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MACHINE VISION TECHNOLOGY FOR ORYZA SATIVA L.(RICE)

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ABSTRACT: In this paper basic problem of rice industry for quality assessment is defined which is traditionally done manually by human inspector. The paper reviews various quality evaluation and grading techniques of Oryza Sativa L.(rice) in food industry. Machine vision provides one alternative for an automated, non-destructive and cost-effective technique. Machine vision in food has broadened its range of applications from grains, cereals, fruits to vegetables including processed products in which there is a high degree of quality achieved as compared to human vision inspection. This paper quantify the qualities of various rice varieties and figure out features which directly or inversely affect the quality of the rice. Based on these features a generalized formula of quality is proposed to be used for quality evaluation of any type of rice variety.

Keywords: Quality Evaluation; Machine vision; Computer vision; Image analysis; Neural network; Chalkiness; Oryza sativa(Rice).

I. INTRODUCTION

The agricultural industry is probably too oldest and most widespread industry in the world. In this hi-tech uprising, an agricultural industry has become more intellectual and automatic machinery has replaced the human efforts[2]. Quality control is of major importance in the food industry because after harvesting, based on quality parameter a food product has been sorted and graded in different grades. 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. There are four major categories of rice worldwide: Indica, Japonica, Aromatic And Glutinous. The quality of rice has distinct effect, so the proper inspection of rice quality is very important.

Food quality is complex, and is being determined by the combination of sensory, nutritive, hygienic-toxicological, and technological properties and it is become more important than the quantity. Quality inspection by humans is neither objective nor proficient because the results, sometimes, may not be reliable due to human errors or inexperienced technicians. [32]. Therefore a quick and more reliable rice quality evaluation system is need as human sensory panel defines different parameters and for assessing quality based on that it is necessary to discover non destructive, accurate and rapid methods. So an advance technology, a non-destructive technique based on image analysis and processing can be developed [29].

Non-destructive quality evaluation of food products is an important and very vital factor in food/agricultural industry. With Non-destructive quality evaluation of food products various parameters which define quality of these products (e.g. size, shape, color, texture, external defects, etc.) are calculated with the help of image processing without affecting physical structure of food products [23]. Efforts are being geared towards the replacement of traditional human sensory panel with automated systems, as human operations are inconsistent and less efficient [36].

Rapid advances in hardware and software for digital image processing have motivated several studies on the development of computer vision systems to evaluate quality of diverse raw and processed foods[1]. Advancement in computer technology leads to use these in the domain of food processing like grading, sorting and quality inspection [28].

In this paper for quality evaluation of rice we present a unified approach to evaluate the quality and to classify the different varieties of rice among the different countries using machine vision. Section-II proposes basic techniques for quality evaluation. In Section- III we review the evaluation being done in the area of Oryza sativa L.(rice) up till now. Section-IV puts forward an approach for quality evaluation OF different varieties of rice. Section-V concludes this paper.

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II. QUALITY EVALUATION USING MACHINE VISION

The increased awareness and sophistication of consumers have created the expectation for improving quality in consumer food products. Visual inspection of the grain by human eyes is a primary method of grain quality inspection commercially. In the food industry, quality evaluation is traditionally performed by human vision of some trained operators/inspectors. The current method for rice quality evaluation is time consuming, tedious, and inherently inconsistent and the results, may not be reliable due to human errors or inexperienced technicians. Therefore a quick and more reliable rice quality evaluation system is needed[32].An objective and cost-effective instrumentation system is needed to isolate rice kernels. Such a system would not only smoothen the progress of rice grading but also serve as a quality control tool for identification different cultivators in rice industry[4].

In view of this, automated rice quality inspection using machine vision is desirable to achieve fast and objective quality measurement. However, increased weight for uniformity and speed have necessitated the introduction of computer-based technologies such as machine vision vs Human Vision[33]. Based on image processing and analysis, machine vision is a novel technology for recognizing objects and extracting quantitative information from digital images.

