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Recognition of Foreign Bodies for Grading of Food Grains using Machine Learning Techniques

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***Abstract*—Farmers sell food grains in market, which is usually assessed by visual inspection by food inspectors is a tedious and time consuming task. In this context, there is a dire need for development of automated system for grading of food grains. In this paper, work is carried out for recognition of foreign bodies (stone, stick, broken grain and worm) in food grain images which is supported by both window and android OS. The proposed mobile app recognizes foreign bodies in food grain images using Back Propagation Network (BPN). Outcome of the proposed work is displayed in the form of pie chart showing the relative percentage of foreign bodies (if any) and food grains in the input image. The developed automated system can be used by the robots for automated food grain assessment, automated sowing, wherein the robot can identify, grade, recognize foreign bodies in food grains.**

***Index Terms*— Food grain, Back Propagation Network, Foreign bodies, grading, image processing.**

I. INTRODUCTION

The percentage of external bodies/foreign bodies decides pureness of the food grains. Detection of foreign bodies in food grains helps the farmer to get higher cost and also it aids in preserving quality of the grain. Detection of foreign bodies also helps the buyer to get good quality of food grains at reasonable price. Natural sources of external bodies in food grains include: stick, stone, broken grains and worms. In addition, external material can also include: small pieces of metals, glass pieces, and plastic as a result of packaging material. Hence, in this context, there is a need for an automated system for recognition of external bodies in food grains to ensure save food products to the consumer [1-4].

This paper presents an automated system (supporting both windows and android OS) for recognition of external bodies in food grains using various machine learning algorithms: BPN, Support Vector Machine (SVM), Decision Tree (DT), Bayes Net (BN) and K-Nearest Neighbor (K-NN). The quality of the food grain will not only serve the farmers about the price but also help customer to get good quality food grains. The developed automated system can be used by the robots for automated food grain assessment, automated sowing, wherein the robot can identify, grade, recognize foreign bodies in food grains. In this paper, proportion of four external

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bodies like stick, stone, broken and worms are recognized and presented in the form of pie chart.
The remaining paper is presented as follows: the related work is explained in section II followed by proposed work in section III. Results and discussions are elaborated in section IV and finally conclusions are briefed in section V.

II. RELATED WORK

Authors Dayanand Savakar[5] and Robert Singh[6] presented recognition and classification of similar looking food grain images, where color and texture features were extracted. BPN is used for classification of food grains. Jagadeesh D. Pujari.et al.,[7], proposed a recognition and classification of normal and affected agriculture produce using reduced color and texture features. Relevant color and texture features are selected using threshold value and classified using BPN classifier. Classification accuracy of both agriculture produce increased after feature reduction. HAN Zhong-zhi et al., [8], defined a process for identifying peanut quality like normal, rubbing injury and damaged in the skin, cut-damage, mildew, germination, impurities like stones using BPN classifier. Shape, texture and color features are extracted and relevant features are selected using Particle Swam Optimization (PCA). Robert Singh et al.,[9], proposed a method for classification of eight different categories of rice sample using BPN classifier and compare the result with KNN, linear discriminant and NB classifiers by extracting texture features. Hong Chen et al. [10] , have used color and texture features to distinguish mildewed, stale and normal peanuts. Fourier Transform and Inverse Fourier Transform are implemented to define the shape of peanuts. The outcome shows that, the proposed technique accomplished an accuracy of 93.33% for mildewed and 80.12% for damaged peanuts respectively. Miroljub Mladenovet al. [11] and Minakshi Patil et al., [12], proposed automatic classification of grains by extracting color and shape features.
Neeraj Julka et al., [13] have proposed a system for detection of foreign bodies (black chickpea, straw, chuff, stone) in wheat kernels with texture features extracted using Non-shannon entropies. Experimental results show that, 98.5% classification accuracy obtained using BPN classifier. A mobile app has built by Priyanka S. et al., [14] for grading of wheat (mixed with stick and stone) using SVM and K-NN classifiers based on the shape and color features. Result shows that, accuracy of quality of wheat was between 80-90% using SVM and K-NN classifiers. B. S. Anami [15], et al., have identified foreign bodies (stones, soil lumps, leaves, stems, weed grains) in bulk food grains like, groundnut, rice, wheat, green gram and jawar using BPN by extracting color and texture features. The maximum and minimum food grain classification accuracies are found to be 97% and 85% respectively. Priyankaran Tanck [16] et al., propose grading of basmati rice with Agmark. Rice may contain dust, stone, broken grain or some other impurities , so author used image processing to sort and grade the rice. Machine vision system is used to grade features like length, area and perimeter. Experimental results shows that, 90% classification accuracy obtained using MATLAB. A mobile app has developed by Asha Gowda Karegowda et al.,[17] for grading of 4 types of peanuts using Class Based Association (CBA) based Fuzzy Inference System (FIS) model. The numerical values of shape features of peanut were converted to linguistic terms followed by application of CBA for generating rules which was input as fuzzy rule database. The outcome of peanut grading is displayed in the form of pie chart showing the relative percentage of peanuts of four grades: low, medium, good and fine quality peanuts.
Pushpalatha K.R. et al.,[18], have worked on reduced feature identification using both Genetic algorithm(GA) assisted filter and wrapper approach. Work is carried out using color, texture and morphological features for classification of 6 different food grains. Experimental results proved enhanced performance of all the 6 different classifiers using reduced features identified by both filter and wrapper approach. Pushpalatha K.R. et al.,[19] presents comparative study of similar looking split bulk grams using two major feature extraction methods, Gray Level Co-occurrence Matrix (GLCM) and Gray Level Run Length Matrix (GLRLM). Two feature selection methods namely; Correlation-based Feature Selection (CFS) and consistency-based subset (CSE) evaluator have been applied separately with six different searching methods. The evaluation of significant features selected is done using six different classifiers. Results shows GLCM better compared to GLRLM. Pushpalatha K.R.et al.,[20] used feature selection using filter approach for classification of 10 different similar looking food grains has been carried out. Texture features are extracted and relevant features are selected using (CFS) filter approach with 5 different search methods. Result shows the feature set selected by the CFS filter have certainly enhanced the classification performance of all the 6 classifiers when compared to their performance with the original feature set.

