Grain Classification and Quality Analysis Using CNN and Support Vector Machine

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Abstract*:* Identification and analysis of quality of different grains is becoming popular because of its crucial purposes including export and health. At present the grain quality is decided manually because of this farmers get affected also the low quality grain is sold as high quality grain and this become serious issue. For that introduced an automated system that is capable to classify the different types of grains along with their quality. This paper deals with the five different varieties of grains. Database is created using these different grains. Different types of features like geometric, colour features are extracted from the images. In this grain identification is done by using the convolutional neural network. And the grain quality is analysed by using the Linear Multiclass Support Vector Machine (LMSVM) along with the extracted grain features. Finally grain is identified according to its quality as good, bad or medium.

Keywords: Image preprocessing, Feature extraction, CNN, Linear Multiclass SVM, quality grading.

I. INTRODUCTION

India is the larger producer of different grains in the world. As countries reach self-sufficiency in grain production, the demand by the consumer for better quality grain has increased. The grading of grain depends upon different parameters such as size, shape , colour and no of broken seeds. Consumers have an interest with classification of food grains automatically and high expectation about the grain quality. The decision taken by manual inspector is affected by external parameters such as vengeance, bias, fatigue etc. Food grain has to be cleaned and ready for the consumption many of the food industries investing expensively for ensuring the high grain quality assessment.

but, even the processing is done, some error will always occur in quality detection. For that need to introduced new ideas and image processing methods for evaluating grain appearance quality. In that an automatic classifier can prevent human errors in the quality evaluation process, which has become an alternative to manual inspection of grain samples The Accuracy and effectiveness of manual testing are improved by the use of these methods.

In this work images of different varieties of grains are obtained by using camera, different features are extracted like morphological, colour and shape features using image processing techniques. These features are used to train the neural network model. The neural network based model is used for classification and quality analysis of various grains. The work is completed by image preprocessing, CNN and Support vector machine.

The rest of the paper is organized as follows: Section II provides the summary of contribution of previous researchers in grain identification and quality analysis. Section III highlights on the theoretical background of the proposed architecture followed by the experimental set up and discussion in Section IV. The results are discussed in Section V. Conclusion and future work directions are mentioned in Section VI.

II.CONTRIBUTION BY THE PREVIOUS RESEARCHERS:

Quality analysis of grain is becoming a popular research area. This section provides brief discussion on different methodologies implemented by earlier researchers which lead a path to implement the reported system with more reliability.

Nadeesha Nagoda et al introduced a method by using machine learning technique with image pre-processing with the use of CDD camera. They had used pre-processing techniques like morphological operations, binarization, noise removal etc. on the database images. Different features were extracted like colour features, texture features and the obtained features were concatenated in a single Histogram. Linear support vector machine was used for classification by using the features extracted. The overall accuracy found were 88%.[1]

N. A. Kuchekar et al. reported a method for grading rice grains. Geometrical features like Area, major axis length and

minor axis size were extracted which provided better classification which was done based on the size of the grain. The accuracy found was Average. [2]

T. Gayathri Devi et.al implemented a machine vision based quality analysis of rice grains. Pre-processing methods like background elimination, edge detection, Morphological operations were implemented. Quality analysis was done by using end points of grain by taking different parameters like length, diagonal, breadth etc. and also the region of boundary. The overall accuracy was 97%.[3]

Deepika Sharma et al proposed a device that determines the quality of food. Initially, a grain sample was moved on the conveyor belt and then an optional picture of the grain was captured by using the camera. This device was beneficial for the food and beverage industry in the later stage of grading purposes, making the crop sorting project less complicated for the public. The accuracy found was 98%.[4]

Megha R. Siddagangappa et al presented**,** two focused on offering a better method for identification of different kinds of grains and rice quality primarily based on color and geometrical features using Probabilistic neural network and image processing concepts. The extracted properties are entered into the PNN classifier for further matching processing. For identification, thirteen types of cereals are considered. The overall accuracy found was 95% [5]

Bhagyashree Mahale et al suggested the image processing algorithms to segment and identify rice grains. To analyse the quality of rice they used the feature as size. The most important advantage of that method was it required minimum time; value is much less and offers higher outcomes compared with manual effects or ordinary methods. The accuracy obtained is good. [6]

Table 1 represents the summary of the work done in this area.

