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Quality Assessment of Food Grain using Digital Image Processing

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Abstract: ***India ranks second in the agricultural output.India is in top five positions for about 80% of products produced from farm. Classification and quality check of food grain is still heavily done manually which may be tedious, time consuming, inconsistence and is influenced by the physiological factors.Bringing automation in food engineering and processing will speed up, increase efficiency and accuracy in quality assessment of food grains.Cost of assessment of quality will automatically be reduced and this cost may go into the hands of its producers ie. farmers.***

Keywords: ***Digital Image Processing, Feature Extraction, Neural Network, MATLAB, Grain.***

I. INTRODUCTION

Grains can be categorized on the basis of the structural properties. Also the quality of the food grain depends on this property. Structural features of an object are known as the morphological features. Morphological features of the grain are extracted using the digital image processing. This process is known as feature extraction. After feature extraction, the collected dataset and the target dataset is analysed by using neural network. It is a supervised learning process as both the input dataset and the target dataset are provided.

II. METHODOLOGY

The following steps where followed to obtain the quality of the food grain:

A. Image Acquisition:

Images must be captured in high resolution. A 13MP camera was used to capture the images.A total of 120 images were captured of three categories of wheat 40 images for each category. The lighting condition must be same for all the images captured. The images were captured in natural daylight with a white background. Also the shadow of the grains should be avoided while capturing the image. It is assumed that the grains in the images are separated at finite distance and also the grains must not lie at the boundary ofimage.

B. Image Enhancement:

The captured images cannot be directly used for the quality analysis. Images need to be processed before moving to feature extraction step. Image enhancement refers to the different operations performed on the image like contrast and brightness adjustment and applying filters to remove the noise from the image. The images where resized to 256x256 pixel so that the further processing steps becomes faster.

C. Image Segmentation:

Image segmentation is done to classify several regions in the image based on its features. After enhancement of the image,the edge of the object in binary image is detected using thresholding. Canny edge detector was used to determine the edges of the food grain which is available in the MATLAB. Holes are noise which was also filled so that we get correct number of the food grain available in an image.

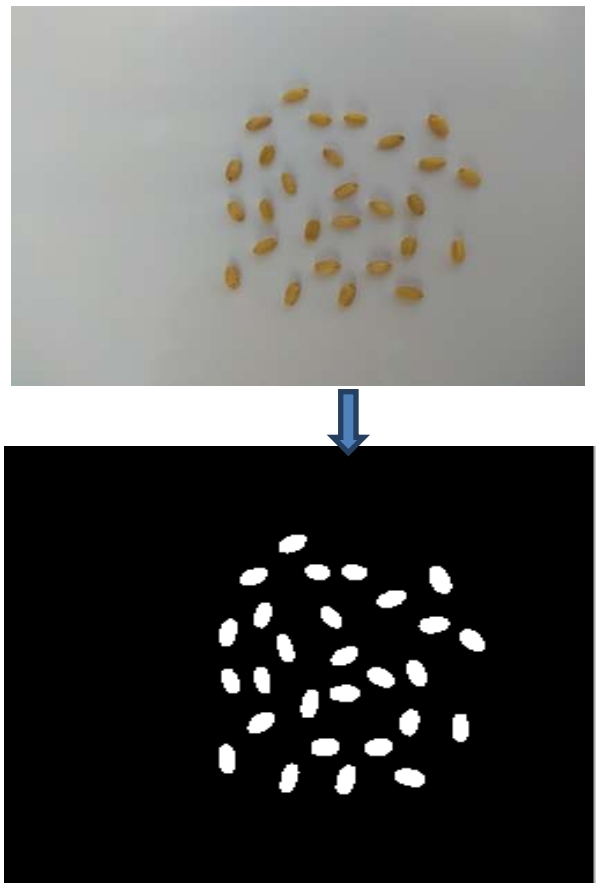

Fig. 1. Image Enhancement and Segmentation

D. Feature Selection and Extraction:

Morphological features, that is,features that are related to the form or structureof the object here grains are taken into consideration. These features were extracted using the MATLAB. Ten morphological features of each food grain are selected and extracted. After getting the count of the grains following morphological features were extracted:

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1. Area: Area is the region that is determined by the number of pixel within the bounded regions that is the edges.

2. Perimeter: The perimeter is determined by the number of pixels at the boundary.

3. Major Axis Length: Major axis is the distance between the endpoints of the longest line that can be drawn across the food grain. The longest line that can be drawn is determined by drawing every possible line in between the boundary points of the food grains.

4. Minor Axis Length: Minor axis is the longest line that can be drawn across which is also perpendicular to the major axis.