III. Proposed Work

An automated system for detection of foreign bodies in food grains (stick, stone, broken and worms) is carried out using shape and texture features given as input to five different classifiers: BPN, SVM, DT, BN and K-NN. BPN outperformed among the various classifiers attempted and the output of the present work presented in the form of pie chart showing relative percentage of foreign bodies and food grains. The proposed work runs on both windows and android OS. Flow of the proposed work of automated recognition of foreign bodies in food grains is shown in Fig. 1. Input images are converted to binary image followed by segmentation using canny edge detection. After segmentation, 21 GLCM texture features extracted from food grain images. In addition, 7 shape features extracted namely: Area, Major axis, Minor axis, Perimeter, Convex Area, Solidity and Extent from food grain images. Grading of food grains is done using five different classifiers: BPN, KNN, DT, BN and SVM. All features extracted need not be significant for classification task. Hence significant features are extracted using Filter Approach with CFS subset evaluator and with Best First Search (BFS), Linear Forward Search (LFS) and Greedy Step Wise (GSW) Search Techniques. In addition, GA was used as search technique with CFS as subset evaluator. The results of the grading are shown in the form of pie chart depicting the relative percentage of foreign bodies and food grains.

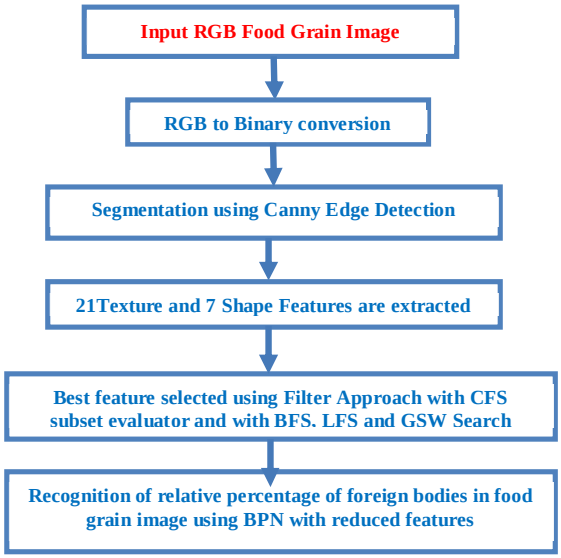


Figure 1 Proposed work flow diagram for recognition of foreign bodies in food grains

IV. Results and Discussions

A Total of around 100 food grain images mixed with foreign bodies are acquired with a digital camera. The different food grain images of varying percentage of foreign bodies with no overlapping are considered for this study as shown in the fig. 2. In the present study, foreign bodies like stick, stone, broken and worms are considered. The input food grain images with foreign bodies (if any) is converted to binary followed by segmentation using canny edge detection. For each of the individual segments (foreign bodies /food grain), 7 shape features and 21 GLCM Texture Features were extracted.