TABLE 1: SUMMARY OF LITERATURE REVIEW

Sr. No	Ref.	Methods used for feature extraction and classification	Accuracy	Limitations
1.	[1]	Feature Extraction: Linear Kernel based Support Vector Machine (SVM), Segmentation based on Watershed algorithm.	Segmentation accuracy 96%. Classification accuracy 88.0%.	An improvement Needs to increase the precision and recall rate.
2.	[2]	Feature extraction based on Local Binary Pattern (LBP), Canny edge detection, image segmentation.	Average accuracy.	The work in future is finding other quality features of rice grains and working on moving image.
3.	[3]	Feature extraction: NB tree classifier, SMO classifier Fast Multilayer perceptron, Image Pre-processing.	Accuracy of 95.78%	Making use of photographic images for Classification.
4.	[4]	Feature extraction: Comparing Area, length, breadth factors. Image analysis, Background subtraction.	High accuracy.	The requirement to orient the kernels manually.
5.	[5]	Feature extraction: NN classifier, Image processing algorithm.	Accuracy between94% to 68%.	Needs to increase precision.
6.	[6]	Feature extraction: Multilayer feed foreword neural network, Image preprocessing and smoothing.	Accurate results Were obtained.	The moisture content in the rice grain can need to be added to grade.
7.	[7]	Feature extraction: Multilayer neural network classifiers. Classification: Data acquisition.	Unsupervised neural network 79%, The Supervised networks 73% accuracy.	The performance decreases as the number of folds decreases.
8.	[8]	Feature extraction: Geometrical, PNN classifier, Image Pre- processing.	Identification accuracy 98%, grading accuracy 90%.	The limitations in the proposed method are the requirement to manually orient the kernels.
9.	[9]	Image acquisition, Image processing and analysis, edge detection, Shrinkage morphological operations etc.	-	To design Such a system on the basis of parameter this can be used to enhance the quality of Rice.
10.	[10]	Feature extraction: BP-NN, SVM, Colour feature extraction. Grain identification, colour- HSV, image acquisition.	Classification accuracy is ranging from 80% to 90%	Time taken for training the SVM using same training set is comparatively very less.
11.	[11]	Dense SIFT features, k-means clustering , Support Vector Machines	83.33% overall accuracy rate.	Big dataset with high Sample and dimension which are not carried out in this network.

III.EXPERIMENTAL WORK

By taking the previous work reference, an Automatic system is introduced which is used for grain type classification and grain quality assessment by using Convolutional neural network And image preprocessing techniques.

The work started with collecting the images of different types of grain for the database creation. The sample grain selected for the experimentation in this research work includes rice, wheat, soybean, yellow gram, corn as shown in Figure 1. Five grains were selected for consisting of 100 images of each type of grain. Out of hundred sample images, 80 images were used for training purpose and remaining 20 were used for the testing. The prepared dataset images were then given to the image pre-processing stage. Image pre-processing includes various techniques like image filtering, image acquisition, binarization, and morphological operation. After image preprocessing next step is extracting the feature from the given image like geometrical feature extraction, colour feature extraction, shape. All the extracted features are stored in the feature vector. The extracted features were then used for grading purpose. The features were given to CNN to train the system for grain identification. CNN only requires raw image data for classification. After getting the result of grain identification we combine the result with the features of training images for the grading purpose.

For grading used in quality analysis, Linear Multiclass SVM was implemented. In linear multiclass SVM the data can be easily separated by using a linear separable line. We are classifying a data using a hyperplane in this data can be easily classified by using straight line hyperplane. The Multi-class SVM is chosen as it has a bigger number of classes that can be classified, as compared to the Support Vector Machine which is limited to only two types of classes. After grading SVM gives the quality of grain as good, medium, bad. According to the class it belongs. The next section describes the block diagram in detail which is shown in Figure 2.

