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Quality Assessment Of Sorghum Grain Using Image Processing Techniques

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Abstract: With a rise in health problems, one of which is malnutrition, in the present work, an attempt is made to find the best quality products of one of the finest and nutrient-dense grains, sorghum. We intend to accomplish this by acquiring data using digital processing techniques and then applying a grading system to give information to consumers about the quality of the grains being used.

The main objective is to introduce a low-cost quality assessment technique of digital image processing system for Sorghum grains. Sorghum is one of the most nutrient-dense grains whose quality is determined by its size and colour. Sorghum grain sphericity, aspect ratio, and shape factor can be determined from the dimensional measurements that are processed using Digital Image Processing. Manually determining the factors of the grain is a tedious task with lesser accuracy. Image processing techniques developed in this study is suitable for measurement of sorghum grain shape and the different quality of sorghum can be separated based on their shape.

Index Terms:Aspect ratio, Digital Image Processing, Grading system, Grain sphericity, Shape factor, Quality Assessment

1. INTRODUCTION

One of the important factors which affect today's market is proper nourishment in the quality of food and food grains should be free of adulteration. By the addition of impurities in food, the composition and quality of food are affected (Deepika Sharma and Sharad D. Sawant,2017). To overcome this problem, image processing has been used to classify food grains (MirolyubMladenovet.al., 2011). Sorghum is one of the most nutrient-dense grains whose quality is determined by its size and color (R. N. Kenghe et.al.,2015). Grain sphericity, aspect ratio, and shape factor of Sorghum can be determined from the dimensional measurements that are processed using Digital image Processing (Pius Emesu et.al.,2013). The grain shape of plant seed is one of the important parameters for the detection and classification of seed quality (HuaGaoet.al., 2008). Manually determining the details of the grain is a tedious task and yields lesser accuracy. Hence, recently the grain images were captured using multi and Hyper spectral (A Nandibewooret.al., 2018 and SwetaMuddebihal et.al., 2017) cameras showing vast information about the grain (Salem B Hebbal et.al.,2015, P Kini et.al.,2018 and PrashantAdiver et.al.,2014). Quality evaluation of food grains using image processing techniques was studied for distribution of quality of food based on grain Colour, Appearance, Flavour, Texture, and Nutritional value. (ChankiPandey et.al.,2020, Muhammad JunaidAsif et.al.,2018 and T.Gayathri Devi et.al.,2017). Disease Classification and Identification of crops helped to acquire insight into feature extraction and its objectives in Image processing (ShaikhRakhshindaet.al., 2019, Pushpalatha S Nikkam et.al.,2020 and Varsha P Gaikwad et.al., 2017). Additionally, image processing techniques like edge

detection, image restoration, image segmentation developed by earlier investigations (NamrataVaradMhapne et.al.,2019, A.M.Raid et.al.,2014 and Abirami S.et.al.,2014) are suitable for measuring different varieties of sorghum grain shape and their separation.
In the proposed method the quality of Sorghum is analysed using the aspect ratio of each kernel. The aspect ratio of each kernel is calculated from the width to its height. Also, the mage sample of the grain is taken by a camera device. After knowing the aspect ratio, the proposed study will also give the grading system for the quality of sorghum kernels..

2. METHODS

The Flow diagram and Detailed design of the proposed work is discussed under the following section.

2.1 Flow Diagram
Figure 1 shows the flow diagram of the proposed work. First, we capture the image of grain(sorghum) using mobile phone camera. The camera must have more than 13 megapixels to get a clear quality image. The image processing algorithm is applied on the image in the next stage. The algorithm will analyze the quality of the grain depending on many factors such as shape, color and texture. Once the calculations of the value of grains are made, the aspect ratio of each grain helps in recognizing the quality of the grains