Machine vision technology aims to emulate the function of human vision by electronically perceiving and evaluating an image[6]. The aim of machine vision is ultimately to replace the human visual decision-making process with automatic procedures. Machine vision provides a mechanism in which the human thinking process is simulated artificially, and can help humans in making complicated judgments accurately, quickly, and very consistently over a long period.

Machine vision is a immediate, financially viable, steady and objective inspection and evaluation technique which makes available one alternative for an automated, non-destructive and cost effective technique.machine vision systems for grain identification have been used under the controlled conditions of a laboratory[28].

The Imaging Setup for quality evaluation of rice contains standard hardware configuration as shown in figure 1.

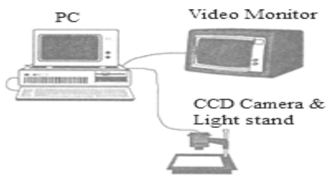

Fig. 1 Imaging setup [20]

Illumination plays a vital role in quality of image. So here proper illumination is adjusted with the help of available light sources. Rice grains are positioned beneath the focus of a camera against a contrasting background. This repeatable, reliable and easy-to-use setup minimizes the pre-processing operations required by maximizing the contrast between target grains and the background[17].

Computer vision is the technology for construction of explicit and meaningful descriptions of physical objects from images of that object (Ballard & Brown, 1982).[1,2].Computer vision is both better and worse than human vision. Perhaps the biggest gain of computer vision is its capability to be objective and unfailing over long periods[33].

A high resolution charge-coupled-device (CCD) camera required for image acquisition, computer disk or tape drives needed for storage, computer hardware and software for processing, cables and software for communication, and video monitor for display. Table-1 consist of essential components of computer vision systems[20].

Table I components of computer vision systems.

Sr.No.	Components
1	Charge-coupled-device (CCD) camera
2	Computer disk/ tape drives
3	Computer hardware and software
4	Cables and software
5	Video monitor

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With the advancement in computer technologies, image processing technology has grown-up to the one of most energetic and effectual research areas especially in the fields of materials trying and quality consideration[17].General methodology for quality evaluation using image processing is shown in following figure-2.

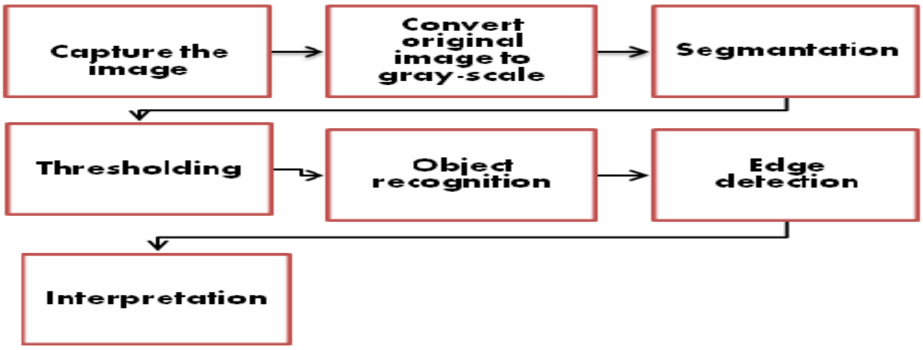


Fig. 2 Block diagram of General quality inspection methodology

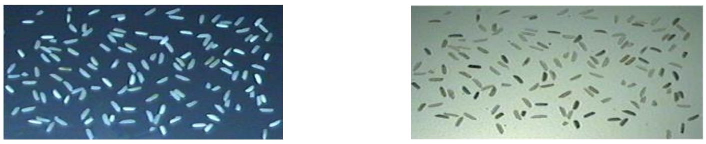
Image processing techniques have been applied increasingly for food quality evaluation in recent years. Recently advances in image processing techniques for food quality evaluation, which include charge coupled device camera, ultrasound, magnetic resonance imaging, computed tomography, and electrical tomography for image acquisition; pixel and local pre-processing approaches for image pre-processing; thresholding-based, gradient-based, region-based, and classification-based methods for image segmentation; size, shape, color, and texture features for object measurement; and statistical, fuzzy logic, and neural network methods for classification.