Figure 1: Sample images of grains

IV. DESIGN METHODOLOGY:

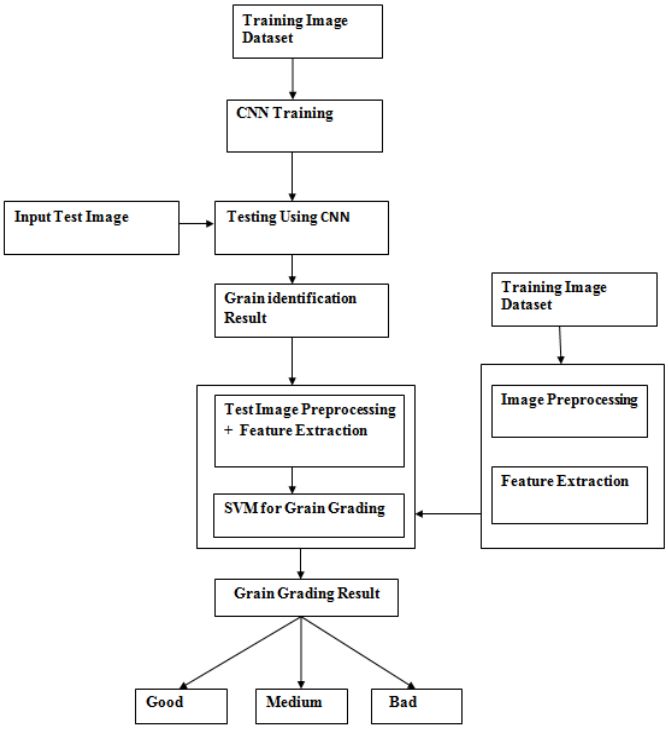

Figure 2: Design Methodology

A. Image pre-processing:

The first step is to create a background approximation image for it. Pre-processing is one of the important steps to improve the quality of captured images. The pre-processing technique uses a small neighbourhood of pixels in the image to obtain a new Luminance value in the output image.

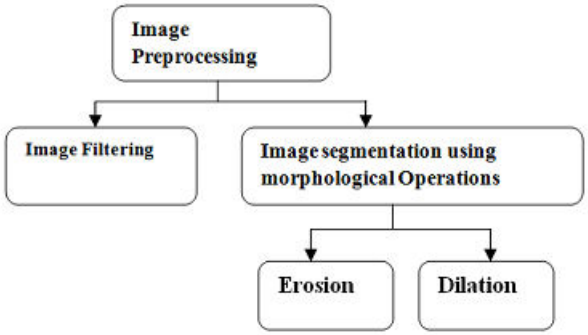

Figure 3: Pre-processing techniques.

1. Image filtering:

Starting with Image Acquisition in that Image of grain sample is taken by camera. The distance between the grain sample and camera is same. So, here we get our input image. Filtering is done for reduce noise and prepare image

For further processing. For that we are using Gaussian filter also averaging filter. Gaussian filter blurs the image by removing noise, high frequency contents like sharp edges. The average filter works by moving through the image pixel by pixel, replacing each value with the average value of neighboring pixels, including itself.

Original image Filtered image

Figure 4: Binarization output

2. Image segmentation using morphological operations:

Firstly convert the colour image to grayscale image using the convert colour. After conversion we used binary Thresholding. For segmentation simple Thresholding method is used. Thresholding is used for creating binary image from given input grayscale image. Thresholding is used mainly for separating an object considered as a foreground from its background

A collection of non-linear operations associated with the morphology of features in a image is understood as Morphological Operation in Image Processing. Mainly it's employed in distorted images Morphological Operations in Image Processing pursues the goals of removing these imperfections by accounting for the shape and structure of the image. Erosion are often used as shrinks or thins objects in binary images. Erosion could be a morphological filtering operation within which image details smaller than the structuring elements are removed.

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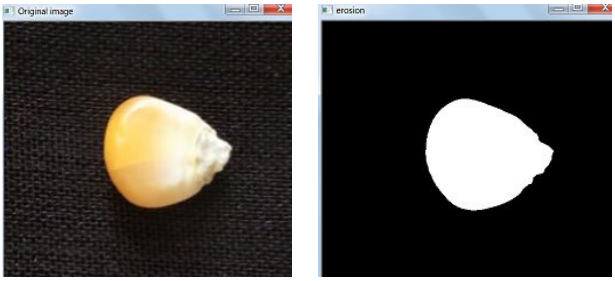
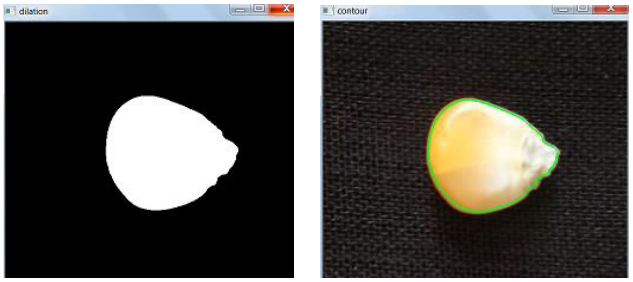
image details smaller than the structuring elements are removed.