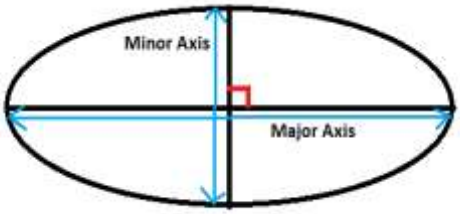

Fig. 2. Major and Minor Axis

5. Eccentricity: Eccentricity of an ellipse here the food grains is the ratio of the distance between the center and one of the foci and the one of the vertices of the ellipse**.**

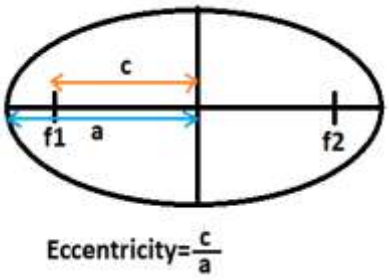

Fig. 3. Eccentricity

6. Convex Area: It the number of pixel in the smallest convex polygon having area equal to the convex hull of the food grain.

7. Solidity: The proportion of pixels in the grain region that were also in the convex hull.

Solidity=Area/ConvexArea

8. Equivalent Diameter: It is the diameter of the circle having the same area as the food grain.

$$\sqrt{(4A/\pi)}$$

9. Compactness: It quantifies the roundness of the food grain.

$$\sqrt{(4A/\pi)/L}$$

10. Aspect Ratio: It is the ratio of the major axis length and the minor axis length.

This extracted feature can be used to classify and determine the quality of food grain

E. Preprocessing of Morphological Dataset:

Supervised learning is used to determine the class and quality of the grain. For supervised learning two datasets are required, first is the input dataset and second is target dataset. The morphological data which were extracted acts as the input dataset. Morphological feature is extracted for each food grain in an image. So the mean of each features where taken for all the food grain in an image. After this, dataset was normalized. Normalization was done for each category of the food grain and not the whole dataset.

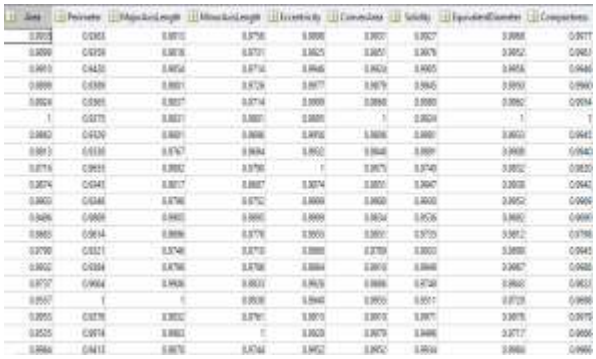

Fig. 4. Input Dataset

Target data was prepared manually. There is one field for the each category of the food grain and additional two fields, one for the good quality and another for the bad quality. The target dataset contains only the binary value that is 1's and 0's. For example we have a grain of category A so the fields for A will contain 1 for images of category A and for all the other categories the value will be 0. The quality of a grain was determined by taking the sum of all morphological features and then taking its average and then comparing the average value with sum of morphological features of an individual image for each category. If value of an individual image is greater than the average the grain quality is assumed to be good else the quality was assumed to be bad quality food grain. This process was repeated for each category of the food grain.

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	A	B	C	D	E
1	Category A	Category B	Category B	Good Quality	Bad Quality
2	1	0	0	1	0
3	1	0	0	1	0
4	1	0	0	0	1
5	1	0	0	0	1
6	1	0	0	1	0
7	1	0	0	1	0
8	1	0	0	1	0
9	1	0	0	1	0
10	1	0	0	1	0
11	1	0	0	0	1
12	1	0	0	0	1
13	1	0	0	1	0
14	1	0	0	0	1
15	1	0	0	1	0
16	1	0	0	0	1
17	1	0	0	1	0
18	1	0	0	0	1
19	1	0	0	1	0
20	1	0	0	0	1
21	1	0	0	1	0
22	1	0	0	0	1
23	1	0	0	1	0
24	1	0	0	1	0

Fig. 5. Target Dataset

F. Training the feed-Forward Neural Network:

The input and the prepared target dataset are feed to the feed-forward-neural network. The neural network can be implemented with help of MATLAB tool.

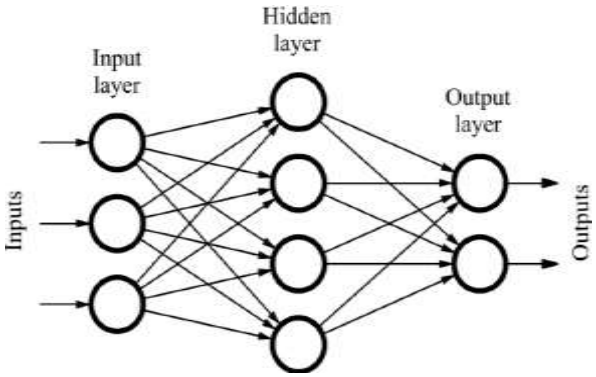

Fig. 6. Feed-Forward Neural Network

In feed forward network, the information moves in only one direction, forward, from the input nodes(length of feature vector), through the hidden nodes (if any) and to the output nodes(number of possible classes). There are no cycles or loops in the network.

