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Analysis of different Approaches to Grading of Soybean using Image Processing and Neural Network

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Abstract: This review paper presents the recent developments of image processing and machine vision system in an automated soybean grading system. In the field of agricultural, the accuracy and efficiency in grading process is very essential to increase the productivity of the yield. Soybean is cultivated in many regions across India. Soybean is one of the most important crops in Maharashtra. In agriculture field, Process Industries quality estimation and grading of soybean seed is one of the important task. The use of good quality seed is very important for the better production of a good quality crop and is essential for export in markets. Quality control process is very important in food industry, based on quality of food products are classified and graded into different grades. Soybean is primarily graded based on its grain shape, colour, size and texture. It is tedious for people to analyze the grades and quality in the market. The Soybean varieties and their quality are assessed through visual inspection by food quality Managers. The decision making capabilities of food quality Managers are subjected to an external influences. In this paper, image processing techniques are implemented to automate the process which overcomes the drawbacks of manual process. Here, various procedures are reviewed to obtain the percentage, quality of soybean seeds based on its size and morphological features.
Keywords: ANN, Grading, Image Processing, Soybean, Morphological, Seed features

I. INTRODUCTION

In India, main source of the income for major population is Agriculture. Almost 70 percent of the population in India depends on farming. Almost 58 percent of the rural people depend on farming. Soybean is one of the important oil crops in India. Soybean is one of the important cash crops. Poor quality of soybean leads to hamper 10 to 15% of production in Asia resulting in loss of earning. Soybean plays an important role in world's oilseed cultivation scenario, due to its high productivity, profitability and vital contribution towards maintaining soil fertility. The soybean crop also has a prominent place as the world's most important oil seed, which contributes 25% to the global vegetable oil production, about two thirds of the world's protein focus on livestock feeding and is a valuable ingredient in formulated feeds for poultry and fish. Soybean contributes remarkably to the Indian edible oil. Presently soybean contributes 25% to the total oil production in the country and 43 % to the total oilseeds. Maharashtra state is located in the western part of India next to the Arabian Sea. It lies between 15° 44' to 22° 6' N and 72° 36' to 80° 54' E. The total area of Maharashtra State is 307,000 square kilometers, which is 9.36% of the country. The total area of Vidarbha is 97,321 square kilometers, which is 2.96% of the country. Considering the area and population, Maharashtra state is the third largest state in India. The population of the state is 80 million, which is 9.47% of the country's total population. In Maharashtra, soybean is cultivated on an area of 3.8 M ha with production of 3.07 m ton with second rank in India, In India, major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, Karnataka and Chhattisgarh. Among these states Maharashtra ranks second in acreage under soybean after Madhya Pradesh. In Maharashtra it constitutes 38.704 lakh hectares area producing 48.565 lakh MT with the productivity 1255 kg/ha in 2013. Area under soybean in Maharashtra vidarbha Amravati region district wise for kharif 2019 is as showing in following CHART.
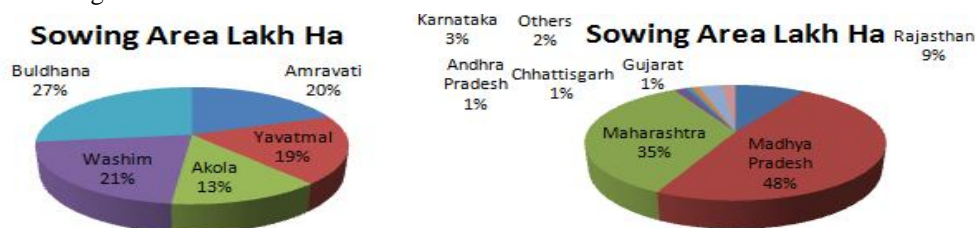

Figure:-1 Region wise Sowing Area, Expected Yield and Estimated Production of Soybean

According to Soybean Processor Association of India Maharashtra is second rank in soybean sowing. The area (37.365 lakh ha) of soybean crop is more in Maharashtra region. The highest productivity was observed in Madhya Pradesh region i.e. 40.107 t/ha.