Dialation can be used to grow or thickness objects in a binary image. It fills the smaller holes of small size. It is also used to fill blank places of images.



Original image Erosion image



Dialation image Contour detected image

Figure 5: Pre-processing output

B. Feature extraction:

Features are the important attributes which are helpful to distinguish one object from another. Feature extraction is an important key step in classification and quality grading of these different types of grains. In these we are going to decide wheather the grain quality is good, bad, or medium. For that we are going to extract various features like geometric features, colour feature etc.

1. Colour Feature Extraction:

Colour features are usually extracted based on each RGB and HSV colour space. RGB represents three important colours: red, green and blue. All the different colours are perceived as these tri-colour combinations. Hue, saturation and value are the three components of the HSV shade space. RGB defines color in terms of the wavelength of light in the colour feature extraction we have extracted RGB colours as R-mean , B-mean,G-mean.

2. Geometrical Feature Extraction:

Morphological features are extracted from image via using its contour images received from the previous. two A collection of connected points represents a grain boundary. The features like area, length, breadth and diagonal using region labelling are useful. The grading of grains for classification and grading grain photographs from the collected images. Geometrical features like area, major axis length, minor axis length, eccentricity and perimeter can also be used for analysis of grain samples. Using image analysis, the first method fuses results obtained on the foundation of colour and form traits whilst the 2nd strategy fuses structure data, color and surface texture records bought by spectra analysis.

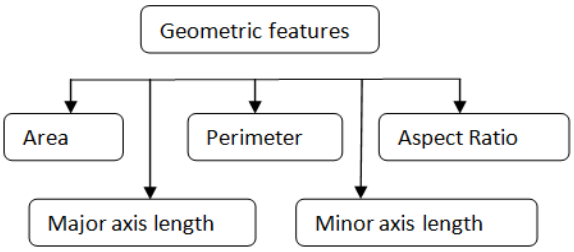


Figure 6: Geometric feature extraction

C. Grain identification Using Convolutional Neural network:

A Convolutional Neural Network (CNN) is a deep learning model which is used for the classification of features and recognize in an computer vision. CNN has an excellent performance in many sectors like computer vision, machine learning , and also object recognition, It is a multi-layer neural network designed to analyze visual inputs and perform tasks such as image classification, segmentation and object detection, which can be useful for various applications. For building a CNN we used tensor flow along with python In this we used image database of 400 images in which we used 80 images for training and 20 images for testing for al the 5 types of grain.

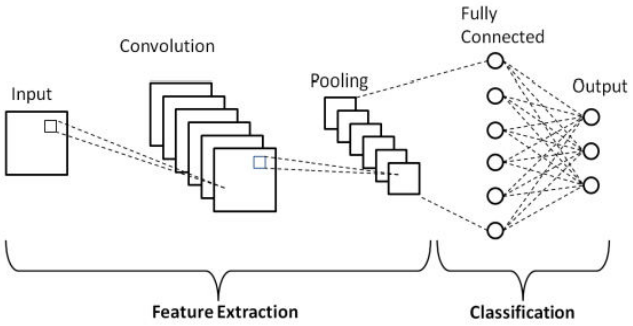


Figure 7: Basic CNN Architecture

Generally, the structure of CNN includes two layers one is feature extraction layer. The input of each neuron is connected to the local receptive fields of the previous layer, and extracts the local feature. Once the local features is extracted, the positional relationship between it and other features also will be determined. The other is feature map layer(Classification) , each computing layer of the network is composed of a plurality of feature map. Every feature map is a plane, the weight of the neurons in the plane are equal. The structure of feature map uses the sigmoid function as activation function of the convolution network, which makes the feature map have shift invariance.

CNN algorithm steps:

Step1- Upload the image dataset.

Step2- Initialize all the filters and weights by taking some random values.