The grading of food grains using five classifiers without filter approach (without feature reduction using 7 shape and 21 GLCM features) is shown in Table I.

Figure 2 Sample food grain images with foreign bodies

TABLE I. COMPARISON OF CLASSIFICATION ACCURACY WITH DIFFERENT CLASSIFIERS

Classifiers	Classification Accuracy in %
BN	72
K-NN	90
DT	87
BPN	91
SVM	84

To improve the performance of the classifiers for detection of foreign bodies, best feature set is selected using filter based feature reduction technique. In this work, as part of filter approach three search techniques BFS, GSW and LFS were used with CFS as subset evaluator for selecting best feature set. It was observed that, all the three search techniques with CFS evaluator selected the same set of 6 relevant features. GA based filter approach was used with CFS as subset evaluator. In this work, traditional search technique perform better compared to bio inspired technique GA based filter approach. From the Table 2, it was observed that, among the five classifiers, BPN classifier (98.5%) performed better using CFS with BFS/GSW/LFS search techniques. The proposed work runs on both the platforms: windows and android OS. The results of proposed work for recognition of foreign bodies are compared with related work and are shown in Table.3.

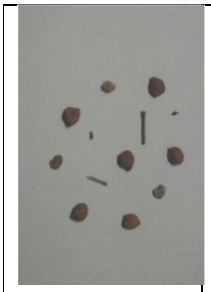
The Sample output with input grain image with and without foreign bodies, the output of classification using confusion matrix and pie chart depicting relative percentage of foreign bodies is depicted in figure 3. The app developed can be easily used by the consumer, food inspector by just uploading the image captured by mobile or using image stored in gallery and get to know the quality of food in form of pie chart showing the relative percentage of foreign bodies and food grain. The snaps of the mobile app is depicted in figures 4 to figure 6.

TABLE II. COMPARISON OF DIFFERENT CLASSIFIERS USING REDUCED FEATURES

Classifiers	Classification Accuracy in % after feature reduction using CFS with BFS/GSW/LFS search	Classification Accuracy in % after feature reduction using CFS with GA search technique
BN	92	89
K-NN	93	90
DT	91	88
BPN	98.5	93.5
SVM	84	82

TABLE III. COMPARATIVE RESULTS OF RECOGNITION OF FOREIGN BODIES BY PROPOSED METHOD WITH RELATED

Reference	Data Set	Feature Extracted	Feature Selection Method	Classifier	Classification Accuracy
Neeraj Julka et al., [13]	Food grains: Wheat, oats, barley, white chickpea foreign bodies: black chickpea, straw, chuff, stone	Non-Shannon entropies	No	NN	NN-98.5%
Priyanka S. Mankoji et al,.[14]	Food grains: Wheat Foreign bodies: sticks and stones	Color and shape features	No	SVM KNN	SVM-87% KNN-81%
B. S. Anami et al.,[15]	Food grains: different food grains Foreign bodies: stones, soil lumps, leaves, stems, weed, grains	Color and Texture Features	No	BPN	BPN:97%
Proposed work	Food grains: Bengal gram and Green gram Foreign bodies :sticks, stones and worms	Shape and Texture Features	CFS subset evaluator with BFS,GSW and LFS search techniques	BN K-NN DT BPN SVM	BN-92% K-NN-92% DT-91% BPN-98.5% SVM-93%

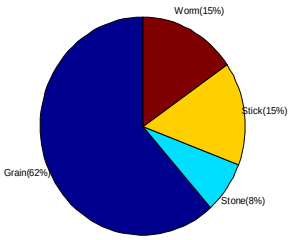


(a)

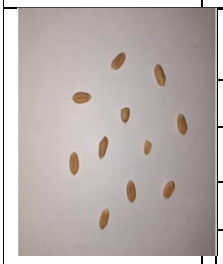
	Grain	Stone	Stick	Worm	Broken	
Grain	6	0	0	0	0	
Stone	2	1	0	0	0	
Stick	0	0	2	0	0	
Worm	0	0	0	2	0	
Broken	0	0	0	0	0	