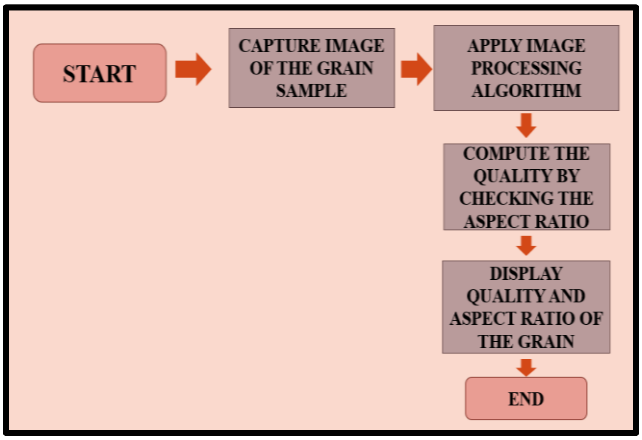

Figure 1. Flow diagram of the proposed work

2.2. Detailed Design
This section includes the Architectural Design, Framework of topological study, Feature extraction. Also, the block diagram of the proposed work is discussed.

A. Architectural Design
Figure 2 shows the Architectural diagram of the proposed system. We first acquire the image. Then, the background of the image is eliminated, later by applying thresholding techniques we enhance the image. Next, the required features are extracted, and then the analysis is made by comparing it with the database.

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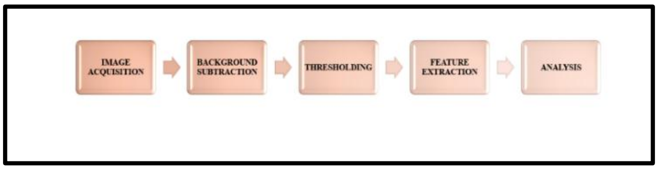

Figure 2.Architectural design.

The implementation of the proposed design is done in the following steps as below:

1. Image Acquisition: Image acquisition is done with the aid of a camera which is fixed at some particular distance above from grain sample. Image sample of the grain is taken by the camera device.

2. Background Subtraction: In this step, the region of interest i.e., the foreground is extracted and the background is eliminated by applying the substation method.

3. Thresholding: It is used to analyse the object in the region in an image. This is done based on the variation of intensity between the object pixel and background pixel.

4. Feature Extraction: In this step, qualitative information of the object is extracted from the given image. The geometrical features of the grain are extracted from the input sample image. The features like Length, Breadth, Thickness, Sphericity, Size, and Surface Area are considered into account.

5. Analysis: This step is done by extracting the features of the image. The features are compared with respective features of the standard quality grain sample. The final quality is then decided to depend on the degree of matching.

B. Framework for Topological Study

Figure 3 gives the topological framework of the proposed work. The given query image is loaded into the system and its features are extracted. We also have an image database collected from which the features are extracted. So, from the query image, the features are compared with that of the features present in the image database, and thus the similarity matching is done. Similarity matching refers to checking the features obtained by extraction done during feature extraction with the values predefined in the database of the images. Later the image that is of most alike is retrieved.

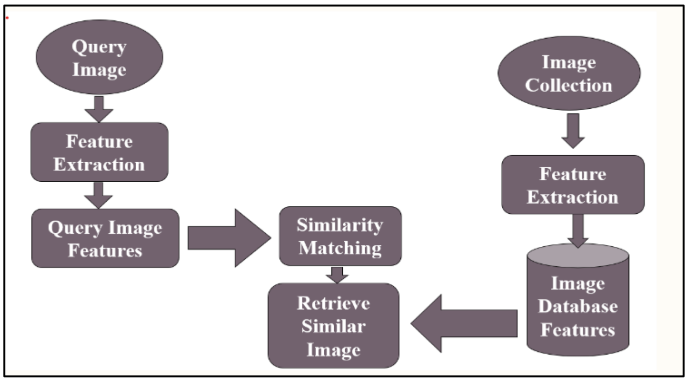

Figure 3. Framework for Topological Study

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C. Feature Extraction

In image processing and computer vision, solving different computational Problems of different applications, features of the image give the relevant information. Features may be an outcome of neighborhood pixels operation or represent the specific structure in the image.

Image's features extraction is done when the image goes through a series of steps (Refer Shape descriptor in Figure 4) that include Grayscale conversion, thresholding, edge detection, morphology, contour extraction, and distance computation. After undergoing all the steps of the shape descriptor, we get a well-defined image which is then checked for shape matching and later the features are retrieved.