Step3- Convolution operation with Relu activation function in this feature detection and feature mapping is done.

- Relu layer (Rectified linear unit)-It is a supplementary step to the convolution operation. It is used to increase the non linearity in the image.

Step4- After feature mapping is done we used the pooling layer which is used for reducing the spatial size of feature convolved. In that we used MAX pooling, it gives the maximum value from the image portion covered by the grain.

Step5 – Flattening is done after the pooling which converts the data into one-dimensional array. We flatten the output of the layers for creating a single long feature vector.

Step6- Fully connected layer take the vector of data created in the flattening step as a input. It connects every neuron in layer to each neuron in the next layer. It Applies weights over the feature analysis to predict the class of the image.

Step7- Fully connected output layer generates the final probabilities to determine the accurate class of the image.

D. Grain Grading (Quality analysis) Using Support Vector machine

1. Support Vector Machine (SVM):

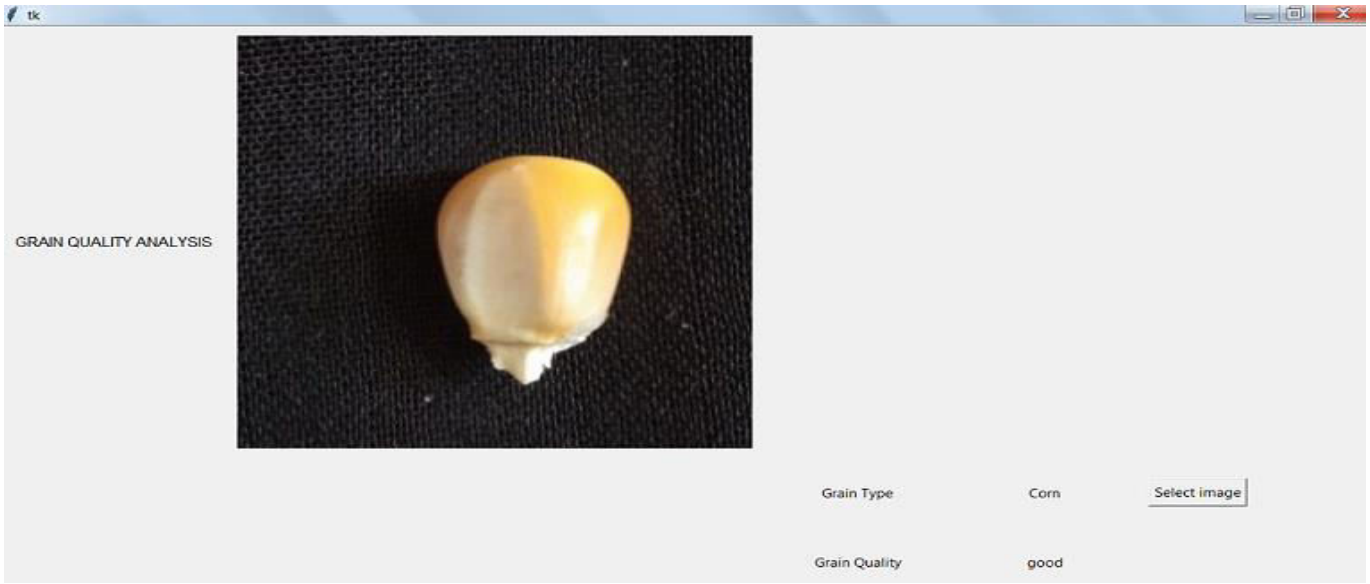
It is a new pattern classifier is trained for classification of samples of grains into grades using their features. We're using SVM for the purpose of quality analysis of the grain. For that we take the output of grain identification from the CNN And the feature we have extracted before. We store all the features of the training images in the form of Exel Sheet. When the test image is applied to the network the image is first get identified according to its type and the features of test image were calculated. Then the comparison is done between the features of test image feature with the features of training image and then quality of grain is determined.After giving SVM model sets of labelled training data for each category, they're able to categorize the object according to its type.