III. ASSESSMENT OF DIFFERENT VARIETIES OF RICE

Images captured by vision system can be used to identify, analyze and quality assessment of different varieties of rice.

A. Oryza Sativa Linnaccus (Thai rice)

In 2008, Siriluk Sansomboonsuk et.al evaluated the quality of three varieties of Thailand paddy (threshed, unmilled rice),rice sample having different translucency level, Jasmine rice, white rice and glutinous rice. The image analysis algorithms are developed for checking the quality of rice kernel as shown in figure 3 (a) and (b). They measured and calculated area, perimeter, circularity and shape compactness as criteria in Fuzzy logic for classifying each kernel. From testing the image analysis algorithms they found accuracy averaging 92% for both of the broken rice and the purity of rice compared with human inspection.



(a) (b)

Fig. 3 (a) An original image from front lighting (b) An original image from backlighting[31].

In 2008 S.Sansomboonsuk et.al developed the appropriate algorithm of Image analysis for Rice Kernel Quality and a computer vision system was developed for evaluating the quality of rice kernels which used to extract features for touching kernels of Thai Jasmine rice (Pathumthani1). The touching kernel features consist of two forms of touching: point and line touching kernels. The shrinkage operation are used to separate touching features and Object recognitions are applied for the line touching feature. Fuzzy logic method was second-hand to sort out and classify the class of each kernel. The first one was still human inspection. They concluded correct results in evaluating the quality of rice kernels.[32].

B.K. Yadav et.al performed for milled whole kernels of ten Thai rice varieties ranging from low to high amylose content (16–29%) with three initial moisture levels (approximately, 8, 12 and 16% d.b.) for monitoring the

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dimensional changes in rice kernels during soaking in relation to the varietal differences manifested by the physicochemical properties. Ten varieties of rough rice samples namely, Mali scented rice-105, Klong Luang scented rice,Suphan Buri scented rice ,SuphanBuri-60, Royal Rice Department-7,Royal Rice Department-23, Suphan Buri-90 ,Suphan Buri-1 ,Chainat-1 and Leuang Pra Tew-123 were obtained from the Rice Experiment Center, Klong Luang, Pathumthani. It was concluded that the changes in milled rice kernel dimensions took place at a faster rate in the beginning and were followed by a withdrawing rate finally leading to an asymptotic state during soaking in water at room temperature. [13].

IV. ATIMONGMONG CHA(PHILIPPINE RICE)

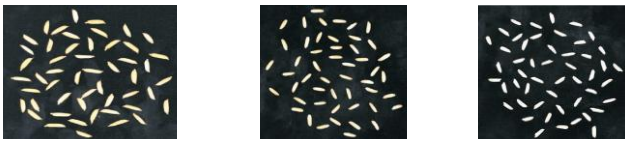
In 2008, Jose D Guzman. et. al proposed the use of a machine vision system and neural networks for automatic identification of the sizes, shapes, and variety of samples of 52 rice grains belonging to five varietal groups of rice in the Philippines as shown in figure4. Using Machine vision and pattern recognition morphological features were extracted from an individual grain.

Fig. 4 Partial pictures of different varieties of Philippine rice.

These morphological features can be used as input variables to Multilayer Neural Network topologies to recognize and categorize coarse rice sizes, shapes, and varietal types at overall average accuracies of 98.76 % and 96.67%, respectively. An average overall correctness of about 70 percent was obtained when the sample images of the 52 varieties were integrated in the group classification [22].

V. ORYZA SATIVA LINNACCUS (IRANIAN RICE)

In 2009, B. Emadzadeh et.al carried out the effort to estimate the algebraic characteristics (size and shape factors) of three Iranian rice varieties namely Tarom Mahalli, Fajr and Neda, at different processing levels by two processing methods such as micrometer procedure and digital image analysis system. Comparison of the results obtained by both procedures showed that the geometric characteristics of all three varieties decrease and sphericity increases after removing the outer and the brownish layers[12]. It was found that the values of micrometer data are having lower for all the geometric factors and that the true size and sphericity. The different varieties of Tarom Mahalli rice is shown in figure 5.