Classification Accuracy: 85%

(b)



(c)

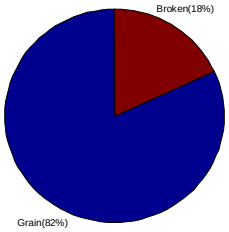


(a)

	Grain	Stone	Stick	Worm	Broken	
Grain	9	0	0	0	0	
Stone	0	0	0	0	0	
Stick	0	0	0	0	0	
Worm	0	0	0	0	0	
Broken	0	0	0	0	2	

Classification Accuracy: 100%

(b)



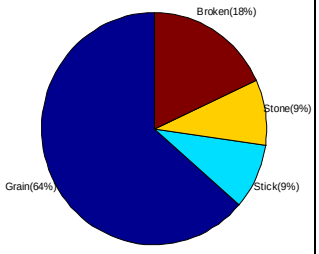
(c)

(a)

	Grain	Stone	Stick	Worm	Broken	
Grain	7	0	0	0	0	
Stone	0	1	0	0	0	
Stick	0	0	1	0	0	
Worm	0	0	0	0	0	
Broken	0	0	0	0	2	

Classification Accuracy: 100%

(b)



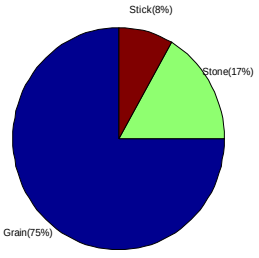
(c)

(a)

	Grain	Stone	Stick	Worm	Broken	
Grain	8	0	0	0	0	
Stone	1	2	0	0	0	
Stick	0	0	1	0	0	
Worm	0	0	0	0	0	
Broken	0	0	0	0	0	

Classification Accuracy: 92%

(b)



(c)

Figure. 3 Sample Output with input image, confusion matrix and pie chart depicting relative percentage of foreign bodies

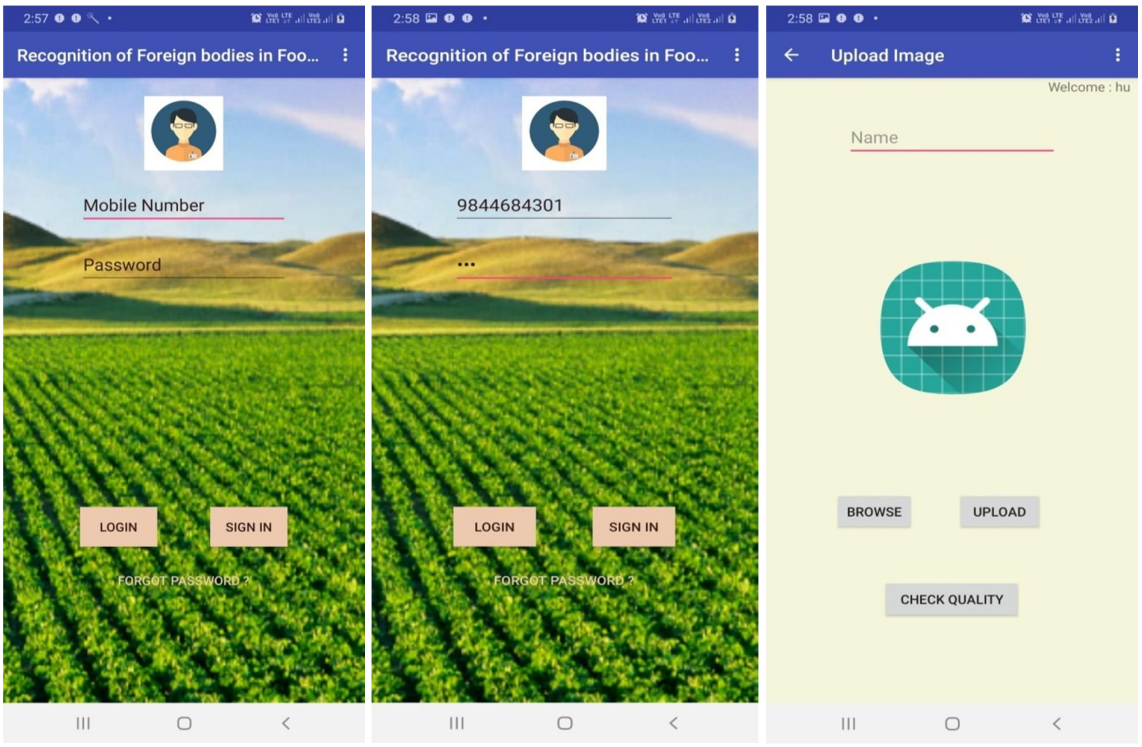


Figure 4 Login and Home Page of mobile app for recognition of foreign bodies in input image