TABLE 2:TEST RESULT FOR OVERALL GRAIN TYPE CLASSIFICATION

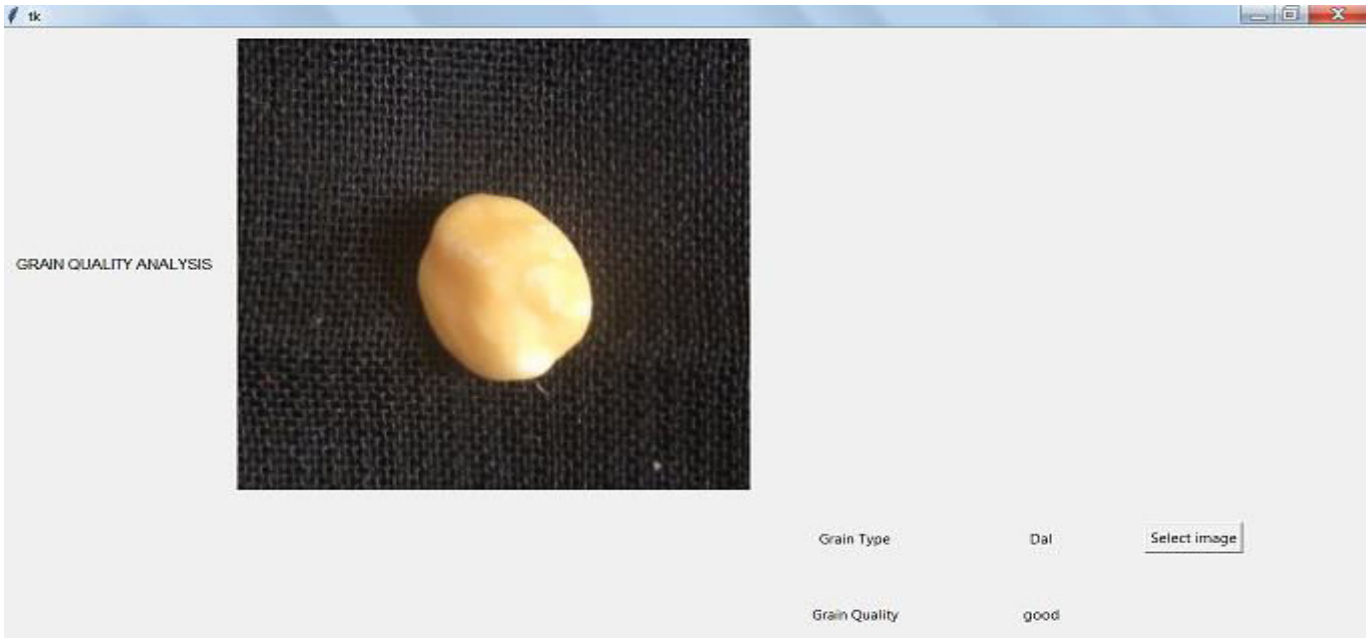
Grain name	No of images tested	No. of images predicted correctly	Accuracy (%)
Rice	15	15	100%
Wheat	15	14	93.33%
Corn	15	14	93.33%
Dal	15	15	100%
Soyabean	15	14	93.33%

As we are going to categorize quality of grain into 3 categories as Good, medium and bad we have to use multiclass support vector machine. In multiclass SVM we are using One VS one method for determining the quality. In one vs one multiclass classification each binary pair of classes and trains classifier on the subset of data containing that classes in this type of classification each classifier predicts one class. And the class which is predicted the most that is the final answer of the classification.

