trend in electrical, electronics and power engineering ,2012.

[20] M. Jinorose, S. Prachayawarakorn, and S. Soponronnarit, "Development of a computer vision system and novel evaluation criteria to characterize color and appearance of rice," Drying Technology, vol. 28, pp. 1118-1124, 2010.

[21] SergiosTheodoridis, K.K., Pattern Recognition, ed. t. Edition. 2008.

[22] A. MohammadZadehJasour, E.AtashpazGargari, Caro Lucas. "Vehicle Fuzzy Controller Design Using Imperialist Competitive Algorithm ,"Control and Intelligent Processing Centre of

Excellence, Electrical and Computer Engineering School of University of Tehran, Tehran, Iran 2008.

[23] E.AtashpazGargari. and C. Lucas, "Imperialist Competitive Algorithm: An algorithm for optimization inspired by imperialistic competition", IEEE Congress on Evolutionary Computation, Singapore, 2008.

[24] E. Biabangard-Oskouyi,. E.AtashpazGargari, N. Soltani, C. Lucas, "Materials Property Characterization from Spherical Indentation Test using Colonial Competitive Algorithm", submitted to Actamateria, 2008.