Nutrients Estimation in Rice Grains using Artificially Intelligent (AI) Sensors

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Abstract

Currently, quality inspection and nutrients estimation of rice grains is very important for evaluating the grade of the food grains. Artificial Intelligence and image processing algorithms play an extensive role in agriculture for assessing the nutrients present in three types of rice grains. The three types of rice varieties include Brown Rice (BR), White Rice (WR) and Enriched White Rice (EWR). One among them is the analysis of the quality and nutrients present in the rice grains. The main difficulty in trading rice grains based on quality and nutrients is presently done by a human inspector. In this paper, a strategy is presented to estimate the quality of rice grains based on the nutrients content in it. The major nutrients for assessing the quality of the rice grains include Manganese, Niacin, Thiamine, Selenium and Magnesium. The proposed method is an application of image processing with Artificial Neural Networks (ANN) trained with Back Propagation Algorithm (BPA) to offer a cost effective solution using Artificially Intelligent (AI) Sensor to assess quality, rating and nutrient based categorization of rice grains based on the colour of the rice grains.

Keywords*:* Rice grains, nutrients, Artificially intelligent sensor, Back Propagation Algorithm (BPA), Pre-processing and Feature Extraction

1. INTRODUCTION

Rice is the staple food consumed by majority population in South India. Country like India focuses on agriculture as a prime source of income to improve the Indian economy. The yield of rice grains is an important guideline to farmers while the paddy crops remain in agricultural lands, but when the processed rice grains reach the market, quality and nutrients become a key component which determines the profit in the agriculture business. The trading of quality rice grains depend on its nutrient content. Rice grain handling is carried out in several stages before it reaches the market for sale. Machine vision techniques can be used for grain quality assessment which relies on visual inspection. Since manual sorting is tedious and time consuming and also subjected to errors, an automated scheme for nutrient based quality determination is advised [1]-[4].

Present scenario states that there is no efficient method available to categorize the nutrients present in the rice grains to increase the marketability of quality grains. Consequently, it turned out to be a critical problem at the consumer end. Manual sorting leads to loss in income to the farmers. Hence, there arises a need for technology to enable automated nutrient identification. Though the manual method of sorting is simple and cheap, the major disadvantage includes lowered efficiency. In case of manual method, the accuracy of quality checking is also a challenging task. Unsorted rice grains may contain many impurities like stones, weeds, seeds, straw and spoiled seeds. The level of automation in testing the quality of rice grains is low and requires manpower for executing the job[5]-[9].

The qualities of rice grains play a vital role because rice is the staple food of the people in our country. The colour, shape and size of the rice grains determine the quality of the rice grains. In India the population is

exponentially increasing and hence it is challenging to handle and process rice grains maintaining the food grade quality and safety standards. The use of chemical based pesticides is nowadays creating very harmful effects to the human race and hence there arises a need for quality and nutrient check in the various types of rice grains. On the other hand the machine vision method is considered to be a very quick and non-destructive method. As the technology is growing wider people are adopting the new technologies [10]-[19].

Grain yield, nutrients contents and quality in different rice grains is evaluated to develop a high yield and good quality rice grains. Agro ecological zones are used in the estimation of examining macro nutrients concentrations. The Parameters like milling, cooking nutrition and quality f rice grain plays an important role in the success of rice breeding [20-22]. The production of rice grains and their nutrient content is affected greatly by environmental conditions. Meteorological measurements and aerial vehicle remote sensing are used to relate rice grain nutrient content and environmental conditions. A study conducted in the analysis of presence of nutrient content in rice grain shows significant variation of Protein and amino acid content. The nutritional quality of rice grain is being affected in great manner by the toxic mineral elements accumulation [23-25).

1.1. Related Work

Jagdeep Singh Aulakh D.R. V.K. Banga [1] purposed Flat Bed Scanning (FBS) method to grade the rice grains using image processing techniques. The external factors like fatigue can be eliminated or reduced by using this technique to identify the broken grains. The images of the rice grains are captured by a digital camera with high resolution. Background extraction is carried out using the image subtraction technique followed by contrast stretching to adjust the contrast of the images. So by this experimentation method the grading of rice grains was done but the efficiency was low and the nutrients present in various types of rice grains were not identified[14]-[16]. Kaur and Verma in their research work have used computer vision methods to sort the rice grains using kernels of full, medium or half sized. Images of optimal resolution are captured using a high resolution camera. The camera is placed perpendicular to the plane in which the paddy fields are located. Images captured under varied illumination with variability in background are tested using image processing algorithms. The quality of the image may be affected due to poor illumination effects and need to be removed so that the image is converted to a binary image followed by erosion and dilation operations. The area of the rice grains were found out by counting the area of each connected portion of the image. Morphological operations were performed to grade the rice grains[13].