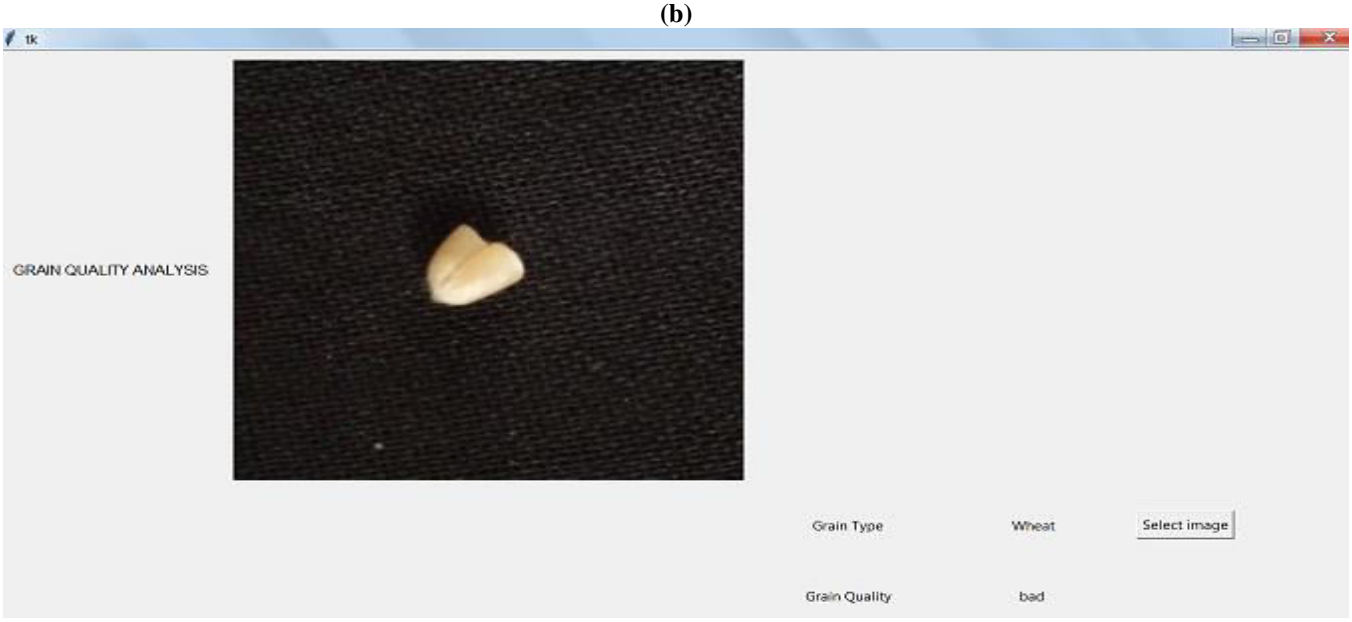
The result obtained based on the quality are summarised according to the comparison between the feature parameter of each grain. The table of comparison is as below:



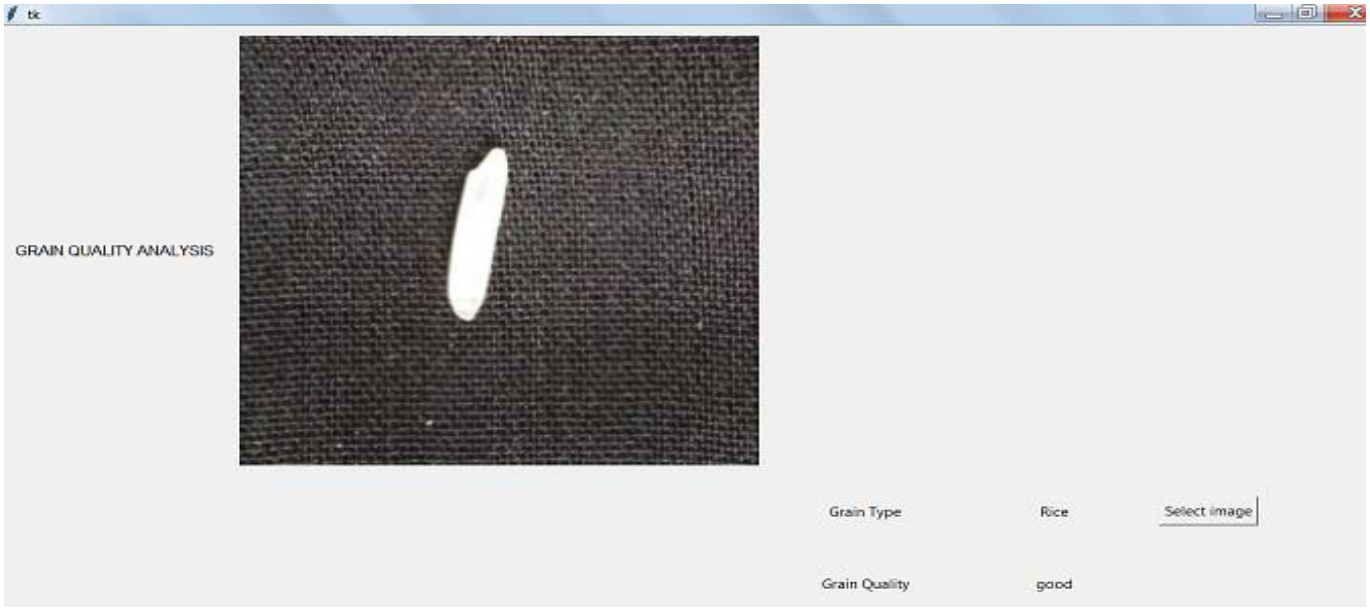
(a)