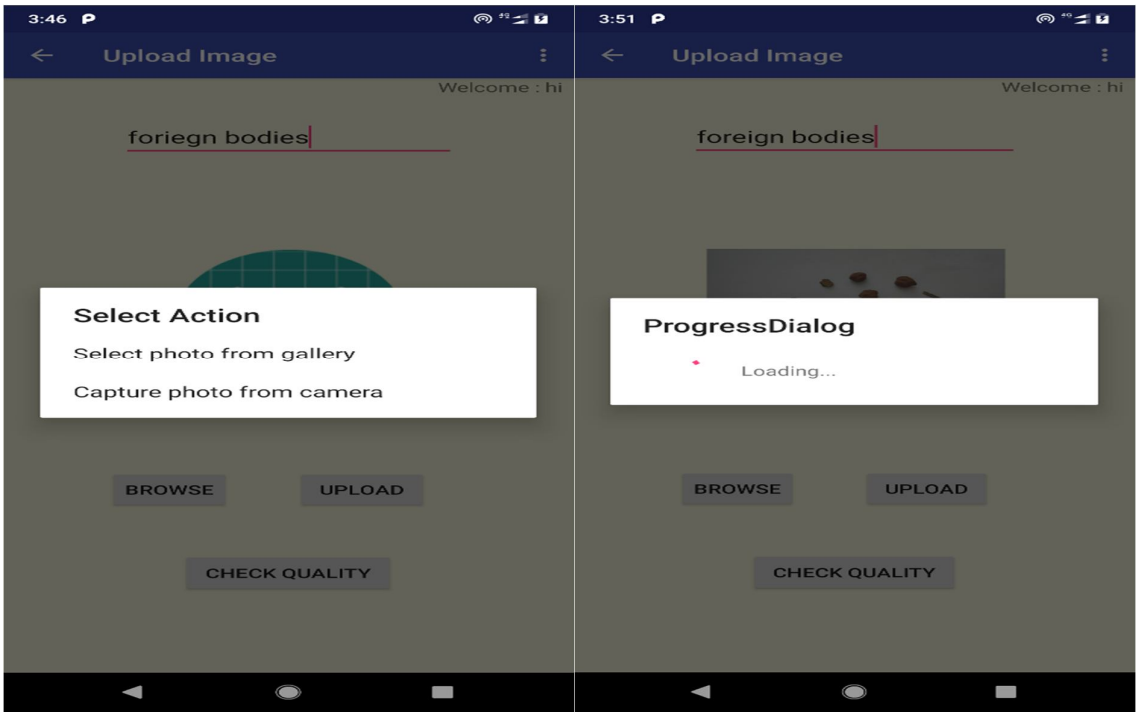


Figure 5 Uploading food grain image either from gallery or captured from mobile camera