II. SOYBEAN GRADING

Soybean seeds grading is a process of sorting rice and assign into its classes or grade. The grading of soybean seeds plays important role in the determination of seed quality method applied in the soybean production industry and its subsequent price in the market. The grade and price of soybean is largely determined by its quality, genetic, agronomic and commercial value. The manual and visual methods are still employed by the soybean grader and industry today. The trained human classifiers can perform quality inspection, this method is highly subjective, susceptible to fatigue, and is affected by human psychological limitations leading to erroneous judgment.

Most of the researchers such as Timothy J. Herrman, Extension State Leader Grain Science and Industry Carl Reed have used grading procedure on the basis of 1. Classes as yellow soybeans and mixed soybeans. 2. Damaged kernels 3. Foreign material 4. Heat- damaged kernels 5. Soybeans of other colours they Examine the sample for heating, odour, animal filth, castor beans, crotalaria seeds, garlic, glass, insect infestation, purple mottled and stained, smut, stones, unknown foreign substances, and other unusual conditions. All samples are inspected by trained human classifiers.

In India The Agmark grade standards for Soybean notified under the Agricultural Produce (Grading and Marking) Act 1937 by the Central Government (Directorate of Marketing and Inspection) are given on the basis of Oil content on dry basis percent by weight, Acid value of oil, Moisture content percent by weight, Damaged, discoloured, insect infested beans percent by weight, Immature, shrivelled beans percent by weight, Splits, broken, cracked beans percent by weight Inorganic foreign matter percent by weight, Organic foreign matter percent by weight they proposed maximum limits of tolerance(percentage by weight per quintal).Also this procedure is all done by manual inspection.

Salome Hema Chitra,S.Suguna and S.Naganandini Sujatha have proposed A Survey on Image Analysis Techniques in Agricultural Product In this work, they implemented a five processing module for seed identification.

D. Wang, M. S. Ram, F. E. Dowell have did Classification of damaged soybean seeds using near infrared spectroscopy. They were classify sound and damaged soybean seeds and discriminate among various types of damage using NIR spectroscopy.

Md Abdul Momin, Kazuya Yamamoto, Munenori Miyamoto and Naoshi Kondo proposed the Machine vision based soybean quality evaluation objective of their research was to develop a machine-vision based proof of concept of a grain quality monitoring system.

Guzman and Peralta applied artificial neural networks to classify the grain samples of Philippine rice grains based on size, shape and 52 varieties of rice grains belonging to 5 varietal groups in the Philippines by using image processing techniques. The system used 3 data sets containing 110 rice grains for each size, shape and variety of rice grain identification.

Neural Networks or neural net (NN) or known as Artificial Neural Networks (ANN) is a technique that inspired by the way biological nervous system works to simulate the learning process. Normally NN is configured for a specific application such as clustering, grading or pattern recognition, prediction system and function approximation through a learning process. In NN, there are four architectural forms that are feed-forward networks, feedback networks, network layer and perceptrons (R C Chakraborthy, 2010). Another definition for NN is a processor of information consisting of simple processing elements connected together [JM Bishop., et al. 1991]. Uhrig, R.E., (1995) stated that NN model represents a human brain. Nodes in NN represent the neurons and a link represents a synapse. According to Paliwal.J, et al., (2001) if the relationship between the inputs and outputs is difficult to translate into the mathematical function but if some input and corresponding output values are known, it is suitable to use NN to solve the problem. Based on the previous works, Neural network is the most popular method used in rice grading. (Wee C Y., et al. 2007) used the same method to classify rice but for capturing the image

III. METHODOLOGIES

Md Abdul Momin, Kazuya Yamamoto, Munenori Miyamoto and Naoshi Kondo proposed the Machine vision based soybean quality evaluation objective of their research was to develop a machine-vision concept of a grain quality monitoring system, targeted at application on a combine harvester.

The machine vision concept of the grain quality monitoring comprised a digital camera, in combination with back, front and structured lighting. A web camera with back and front lighting was used to evaluate the accuracy of detection of (1) normal (undamaged) beans, (2) split beans, (3) contaminated beans (4) defect beans and (5) stem/pod material. 50 sets of data were collected where a fixed number of these objects were randomly arranged in an imaging cell with a size of 50 mm. A digital image processing algorithm was able to distinguish each targeted dockage fraction present in the soybean samples based on front lit and back lit images.