Basis operation which is performed is classification of the food grain based on it morphological features. The grains are classified based on two parameters that is,which category it belongs to and what is its quality. The feed dataset was divided randomly into three sets, 70% for training, 15% for validation and 15% for testing. A total of 10 hidden layers were used for the feed-forward neural network. The neural network was trained. The cross entropy after training was 1.00648 and the error percentage was 50%.

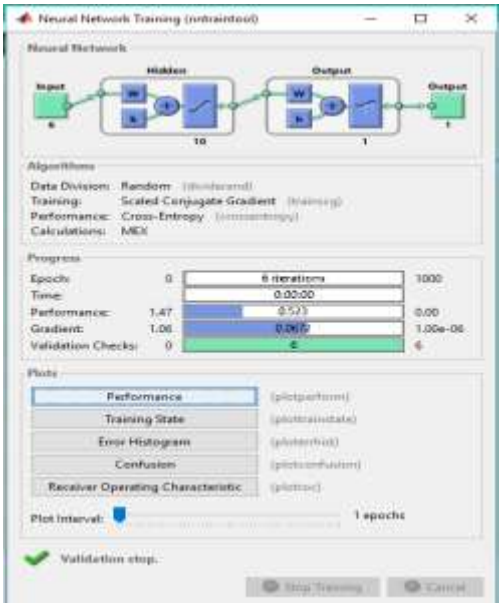

Fig. 7. Feed Forward Neural Network Training Report

After training the neural network the model is prepared for the given input dataset and target dataset for which the code can be generated.

G. Testing the Obtained Model:

The efficiency of the model obtained after training is determined by providing the new dataset as input. The input data will contain same number of fields as in case of input dataset used for training purpose. The input dataset must also be normalized. The model determines both the category and the quality of the food grain. The output of the neural network will always be values between 0 and 1. The returned number of values will be same as the numbers of fields in the target dataset.

For example, the neural network is trained for three categories of food grain. The ten normalized morphological feature for an images is provided as the input. The output contains 5 values, first three values are for the category and the last 2 values are for quality. Forth value is for good quality and the fifth for the bad quality. The field whichobtains maximum value among the first three, the food grain belongs to that category. Similarly in case of quality, if the forth value is greater than the fifth the food grain is of good quality else it is of bad quality. Consider this output values:0.5291, 0.0189, 0.0017, 0.4500, 0.0003.Here 0.5291, 0.0189, 0.0017 corresponds to category A, B, C respectively. 0.5291 is maximum among them so the grain belongs to the category A grain. Next 0.4500 and 0.0003 corresponds to the good and bad quality. 0.4500 is greater than 0.0003 so the quality of the food grain is good.

H. Building the GUI:

A Graphical User Interface is build where the user can upload the image and get the output in the form of

category and quality of the food grain. The GUI is also prepared using the MATLAB.

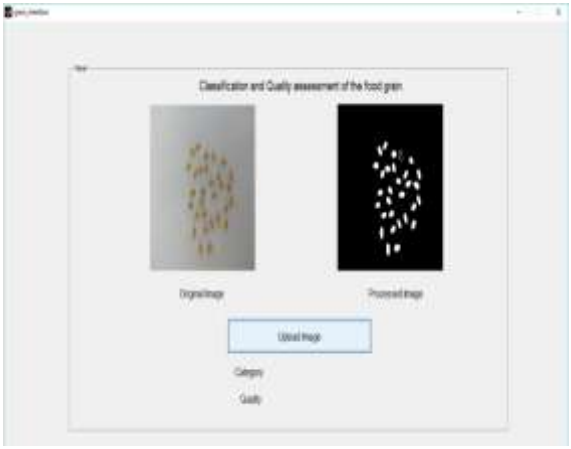

Fig. 8. GUI

III. CONCLUSION

The accuracy of the model obtained is 85%. Theefficiency can be improved by enhancing the quality of the captured image. The image pre-processing step can be changed to get better results. The major drawback of this methodology is that the image for testing must be captured in ideal situation in which the training images where captured.The followed methodology can be used in food processing industry for sorting the good quality food grains before going for further processing.

IV. FUTURE ENHANCEMENT

This paper proposes the classification and assessment of the quality of food grain based only on the morphological features of the food grain. Color features of the food grain are not included which may also heavily affect the quality of the food grains. In future, the color features may be included along with the morphological features which will result into better quality assessment. Also in this paper it is limited for quality assessment of the food grain only but the same methodology can be used to obtain the quality of the other food items such as fruits and vegetable.

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