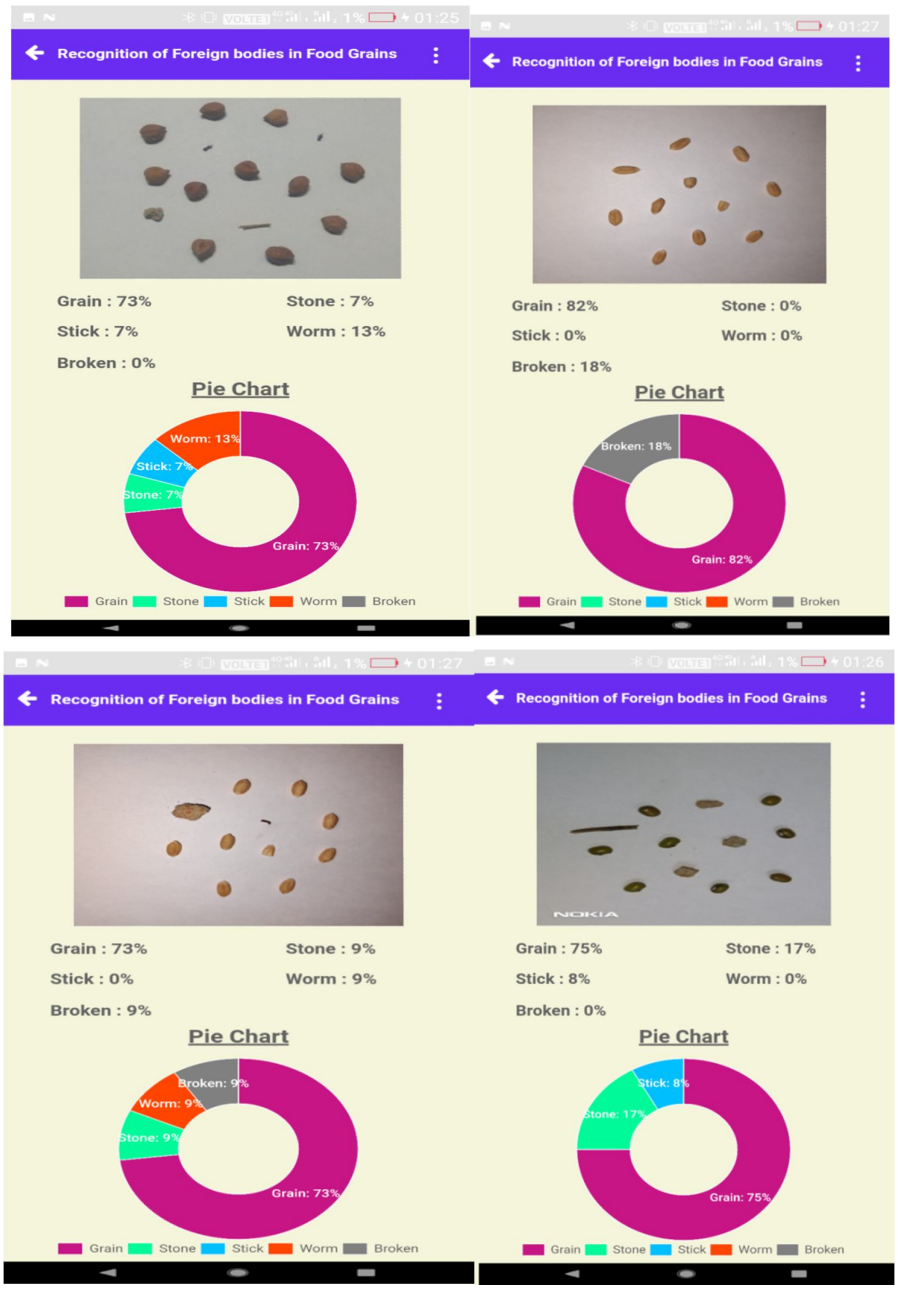


Figure 6 Sample Outcome of proposed work depicting relative percentage of foreign bodies in input image

V. CONCLUSIONS

Work is carried out for recognition of foreign bodies (stone, stick, broken and worm) in food grain images which supports both window and android OS platform. The proposed mobile app, recognizes foreign bodies in food grain images using BPN. The input image is captured using mobile camera or by browsing the image which is already stored in database gallary. Out of 28 features (texture and shape) extracted, the prominent 6 features identified by CFS subset evaluator with three search techniques BFS, GSW and LFS is used for recognition of foreign bodies in food grains. Outcome of the proposed work is displayed in the form of pie chart showing the relative % of foreign bodies and food grains in the input image. It was observed that, for some of the input

images a very small percentage of stone was misclassified as grain and vice versa. Overall the proposed method resulted in an accuracy of 98.5%.

REFERENCES

[1] Gebejes, R. Huertas, "Texture Characterization based on Grey-Level Co-occurrence Matrix", Conference of Informatics and Management Sciences, Page:375-378, ICTIC 2013.

[2] Poornima Dered, Shanmukhappa A. Angadi, "A Versatile Mobile Application for Grading Agriculture Produce: A Prototype implementation for Jowar", International Journal of Recent Trends in Engineering & Research (IJRTER) Volume 02, Issue 09; September – 2016.

[3] Majumdar S, Jayas DS., "Classification of bulk samples of cereal grains using machine vision", Journal of Agricultural Engineering Research, Volume 73, Page:35–47,1999.

[4] Giaime Ginesu, Daniele D. Giusto, Volker Märgner, Peter Meinlschmidt, "Detection of Foreign Bodies in Food by Thermal Image Processing", IEEE Transactions on Industrial Electronics, Volume 51, No. 2, April 2004.