(a) Paddy rice (b) Brown rice (c) White rice

Fig. 5 Different varieties of Tarom Mahalli rice [12].

In 2009 E.Ghasemi et.al investigated textural and morphological properties of cooked rice grains. Stewing of rice grains by steam after boiling in excess water can be used for cooking rice perfectly. The special effects of this procedure in cooking of three varieties of Iranian rice Sang Tarom, Domsiyah and Fajr were investigated. [19].

VI. ORYZA SATIVA LINNACUS(CHINESE RICE)

In 2002,Y. N. Wan developed an automatic grain kernel handling system in which 1296 singularized kernel images per minute were taken for machine vision inspection. He proposed a Windows-based software program for rice quality inspection[30]. In this study, Sixteen parameters relating to rice appearance characteristics were used to categorize rice

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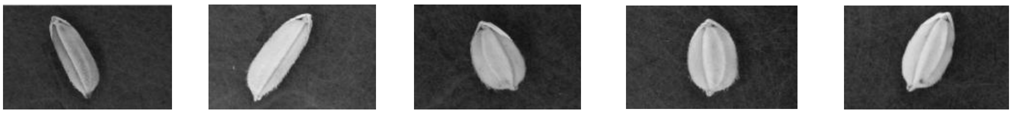
kernels into 13 inspection categories. sound kernels, green mature kernels, chalky kernels (white, green), cracked kernels, broken kernel, immature kernels (green, white), dead kernels (white, green), damaged kernels (including rusty, discolored, abnormal, and insect-damaged kernels), off-type kernels and paddy.

In 2005,Chang-Chun Liu et.al, recognized five calibrated models by using back propagation neural network program and four different morphological and color features for classifying paddy rice ,from five paddy rice cultivars grown in Taiwan (Tainung Sen 20, Taichung 10,Tainung 67, Taikeng 8, and Taikeng 9)as shown in figure 6.



(a) Tainung sen20 (b) Taichung sen10 (c) Tainung 67 (d) Taikeng 8 (e) Taikeng 9

Fig. 6 Different varieties of paddy rice cultivators[14].

In 2008,Xu Lizhang et.al estimated Multi-scale edge detection algorithm of four different variety of Chinese rice namely Wugeng13,Wuxiangeng14, Eyou512, you084 were used in this exploration with internal damage, based on Computer Vision. They were classified Rice kernels with an average accuracy of approximately 96.5% to none crack, 93.4% to single crack,84.2%to double cracks and 83.4% to multiple cracks compared to human inspection. The processing time was between 0.45 and 0.12 s/kernel[35].

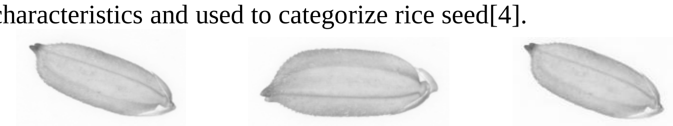
In 2010, Dai Xiaopeng.et.al established Rice Chalkiness Measurement algorithm based on Image processing Technique .they used different samples of Chinese rice for example Fengyuan B, Miyang 46 and Nipponbare etc.

(a) (b)

Fig. 7 (a) Grain image (b) Chalkiness result[18]

Figure 7 (a) shows the Initial image and (b) Chalkiness result in rice varietal type. From that they were concluded, use of computer image processing method compared to the artificial eyes measurement is objective, accurate, quick and convenient to evaluate rice's Chalkiness materialization with greater exactness and Consistency[18].