tk
GRAIN QUALITY ANALYSIS
Grain Type
Dal
Select image
Grain Quality
good

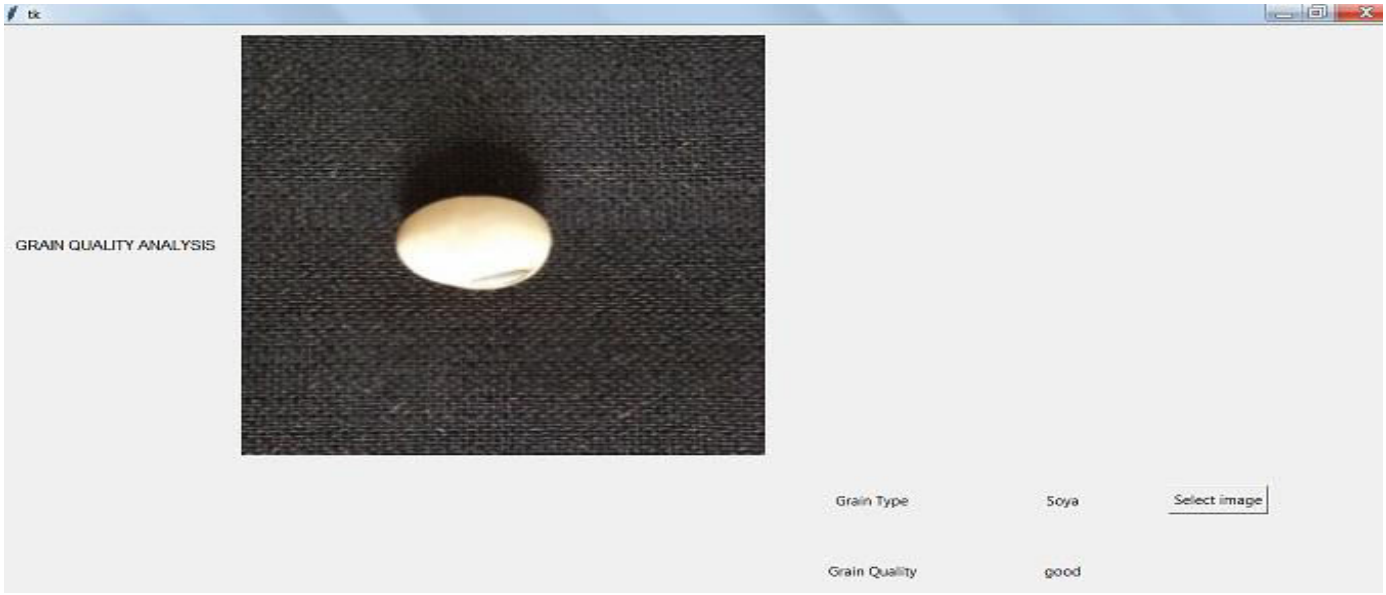
(b)


tk
GRAIN QUALITY ANALYSIS
Grain Type
Wheat
Select image
Grain Quality
bad

(c)



(d)



(e)

Figure 8: (a) to (e) Final Result of Grain Identification and Quality Analysis

V. CONCLUSION AND FUTURE SCOPE

In this paper, system is presented which consists of an image processing algorithm along with convolutional neural network for identifying and SVM for analyzing the quality of grain. There are such a large amount of inferior quality grains arriving to the market day by day. Today in market; grain with adulteration is sold without being analysed. However, there's no accurate method to resolve this problem Therefore, this has become a significant issue for both the consumer and also the governments. This research work will help in identification and classification of types of grains using image processing and convolutional neural network techniques. The overall accuracy obtained is 95.55%. The implemented system is robust in terms of implementation cost and the time required.

The work can be extended to test more number of grain samples. Some other classifiers would be also tested for this.

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