[5] Dayanand Savakar, "Recognition and Classification of Similar Looking Food Grain Images using Artificial Neural Networks", Journal of Applied Computer Science and Mathematics, Volume 13, Issue 6, 2012.

[6] K s h Robert Singh, "Color and Texture Features for Classification of Bulk Grains using Artificial Neural Network", International Journal of New Innovations in Engineering and Technology, Volume 4, Issue 1, Page: 19-25, November 2015.

[7] Jagadeesh D. Pujari, Rajesh Yakkunidimath, Abdulmunaf S. Byadgi, "Recognition and Classification of Normal and Affected Agriculture produce using reduced color and Texture Features", International Journal of Computer Applications, Volume 93, No.11, Page: 17-24, 2014.

[8] HAN Zhong-zhi, ZHAO You-gang, "A Method of Detecting Peanut Cultivars and Quality Based on the Appearance Characteristic Recognition", Second International Conference on Information and Computing Science, Page: 21-24, IEEE Computer Society, 2009.

[9] Ksh Robert Singh, Saurabh Chaudhury, "Comparative analysis of texture feature extraction techniques for rice grain classification", IET Image Processing, Volume 14, Issue 11, Page:2532 - 2540 ,2020.

[10] Hong Chen, Jing Wang, Qiaoxia Yuan ,Peng Wan, "Quality classification of peanuts based on image processing", Journal of Food, Agriculture & Environment ,Volume 9,Page:204-209, 2011.

[11] Miroljub Mladenov, Stanislav Penchev, Martin Dejanov, Metin Mustafa, " Automatic Classification of Grain Sample Elements based on Color and Shape Properties", U.P.B. Sci. Bull., Series C, Volume 73, Issue 4, 2011.

[12] Minakshi Patil, Sneha Pawar, Sushant Sakate, Shardul Joshi, Vidya Sarode, " Grain Detection Using Image Processing", International Journal of Scientific and Engineering Research Volume 9, Issue 3, March 2018.

[13] Neeraj Julka, A. P. Singh, "Detection of Foreign Materials in Wheat Kernels using Regional Texture Descriptors", International Journal of Recent Technology and Engineering (IJRTE) ,Volume 8, Issue 4, November 2019.

[14] Priyanka S. Mankoji, Uttam Patil, "A Versatile Mobile Application for Quality Prediction of Wheat Grain using Machine Learning Algorithms", International Journal of Advanced Research in Computer and Communication, Volume 6, Issue 7, July 2017.

[15] B. S. Anami, D. G. Savakar, "Improved Method for Identification and Classification of Foreign Bodies Mixed Food Grains Image Samples", Artificial Intelligence & Machine Learning Journal, Volume 9, Issue I, Page:1-56, ICGST, Delaware, USA, Feb. 2009.

[16] Priyankaran Tanck, Bipan Kaushal, 2014, " A New Technique of Quality Analysis for Rice Grading for Agmark Standards", International Journal of Innovative Technology and Exploring Engineering (IJITEE)ISSN: 2278-3075, Volume 3, Issue 12, May 2014

[17] Asha Gowda Karegowda, Pushpalatha K. R., Pramod P., "Mobile App for Grading of Peanuts using Fuzzy Inference System", International Journal of Engineering and Advanced Technology (IJEAT), Volume 9, Issue-1, Page:1262-1269, October 2019.

[18] Pushpalatha K. R., Asha Gowda Karegowda, "Enhanced Classification of Bulk Food Grains using Genetic Algorithm assisted Feature Reduction Techniques", 3rd International Conference on Electrical, Electronics, Communication, Computer technologies and Optimization Techniques(ICEECCOT-2018), GSSSIETW, Mysuru, Karnataka, India, 14th &15th December 2018.

[19] Pushpalatha K. R., Asha Gowda Karegowda, "Comparative Study of Classification of Split Bulk Grams using Different Significant, Feature Selection Techniques", International Journal of Applied Research on Information Technology and Computing, Volume ,9, Issue 3, Page:225-237, December 2018.

[20] Pushpalatha K. R., Asha Gowda Karegowda, "CFS Based Feature Subset Selection for Enhancing Classification of Similar Looking Food Grains- A Filter Approach", Second IEEE International Conference on Emerging Computation and Emerging Technologies (ICECIT 2017), Siddaganga Institute of Technology, Tumkur, Karnataka, India, 15th and 16th December 2017.