For classifier performance, feature extraction plays a significant role to represent segmented images on a vector of fixed features that should be distinct and relevant. We use three features for our proposed method namely, Texture, Shape, and Color.

All of these are useful for classifications of damage and non-damaged grains.

1. Texture features: Texture features are extracted using the Grey Level co-occurrence matrix (GLCM). GLCM method is a statistical analysis tool of grey-level images. The distribution of grey levels is measured based on the spatial relation of pixels using given distance and directions in the image.
2. Shape Features: Shape Features specify the different geometric characteristics of an object which include area, perimeter, circularity, and complexity.
3. Color Feature: colour features are acquired by various methods such as colour histogram, colour structure descriptor, and colour moments.
4.

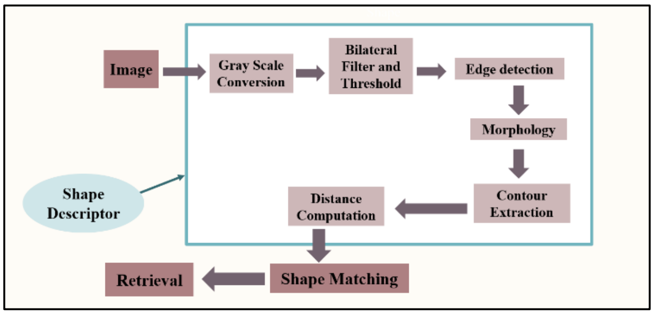

Figure 4. Feature Extraction

Figure 4 depicts the image which goes through various phases in order to extract features. It is then sent to a shape descriptor where several computations are made to analyze the image and retrieve the data. This data is used further for shape matching and retrieval of similar data set present in the database for computation. In greyscale conversion, the RGB values (24 bit) of the image is converted into grayscale value (8 bit). The bilateral filter smoothens the image and changes the intensity of each pixel with a weighted average of intensity values from nearby pixels. In thresholding, the image is converted from grayscale to binary i.e., in black and white. The boundaries of the image are detected using edge detection. The image is then analysed using the morphological technique. (Morphological techniques include processing image for size, colour, and texture). In the contour extraction, the information about the general shape of the image is extracted through which its different characteristics will be examined. In the distance computation, the measure of separation of points in the image is provided. In the shape matching the shape is recognized and it also provides a statistical relationship between the currently viewed object and that stored in the database. In this shape, descriptor plays a major role. After going through all the phases, an image is retrieved at the end.D. Proposed System (Prototype of The Project).

Figure 5 shows theproposed system which explains the basic steps for analysing the sorghum kernels are given below:

1. The original image is converted into a grayscale image.
2. In the next step, the grayscale image is converted to Binary Image i.e., Black and White or 0 and 1. This is generated using threshold operation. When a pixel is above the threshold value then it is turned white (1) and if the pixel which is below the threshold value is turned Black (0).
3. Image Filtration is used to change the range of the images without changing the pixel positions. This is done to modify or enhance image properties and to extract the specific information from the pictures such as edges, corners, and blobs by smoothening the images i.e., enhancing or detecting edges in the image is the done.
4. Erosion is carried out to shrink the image and strip away extrusions and jointed objects.
5. Dilation is used to enlarge the images. It is used for bridging gaps of character due to poor resolution, it leads to thickening, thus repair breaks and intrusions.
6. Edges of objects in an image are detected using Edge Detection.Edges are the locations where images have a high degree of rapid intensity, and they play a significant function in human perception. Edge detection is the texture identifying the end of one section and the beginning of another in the image. It decreases the quantity of data in an image without affecting its structural features.

The proposed method uses the Canny Edge Detection. The main objectives of the canny edge detection are as stated below:

- **Low Error rate:** The probability of detecting all edge points should be found, with a minimum of false responses.
- **Localization:** The detected edges should be as close as possible to the true edge points.
- **Number of responses:** There should be only one response for each real edge point.

