Appendix B

B.1 Research Publications

Development of a Classification System for Quality Evaluation of Oryza Sativa L. (Rice) Using Computer Vision

Abstract:
Carrying out effective and sustainable agriculture product has become an important issue in recent years. Agricultural production has to keep up with the ever-increasing population. A key to this is the usage of modern techniques (for precision agriculture) to take advantage of the quality in the market. The paper reviews various quality evaluation and grading techniques of Oryza Sativa L. (rice) in food industry using computer vision and image processing. In this paper basic problem of rice industry for quality assessment is defined which is traditionally done manually by human inspectors. Computer Vision provides one alternative for an automated, non-destructive and cost-effective technique. In this paper we quantify the qualities of various rice varieties in Asian subcontinent and figure out features which directly or indirectly affect the quality of the rice. Based on these features a generalized approach of quality is proposed to be used for quality evaluation of any type of rice variety.

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A Machine Vision Approach for Indian Basmati Rice Classification Using Geometrical Features and Cart

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Abstract: Carrying out effective and sustainable agriculture product has become an important issue in recent years. Agricultural production has to keep up with an ever-increasing population. A key to this is the usage of modern technique for precision agriculture to take advantage of the quality in the market. The paper presents a solution for quality evaluation, grading and classification of INDIAN Basmati Rice using machine vision and image processing. In this paper basic problem of rice industry for quality assessment is defined which is traditionally done manually by human inspector. Machine Vision provides an alternative for an automated, non-destructive and cost-effective technique. In this paper we quantify the quality of ORYZA SATIVA SSP Indica (Basmati rice) and figure out features which directly or indirectly affect the quality of the rice. Based on these features CART (Classification And Regression Tree Analysis) is being proposed to evaluate the rice quality.

Keywords: Machine Vision, Combined Parameters, Oryza Sativa SSP Indica (Basmati Rice), Data Mining Techniques, CART

1. Introduction

The past few years were marked by the development of researches that contribute to reach an automatic classification technique of rice varieties grown in various Asian sub continents. As it is perceived to be a possible solution to prevent human errors in the quality evaluation process. Machine vision system which is a promising technology in the quality control can replace the human operator. After hours of working the operator may lose concentration which in turn will affect the evaluation process. So a Machine vision system proved to be more efficient at the level of precision and rapidity. But, the natural diversity in appearance of various rice varieties makes classification by Machine vision a complex work to achieve. Many researches were carried out to classify grains. Characterization models were based on morphological features, colour features ([2], [22]) or textural features ([3]). Other researchers ([15–18]) have tried to combine these features for the sake of improving the efficiency of classification. Recently, wavelet technique was integrated in grains characterization ([19, 20]).

Data mining is the process of discovering interesting knowledge, such as patterns, associations, changes, anomalies & significant structures from large amount of data stored in databases or other information repositories. At present, data mining technology started late, it is used only when classical mining algorithm is applied in agricultural data processing, not to mention a set of systematic research and development methods. To solve the above problems, this paper presents a theoretic framework for agricultural data mining platform, including various soft computing techniques used worldwide in the classification process of rice in the Asian subcontinent. In this bio-tech upswing, an agricultural industry has become more intellectual and automatic machinery has replaced the human efforts [1].

In 2006, N. Shobha Rani et al. examined Historical significance, grain quality features and precision breeding for enhancement of export quality basmati varieties in India like Badshahbug, Kalanirani, Ambenotul 159, Jevaga Samba, Chirintyaga, Badshah Pasand, Randhuripagal and Talusmanjariti etc. [20]. But the work was limited to individual seeds and occlusion affected problem. In 2010, Bhupinder Verma determined Image Processing Techniques for Grading and Categorization of three different
Computer Vision Based Classification of Indian Gujarat-17 Rice Using Geometrical Features and Cart

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Abstract

Agricultural production has to be kept up with an ever-increasing population demand which is an important issue in recent years. The paper presents a solution for quality evaluation, grading and classification of INDIAN Gujarat-17 Rice using Computer Vision and image processing. In this paper basic problem of rice industry for quality assessment is defined and Computer Vision provides one alternative for an automated, non-destructive and cost-effective technique. In this paper we quantify the quality of ORYZA SATIVA SSP Indica (Gujarat-17) based on features which affect the quality of the rice. Based on these features CART (Classification and Regression Tree Analysis) is being proposed to evaluate the rice quality.