Naiquin Zhang proposed a method to identify the protein content in wheat grains using [3] a real time image processing algorithms. This method's output was based on the colour, cleanliness, and size of the rice grains. Mandeep Saini et al, in his work have proposed an image based scheme to increase the production of wheat as the chief food crop for humans instead of maize. Quality finding of the wheat is a very cumbersome process. Expert judge will determine the quality of wheat in manual mode and is also time consuming Process. The challenge is to distinguish between the similar color and shape of the rice grains. As a solution to this problem, Image processing algorithms are used to classify wheat[4].

S.V. More et al, [5] in their paper throws light of how to detect the carbohydrates, protein, fiber, vitamins, minerals and antioxidants. Based on these values of constituents, the quality of the rice grains is graded.

Yosuke Yoshioka et al., [6] have indicated a method to evaluate the effectiveness of the image scanner to detect and measure the chalkiness of the rice grains and grade them based on the chalkiness using visual assessment methods. Nearly, 246 types were taken for analysis.

2. METHOD

Three different rice varieties are taken for nutrient estimation. This includes Brown Rice (BR), White Rice (WR) and Enriched White Rice (EWR). The various nutrients to be estimated are Manganese, Niacin, Thiamin, Selenium and Magnesium. First a look up table is formed in consultation with the agriculturalists and dietician to identify the presence of the nutrients in the above mentioned three varieties of rice grains. The images of the rice grains pertaining to the three varieties is depicted in Figure 1. The nutrients content in various rice varieties are presented in Table 1. The procedure for using image processing algorithms in nutrient identification in rice grains is illustrated in Figure 2.

Brown rice (BR)	White rice (WR)	Enriched white rice (EWR)

Figure 1. Images of Rice grains

Table 1. Nutrients content in various Rice Varieties

Nutrients	Brown rice(BR)	White Rice(WR)	Enriched White Rice(EWR)
Manganese	42% DV	16% DV	16% DV
Niacin	16% DV	3% DV	9% DV
Thiamine	15% DV	2% DV	14% DV
Selenium	11% DV	–	14% DV
Magnesium	9% DV	2% DV	2% DV

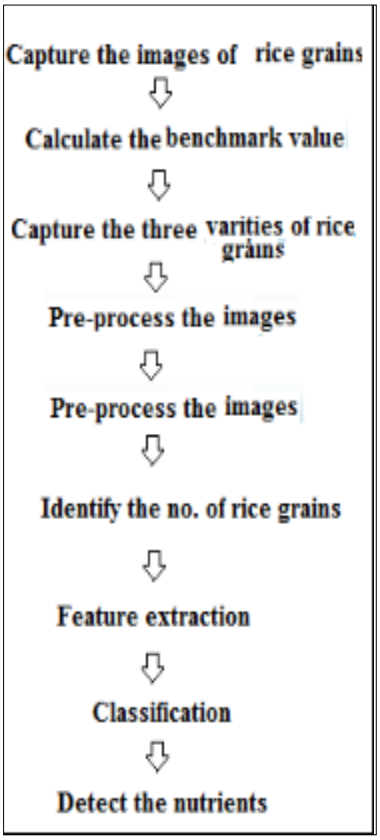

Figure 2. Schematic for Image processing in nutrient identification in rice grains

The features are extracted from the three varieties of rice images. These features are then used to train the Feed Forward Neural Network (FFNN) using Back Propagation Algorithm (BPA), whose architecture is, described Figure 3.

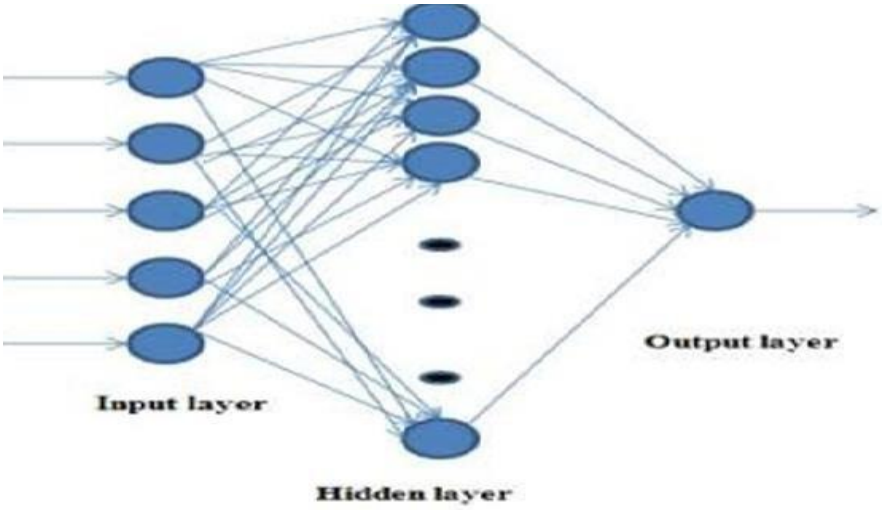

Figure 3. ANN architecture with BPA

3. RESULTS AND DISCUSSION

Studies related to real scenario state that all solutions related to nutrient identification from rice images do not have expected accuracy level. Hence to increase the detection efficiency this image based scheme plays a vital role. However, all the applications are only provide knowledge about some limited information. Therefore, it is needful to develop an indigenous nutrients detection system which directly predicts the nutrients and quality of rice with online images. The framework for nutrients detection is shown in Figure 4.