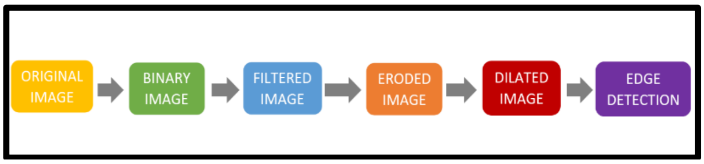

Figure 5. Proposed System

3. RESULTS AND DISCUSSIONS

In this section, we discuss the implementation and outcomes of the proposed system.

A. Implementation

The main aim of the study is to solve the problem in industries and also replace human exertions in the process of quality assessment as it takes a long time and also gives uncertainty in results. Low-cost equipment for quality assessment is much needed in today's

industry. The aspect ratio is the ratio of width to height of the kernel that was taken into consideration in the proposed work. The height, width, and thickness are taken into consideration between the range from 5.02 to 5.69mm, 4.25 to 4.63, and 3.22 to 3.53mm respectively. The grain size is calculated between the aspect ratio of 4.09 and 4.53 (ChankiPandey et.al.,2020).
The difference in the type of grading was made based on the amount of moisture content present in the kernel. The increase in moisture content is in line with the existing results (GikuruMwithiga et.al 2020) and is a linear increase in the grain dimensions. Furthermore, the increase in moisture content particularly with high temperature results in accelerated grain deterioration and promotes the growth of insects and fungi.
The calculation based on the aspect ratio and further grading is devised. The following formula was taken into consideration for the evaluation of the aspect ratio.
Aspect ratio = float (w) /h; where '**w**' is width and '**h**' is height
If (aspect ratio< 1); then, Aspect ratio =1/aspect ratio.
A lesser aspect ratio implies a lesser dimension; a lesser dimension implies lesser moisture; lesser moisture implies better grain quality. On this basis, the grading system is formulated by considering three grading systems as Best, Better, and Average. as shown in the result (**Figure.7**).

B. Outcomes

Figure 6 explains the overall outcome of the proposed system. The detailed process is discussed as follows:

Original image: The accuracy and speed of the process are influenced by the image's resolution, size, and format. A lower-resolution image displayed in **Fig.6(a)** is less accurate, but it is usually smaller and faster to analyse, whereas a high-resolution image displays all the finer features but takes a long time to process.

Hence an image with appropriate resolution needs to be selected which will be suitable for a particular application (ChankiPandey et.al.,2020). The original image represents the image that is captured by the user.

Binary image: Binary images are shown in **Fig.6 (b)** in which each pixel has only two possible intensity values. Thresholding a grayscale or colour image to separate an object from the background is a common way to create binary images. The foreground colour refers to the colour of the object (which is usually white).
Filtered image: In image processing, filters are mainly used to suppress either the high frequencies in the image, i.e., smoothing the image, or the low frequencies, i.e., enhancing or detecting edges in the image as in **Fig. 6c**.