In 2010, Ai-Guo OuYang.et.al specified a comfortable methods for identifying dissimilar variety of rice seed using Machine vision Technology and a recognition system which was consisted of an automatic assessment machine. The intention of this revision was to enlarge a machine vision system to identify the varieties of rice seed by its color features and its peripheral size of rice seed images.For this task they had taken five varieties of Chinese rice as shown in figure 8.Visual C++ 6.0 carried out image analysis[4].A back forward neural network was trained to identify rice seeds. Particular rice variety assessment software was created to set up the ten grading parameters which were relating to rice appearance characteristics and used to categorize rice seed[4].



(a) (b) (c)

Fig. 8 Different varietal rice (a) No.5'Xiannong' (b) 'Jinyougui' and (c)'You166'[4].

VII. ORYZA SATIVA SSP INDICA (INDIAN RICE)

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 Badshahbhog , Kalanamak,Ambemohar 159, Jeeraga Samba, Chttimutyalu , Badshah Pasand, Randhunipagal and Tulasimanjari etc. [27].

In 2010, Bhupinder Verma determined Image Processing Techniques for Grading and Categorization of three different Indian rice varieties namely Markfed Supreme, Markfed Golden, Hafed Basmati. For this purpose, he developed

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semi-automatic FBS procedure for classification and grading of these rice. Some parameters measured like Area, perimeter, maximum length, maximum width, compactness and elongation. [9].
In 2010, S. Shantaiya et.al developed digital image analysis algorithm based on color, morphological and textural features to identify the six varieties rice seeds in Chhattisgarh region [30].

A. Oryza Sativa Linnacus (Korean rice)

In 2011,Choon Young Lee et.al estimated intellectual cataloging methods of grain kernels using computer vision analysis for categories seven kinds of grain kernels including four different varieties of Korean rice such as common rice, glutinous rice, brown rice and rough rice. They were extracted some color and morphological features .

IV. PROPOSED APPROACH FOR QUALITY EVALUATION OF RICE

The automatic detection of rice grain is the important application of digital image processing as shown in figure 11. The process of this application includes several steps as shown in following table-3 for Oryza Sativa.

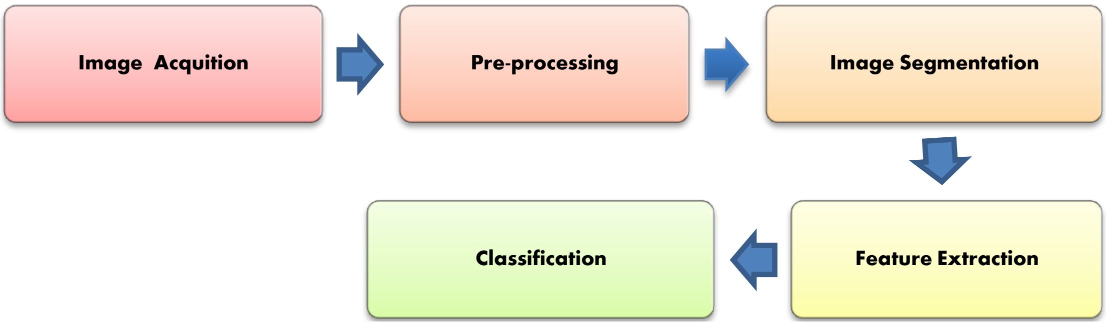

Fig. 11 Common image processing system configuration[26].

Table II Proposed method to compute quality of rice seeds.

Sr.No.	Steps
1	Select the region of interest of the rice seeds
2	Convert the RGB image to gray images
3	Apply the morphological operations.
4	Calculate the parameters of interest of the rice seeds.
5	Find the histograms of the same.
6	Compute the threshold values based on histograms.
7	Evaluate the quality based on above process.

An acquired image can be converted from color to gray scale since the color parameter is not of importance. Segmentation is done to identify relevant parts of a rice based on morphological operation. Here different parameters based on size, shape etc. is calculated. Based on it the quality quantification can be done.

V. CONCLUSION

This paper presents a quality analysis of different varietal rice via image processing algorithm. Traditionally quality evaluation and assessment is done by human sensory panel which is time consuming and there is deviation in results and expensive. This can be replaced with Machine vision and Neural network.

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