Sudhir Gupta, Smitha Patil, Asha Kulkarni and Zoheb Hukkeri proposed the Classification of Soybean seeds by Color Image Analysis. Color features in the RGB (red-green-blue) colorspace are computed. A FFN neural network is trained to classify sample soybean seeds. Image features of the soybean seeds were extracted to characterize the physical quality attributes of soybeans. Color features were computed and tested.

They included the means and standard deviations of R, G, and B (red, green, and blue); the means of H, S, and I (hue, saturation, and intensity); excess red (2R–G–B), excess green (2G–R–B), and excess blue (2B–R–G). Algorithms were developed in Windows environment using Matlab 7 programming language to extract color features of individual soybean seeds. From the red , green , and blue color bands of an image, hue , saturation, and intensity were calculated.

Irfan S. Ahmad, Research Associate, John F. Reid, Professor, Marvin R. Paulsen, Professor, Department of Agricultural Engineering, and James B. Sinclair, Professor, Department of Crop Sciences, University of Illinois at Urbana-Champaign, proposed Color Classifier for Symptomatic Soybean Seeds Using Image Processing Symptoms associated with fungal damage, viral diseases, and immature soybean seeds were characterized using image processing techniques.

A Red, Green, Blue (R)(G)(B) color feature of seed image decision model discriminated between asymptomatic and symptomatic seeds for inspection and grading of seeds.

 The color analysis exhibit distinct color differences between the asymptomatic and symptomatic seeds. A model consisting of six color features including averages, minimums, and variances for Red ,Green and Blue pixel values was developed for describing the seed symptoms.

Mihir Narandas Dudhrejia got Doctor of Philosophy in Computer Engineering for Grain Quality Analysis using Image Processing Approach. A Thesis submitted to Gujarat Technological University. In this research, efforts are made to investigate techniques used for the quality analysis.

The main attempt is to compare the relative applicability of human v/s machine based approach of analysis. The research was done for grading of different rice samples using Image processing and Microsoft Visual Studio 2012 and Microsoft .Net framework 4.5. Implementation is made using Microsoft.

Net technologies for extracting individual kernel features. Different rice varieties are added and related measurement parameters are added to make grain analyser database more robust.

Ajay.G et al., (2013), have proposed a quality evaluation of rice grains using morphological methods. Among the milled rice samples, the quantity of broken kernels are determined with the help of shape descriptors like length, width, and perimeter are considered. Once the geometric features are extracted, the lengths of the grains are obtained using a threshold value for the length. The grains whose values are less than 75% of the normal grain size are considered as broken.

Aulakh. J.S. et al., (2012), have proposed image processing techniques for grading of rice samples based on their sizes. The images were captured using a Flat Bed Scanner (FBS) and then converted to binary image to which they apply morphological operations and by the objects features were extracted by finding the properties of the connected components and get the information regarding connectivity, image size, numobjects, pixelidxlist. The stem graphs were plotted and the grain kernels which have lesser values than a threshold were discarded.

Hemender, Sushma Sharma, V. S. Mor, Jitender and Axay Bhuker Department of Seed Science & Technology, Chaudhary Charan Singh Haryana Agricultural University, Hisar, India proposed Image Analysis A Modern Approach to Seed Quality Testing.

Umar Faruk Abdulhamid, Muhammad Ahmad Aminu and Simon Danie Department of Mathematical Sciences, Kaduna State University, Kaduna, Nigeria proposed Detection of Soya Beans Ripeness Using Image Processing Techniques and Artificial Neural Network. The research objectives is to detecting the ripeness of soya beans. The research taken the colour and texture of leaves as features through image processing techniques. In the preprocessing phase and artificial neural network for the detection of ripeness with the use of MATLAB software as the simulation tools. An accuracy proposed by research paper is about to 95.7% obtained in the classification of the various categories of soybeans leaves.

Anami, and Savakar have proposed a technique in identifying and elimination of foreign particles in the image samples. They used other material apart from the food grain as foreign body objects. When they observed the foreign bodies present likes stone, leaves, dust, other types of grains etc. Here they considered both colour and texture for their study work. They perform experiments by first collecting the samples of rice grain. The features of the images were acquired and were stored as knowledge database. Texture and color features were extracted in order to classify and recognize the food grains.