Keywords

Machine vision  Combined parameters  Oryza sativa SSP indica
Mining techniques, CART

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Feed Forward Neural Network Classification for INDIAN Krishna Kamod Rice

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ABSTRACT  
The carrying out effective and sustainable agriculture product has become an important issue in recent years. Agricultural production has to keep up with an ever-increasing population. A key to this is the usage of modern techniques for precision agriculture to take advantage of the quality in the market. Classification of rice seeds from the bare human hands is neither cost effective nor recommended. The automatic grading for analysis of quality has become the need of the hour. This paper recommends an add-on approach to quality experts for the quality analysis of INDIAN Krishna Kamod Rice using computer vision and soft computing techniques. Computer Vision provides a grading methodology, non-destructive technique, along with multi-layer feed forward neural networking which achieves high degree of quality than human vision inspection.

Keywords  
Computer Vision, feed forward neural network, Indian Krishna Kamod rice seeds, non-destructive.

1. INTRODUCTION  
Indian agricultural production and development is considered to be too old and most widespread in the whole world. In this era of Digital India where hi-tech upbringing of an agricultural industry has become more intellectual and automatic machinery has replaced the human efforts [1]. In India it is high time to overcome the need of ever-increasing demand of production by advancement in agricultural sector. Due to automation need of high quality and safety standards achieved with accuracy, along with fast and cost effective quality determination of agricultural products has increased a lot [11]. Quality being a major consideration in any food product is determined from its physicochemical properties by human sensory panel which is time consuming, may be varying results and costly as well as destructive chemical analysis [10]. Significant developments have been made in this field of computer vision since past few years [4]. Efforts are being geared towards the replacement of traditional human sensory panel with automated systems, as human operations are inconsistent and least efficient [5].

Oryza Sativa L. (Rice) is a vital worldwide agriculture product. It is one of the leading food crops of the world as more than half of the world’s population relies on rice as the major daily source of calories and protein. Rice (Oryza Sativa L) is cultivated in several countries such as India, China, Indonesia, Bangladesh and Thailand which are considered as the major producers. India is the world’s 2nd largest producer and consumer country of rice for a very long time. It is one of the leading food crops of the world as more than half of the world’s population relies on rice as the major daily source of calories and protein.

The research work summarized in this paper focuses on the problem faced by Indian rice industry and its cost effective solution. Second section comprises of the particular problem of quality evaluation of Krishna Kamod Rice seeds. The next section discusses about the various proposed methodology being used along with the materials for calculating parameters for the quality of rice seeds. The proposed system as well as proposed algorithm for computing Rice seeds with long, small and normal seeds classification is also discussed in the same section. Section 4 concentrates on the quantification for the quality of rice seeds based on computer vision processing and analysis. Section 5 shows classification of rice seeds using multi-layer feed forward neural network for quality evaluation. Section 6 provides the conclusion of the proposed process.

2. PROBLEM DEFINITION  
Krishna Kamod rice (Oryza Sativa L) seeds contain foreign elements in terms of long as well as small seed as shown in Figure 1. These seeds are having very much importance in quantifying quality. At the time of processing these seeds are removed.

![Fig. 1 Rice seeds with and without foreign elements](image)

![Fig. 2 Foreign elements in the sample](image)

Proper removal of this seed is necessary if it is not so then it creates degradation in quality of rice seed. This paper proposes a new method for counting the number of Krishna Kamod rice (Oryza Sativa L) seeds with these foreign elements as shown in Figure 2 using non-destructive technique based on artificial neural network to quantify the quality of Krishna Kamod rice (Oryza Sativa L) seeds.

3. MATERIALS AND METHODS  
In this section we discuss the proposed algorithm. Here we have used different varietal samples of Krishna Kamod rice. We define quality based on the combined measurement technique. We use minor axis length, major axis length,
Non-Destructive Quality Analysis of JIRASAR Oryza Sativa SSP Indica (Indian Rice) using Feed Forward Neural Network

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ABSTRACT
The carrying out compelling and reasonable agriculture product has turned into an important issue in recent years. Agricultural production needs to stay aware with an ever-increasing population. A key to this is the utilization of present day strategies (for precision agriculture) to exploit the quality in the market. Classification of rice seeds from the exposed human hands is neither savoy nor prescribed. The automatic grading for examination of quality has turned into the need of great importance. This paper prescribes an extra way to deal with quality specialists for the quality investigation of INDIAN JIRASAR Rice using computer vision and soft computing techniques. Computer Vision gives a grading methodology, non-destructive technique, along with multi-layer feed forward neural networking which achieves high degree of quality than human vision inspection.