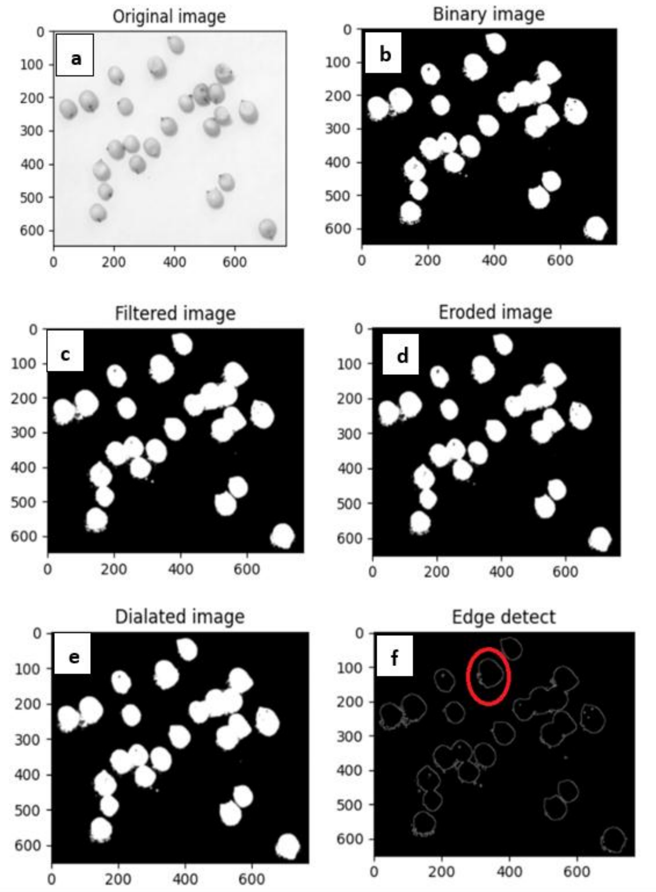

Figure 6.(a) Original image of the sample Sorghum seeds, (b) Binary image of the input data set, (c) Filtered image, (d) Eroded Image, (e) Dilated Image, and (f) Edge Image

Eroded image: Erosion (usually represented by θ) is one of two fundamental operations (the other being dilation) in morphological image processing from which all other morphological operations are based. It was originally defined for binary images, later being extended to grayscale images, and subsequently to complete lattices. The basic effect of the operator on a binary image is to erode away the boundaries of regions of foreground pixels (i.e., white pixels, typically). Thus, areas of foreground pixels shrink in size, and holes within those areas become larger as shown in **Fig.6d**.

Dilated image: In Fig.6e, the process of structuring element B on image A and moving it across the image in a way like convolution is defined as a dilation operation. The two main inputs for the dilation operator are the image that is to be dilated and a set of coordinate points known as a structuring element which define also as a kernel. The exact effect of the dilation on the input image is determined by this structuring element

Edge detection: In **Fig.6(f)** the edge detection is based on recognition of edges by diverse edge operators. Discontinuities in colour, grey level, texture, etc. are detected by edge operators. Canny edge detection is an optimal recognition process to detect the greyscale image boundaries. Canny edge detector distinguishes the edges by locating the local maxima and minima of the gradient of the intensity function. The Canny edge detector blurs the images faintly and then applies an algorithm that thins the edges to one pixel efficiently.The red circle in **Fig. 6(f)** indicates the kernel whose texture was not appropriate.

After calculations, the aspect ratio is in the range of 1.15 to 1.23. According to the proposed grading system, if the aspect ratio < 1.20 the grains are best; if the aspect ratio ≥ 1.21 to 1.23 the grains are better (medium), and if the aspect ratio ≥ 1.23 it is average.

Figure 7 shows the generated output aspect ratio of each kernel and also the average aspect ratio (The aspect ratio of a geometric shape is the ratio of its sizes in different dimensions). Here aspect ratio refers to the ratio of sorghum grain of its width to its height of all the kernels. This helps in analysing the quality of sorghum kernels. The average aspect ratio gives us the assessment of the quality of the total number of grains taken into consideration.

```
Starting
No. of sorghum kernals= 24
2.5 (Average)
1.07 (Best)
2.5 (Average)
2.0 (Average)
1.0 (Best)
1.29 (Average)
1.13 (Best)
2.5 (Average)
2.0 (Average)
2.11 (Average)
1.5 (Average)
1.47 (Average)
2.0 (Average)
1.01 (Best)
1.33 (Average)
2.0 (Average)
1.11 (Best)
1.05 (Best)
1.39 (Average)
2.0 (Average)
1.15 (Best)
1.19 (Better)
1.09 (Best)
1.0 (Best)
Average Aspect Ratio= 1.56 (Average)
```

Figure 7.Induvial and average aspect ratio of sorghum grains.

4. CONCLUSION

- To prepare an application that will meet the societal needs for healthy living by providing adequate nutritional information and knowledge about the quality of the grains.
- Assuring that the people consume only the best quality of food by consciously checking the quality in numerical values.
- The supply chain will henceforth be aware of the system, creating a stringent atmosphere for quality goods for the whole supply chain.

Future Scope:

- To capture pictures dynamically.
- To develop methodologies for other food grains and develop a full-fledged quality assessment application that takes into consideration many other food grains including rice and wheat.
- Use of different classifiers to enhance the result and compare the values using different algorithms.

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