IV. COMPARISON BETWEEN EXISTING METHODS

This review paper presents old methods as well as recent advancements of using computer-vision based systems for classification of soybean seeds. A computer machine learning using image processing techniques involves five basic processes such as image acquisition, preprocessing, segmentation, object detection and classification. This survey highlights these approaches in context of soybean grading practices and summarizes their relevancy to precision farming. In Table-1 summarizes research that has been reported on methods developed using image processing techniques.

Sr. No	Author Name	Methodologies
1	Timothy J. Herrman, Extension State Leader Grain Science and Industry Carl Reed	Determine the test weight per bushel of the sample by Manual Inspection.
2	Agmark specifications	Central Government (Directorate of Marketing and Inspection) are given on the basis of Oil content on dry basis percent by weight, Acid value of oil, Moisture content percent by weight, Damaged, discoloured, insect infested beans percent by weight, Immature, shrivelled beans percent by weight, Splits, broken, cracked beans percent by weight Inorganic foreign matter percent by weight, Organic foreign matter percent by weight they proposed maximum limits of tolerance(percentage by weight per quintal).Also this procedure is all done by manual inspection.
3	Salome Hema Chitra,S.Suguna and S.Naganandini Sujatha	Proposed A Survey on Image Analysis Techniques in Agricultural Product. Using processing technique extract features like colour, shape and texture for normal and defected seed from input image.
4	D. Wang, M. S. Ram, F. E. Dowell	Proposed Classification of damaged soybean seeds using near infrared spectroscopy.
5	Md Abdul Momin, Kazuya Yamamoto, Munenori Miyamoto and Naoshi Kondo	Proposed the Machine vision based soybean quality evaluation, A digital image processing algorithm was able to distinguish each targeted dockage fraction present in the soybean samples based on front lit and back lit images.
6	Sudhir Gupta, Smitha Patil, Asha Kulkarni and Zoheb Hukkeri	Proposed the Classification of Soybean seeds by Color Image Analysis. A FFN neural network is trained to classify sample of soybean seeds. Image features of the soybean seeds were extracted to characterize the physical quality attributes of soybeans.
7	Irfan S. Ahmad, Research Associate, John F. Reid, Professor, Marvin R. Paulsen, Professor	Proposed Color Classifier for Symptomatic Soybean Seeds Using Image Processing Symptoms associated with fungal damage, viral diseases, and immature soybean (Glycine max) seeds were characterized using image processing techniques.
8	Mihir Narandas Dudhrejia	The research was done for grading of different rice samples using Image processing and Microsoft Visual Studio 2012 and Microsoft .Net framework 4.5. Implementation is made using Microsoft .Net technologies for extracting individual kernel features.
9	Guzman and Peralta	Applied artificial neural networks and image processing to classify the grain samples of Philippine rice grains based on size and shape
10	Lilhare and Bawane	Applied two layers of the feed forward neural network to classify varieties of paddy rice seed into 3 groups which were large, medium and small based on morphological features.
11	Hemender, Sushma Sharma, V. S. Mor, Jitender and Axay Bhuker	Proposed Image Analysis A Modern Approach to Seed Quality Testing.
12	Umar Faruk Abdulhamid, Muhammad Ahmad Aminu and Simon Danie	The research objectives is to detecting the ripeness of soybeans. The research carred out on colour and texture features of leaves through image processing techniques in the pre-processing phase and artificial neural network for the detection of ripeness with the help of MATLAB software as the simulation tools. An accuracy proposed of 95.7% is obtained in the classification of the various categories of soya beans leaves
13	Anami, and Savakar	have proposed a technique in identifying and elimination of foreign particles in the image samples. Here they examine both colour and texture for their study. They carried out the work by first collecting the images of the samples. The features of the images were acquired and were stored as knowledge base. Texture and color features were extracted in order to classify and recognize the food grains.

V. CONCLUSION

This paper presented a survey on using image processing techniques used in an automated soybean grading systems in an agricultural context. Most of the work in this field uses image processing methods like background subtraction, feature extraction and training and classification. An image processing based solution is also explored from the published literature for automatic seed sample recognition, classification and recognition of foreign particles from images using color and texture features. There is a necessity to select the most appropriate techniques to assist decision-making. The image processing techniques have been used widely across agricultural contexts. It can be an effective tool in food quality assessment. There are number of applications and methods to select for implementation to real time needs. While the existing soybean classification methods sustaining the needs of today, there are more and more new methods are evolving to assist and ease the soybean classification.

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