Keywords
Computer Vision, Soft Computing technique, digital image processing, Indian Jirasar rice seeds, non-destructive.

1. INTRODUCTION
Indian agricultural production and development is thought to be excessively most seasoned and most broad in the entire world. In this time of Digital India where hi-tech upbringing of an agricultural industry has turned out to be more intelligent and automatic machinery has supplanted the human endeavours [1]. In India the opportunity has already come and gone to defeat the need of always expanding interest of generation by advancement in agricultural sector. Because of computerization need of high quality and safety standards achieved with accuracy, alongside quick and financially savvy quality assurance of agricultural products has expanded a great deal [11]. Quality being a noteworthy thought in any sustenance item is food product is determined from its physicochemical properties by human sensory panel which is tedious, may be varying results and costly as well as destructive chemical analysis [10]. Significant developments have been made in this field of computer vision since past few years [4]. Endeavors are being adapted towards the substitution of customary human tangible board with mechanized frameworks, as human operations are conflicting and less effective [5].

Oryza Sativa L. (Rice) is a fundamental overall agriculture product. It is one of the main sustenance yields of the world as the greater part of the total populace depends on rice as the real day by day wellspring of calories and protein. Rice (Oryza Sativa L.) is developed in few nations such as India, China, Indonesia, Bangladesh and Thailand which are considered as the real makers. India is the world’s second biggest producer and purchaser nation of rice for quite a while. It is one of the main nourishment harvests of the world

as the greater part of the total populace depends on rice as the significant day by day wellspring of calories and protein [15]. The research work explained in this paper concentrates on the issue confronted by Indian Rice industry and its cost effective solution. Second section contains the specific issue of value assessment of Jirasar Rice seeds. The following segment examines about the different proposed philosophy being utilized alongside the materials for computing parameters for the nature of rice seeds. The proposed framework and additionally proposed calculation for processing Rice seeds with long, small and normal seeds classification is also discussed in the same section. Section 4 focus on the measurement for the quality of rice seeds based on computer vision handling and investigation. Section 5 indicates classification of rice seeds using multi-layer feed forward neural network for quality evaluation. Section 6 provides the conclusion of the proposed process.

2. PROBLEM DEFINITION
Foreign elements in terms of long as well as small seed as shown in Figure 1 have included in Jirasar rice (Oryza Sativa L) seeds. These seeds are having particularly significance in evaluating quality. At the time of handling these seeds are removed. Appropriate evolutions of this seed is fundamental in the event that it is not all that then it makes corruption in nature of rice seed. This paper proposes another strategy for tallying the quantity of Jirasar rice (Oryza Sativa L) seeds with these foreign elements as shown in Figure 2 a and b using non-destructive technique based on artificial neural network to quantify the quality of Jirasar rice (Oryza Sativa L) seeds.

3. MATERIALS AND METHODS
In this section we talk about the proposed algorithm. Here we have used different varisial samples of Jirasar rice. We characterize quality in view of the consolidated estimation method. We use minor axis length, major axis length, eccentricity, area, convex area, perimeter and extent of rice seed for counting the number of Jirasar rice (Oryza sativa L) seeds with long seeds, normal seeds as well as little seeds.

Fig. 1 Rice seeds with and without foreign elements

Fig. 2 a Long seeds present in the sample

Fig. 2 b Foreign elements in the sample
Graphical User Interface Approach for Quality Evaluation of Indian Rice

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ABSTRACT
Modernization with automation incorporated makes a system more powerful. In the present world quality inspection of food products is a very important factor for evaluating the grade of food. In agricultural field, image processing is also used to evaluate the quality of rice. Major problem of rice industry is quality assessment is manual assessment done by human inspector. In this paper a method is presented to evaluate the quality of rice. Proposed method is an application of computer vision technique. Computer Vision provides an alternative for non-destructive and cost effective technique for Grading and Classification of rice using framework and neural network techniques. Some Geometrics features are useful for quality evaluation. In this paper proposed method is used to increase the accuracy of the rice quality detection by using such features with GUI (Graphical User Interface) and feed forward neural network. Artificial neural network detects the quality of rice by using features provided at the time of training and also the extracted features of rice and provides the result by comparing these features. It grades and classifies rice images based on obtained features.