3.1. Image Acquisition

Acquiring the images of the rice is the major part in implementing image based schemes which gives an idea to the buyers about the nutrient value present in the rice images. Apart from this step, the method includes preprocessing the rice images and the great challenge in image acquisition is that the testing and selection of an appropriate gadget like high resolution cameras.

3.2. Image Pre-Processing

Image processing is a procedure to change the input rice image into a required form which can be subsequently processed through various stages like colour conversion and RGB channel extraction [2, 3]. The image pre-processing include filtering, color conversion and detail enhancement of image [12-16].As per the recent researches that has been conducted over the related image pre-processing techniques carried out for detecting the nutrients in various rice varieties as mentioned in Table 1.

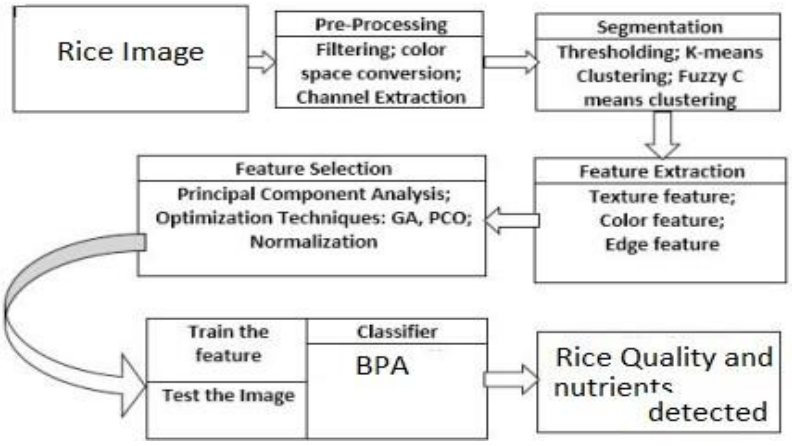

Figure 4. Framework for Nutrients Detection in Rice

3.3. Segmentation

Image segmentation is way that is meant way for sectioning the rice images into its basic building blocks called the pixels for nutrients identification a computerized image processing algorithm. Segmentation helps to detect the region of interest by dividing the entire image into smaller parts, thereby enabling the researcher to detect the region of interest. RGB image to grayscale image model is used here [7, 8].

3.4. Feature Extraction

Feature extraction technique is an important part prior to image classification. The features are the key parameters that facilitate the rice image classification. They include color and shape extraction. Color extraction is an important factor of distinctive classes. Digital image processing techniques produce color evaluation is tremendously functional when researching the nutrient determination [5]. An image pixel typically addressed in the RGB space, in which the color space at each pixel addressed as a combination of pixel values in RGB planes respectively [6]. Shape descriptors include Major Axis Length (MaAL) and Minor Axis Length (MiAL) as twofold parts. The extracted features are used to train the ANN classifier [7].

3.5. Classification

The experimental results illustrate that the overall detection rate of rice nutrients dependent on foremost segmentation step and selecting suitable ANN architecture parameters for training with BPA. The accuracy level is 95.92%, which is very superior to the other methods of conventional classification as shown in Figure 5.

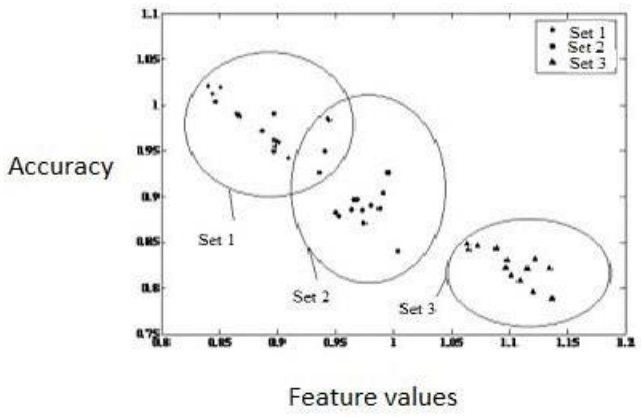

Figure 5. Results for nutrients detection in three varieties of Rice

4. CONCLUSION

This research work enlightens the researchers with the knowledge about three different types of rice and the nutrients present in them. Also, this paper will enable the researchers to have an insight about pre-processing, segmentation, feature extraction, and classification techniques. Various issues related to nutrients detection in rice plants are discussed here so as to provide a common acceptable framework for quality detection and enhancement. The performance of the proposed AI sensor with intelligent classifier was found to be satisfactory because the accuracy value is 95.92%.

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