Keywords
Feature extraction, GUI (Graphical user interface), Image processing, Quality analysis.

1. INTRODUCTION
Agriculture field has played an important role in economic development of India. Digital Development in agriculture sector is growing exponentially as compared to development in other sector. So, there is need to develop some new technique for agricultural sector. There are various rice varieties are available in India like Basmati, Ponja, Masoori, Parimal, Jirasar, Kanid etc. Still in India, the traditional inspection of rice is performed by human experts. It is not only time consuming but a laborious technique too. As it is perceived to be a possible solution to prevent human errors in the quality evaluation process. Machine vision system which is a promising technology in the quality control can replace the human operator[1]. After hours of working the operator may lose concentration which in turn will affect the evaluation process. Hence a Machine vision system is proved to be more efficient at the level of precision and rapidity. But, the natural diversity in appearance of various rice varieties makes classification by Machine vision a complex work to achieve. Many researches were carried out to classify grains. Characterization models were based on morphological features, colour features or textural features[2]. Other researchers[20-21] have tried to combine these features for the sake of improving the efficiency of classification. Recently, wavelet technique was integrated in grains characterization[22-23].

Grading of rice is necessary in evaluating agricultural produce, meeting quality standards and increasing market value. The features that can be extracted from an image of any rice are its Major Axis, Minor Axis, Eccentricity, Area, Convex Area, Perimeter and Extent[17]. These features help the user to classify the rice. In this Paper, an automatic framework is used to analyse the rice quality which is based on Major Axis, Minor Axis, Eccentricity, Area, Convex Area, Perimeter and Extent. Rice should be tested via non-destructive techniques because these are delicate materials. If the classification and grading is done through manual methods, the procedure will be too moderate and at times it will be mistake inclined. Human choose the rice on the premise of bare eye perception[7]. On the off chance that these quality measures are mapped into computerized framework by utilizing appropriate programming dialect then the work will be speedier and blander free. Lately, PC machine vision and picture preparing methods have been discovered progressively helpful in the agrarian business, particularly for applications in quality review and shape arranging. The exploration work abridged in this paper concentrates on the issue confronted by Indian Rice industry and its financially savvy arrangement. In this paper we have talked about different rice assortment (Oryza Sativa L) seeds containing various size of rice seeds available.

In this paper at first user select the type of rice variety like Basmati, Ponja, Masoori, Parimal, Jirasar, Kanid etc. and systems automatically evaluate the sample using its geometrical properties. Second elaborates the quality factor. Proposed methodology being used is enumerated using physical properties exploited from the image of the rice sample. The last three sections exemplify the result and discussion part based section 3 along with the data mining technique so used in our research work. With the help of this paper we propose a Framework for classification of rice.

2. PROBLEM DEFINITION
Automisation using a graphical user friendly system is introduced through this research paper. As previously the age-old technique of quality evaluation was through mere naked eye inspection of low exports. It was not only biased but also inaccurate way. As the various rice varieties like Basmati, Ponja, Masoori, Parimal, Jirasar, available in this region comprise of different geometrical properties. They are unique in themselves in such a way that they make a wide difference with each other too. The before said thing is justified as shown in the first image of this paper. The different variety of rice in aforesaid sample degrade the quality of rice. In the below figure blue encircle one is a regular seed while the red encircled one is a small seed and green one is long seed.
Author’s Publications

INTERNATIONAL JOURNAL


INTERNATIONAL CONFERENCE AND BOOK CHAPTER


3. Niky K Jain, S O Khanna and Chetna Maheshwari, "Computer Vision Based Classification Of Indian Gujarat-17 Rice Using Geometrical Features and Cart", *International Conference Computational Intelligence in Data mining (ICCIDM)*, 2015. Published in *SPRINGER* Digital Library, Computational Intelligence in Data Mining-Volume 3 Pages: 205-216. ISSN-2190-3018