An Improvised Algorithm For Computer Vision Based Cashew Grading System Using Deep CNN

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***Abstract*—Computer vision is becoming popular at the present days in agricultural area with an assortment of technological improvements for grading, sorting, classification. Though there are much technical advancement, cashew grading and sorting are still difficult task in daily market. In this research work we discussed about the computer vision based grading system and also an overview of deep Convolution Neural Network (CNN). The CNN with deep layer has tremendous achievement in many image classification applications. The deep CNN which itself extract the features of the image for classification was the added advantage. In this work the various parameters are considered for optimization of CNN. This work portrays the importance grading cashew nut and also proposed a framework for computer vision based grading system for cashew nut using deep CNN.**

Keywords—Grading; computer vision; cashewnut; deep CNN; classification;

I. INTRODUCTION

Cashew is an important tropical crop in India. India plays major role in consuming and exporting cashews in world wide. During 2010 about 6.74 lakh tones of raw cashew nut was a probable yearly production over the area of 9.53 lakh hectare [1]. Cashew nut attains the great economical status in the global export commodity. 65 % of universal cashew exports were through by our country. For the duration of 2016-2017, 82,302 million tones of cashew kernel were exported with the value of rupees 5168.78 core [2]. There is special demand in the world market for the quality of cashew nut in panruti [18]. Cuddalore district in Tamil Nadu state has the total production area of 77% [18]. These above mentioned statistics was achieved by the standard quality. The quality of the cashew nut is has a significant aspect, consequently the grading and sorting are considered as important factor in global market. The cashew nut grading should meet the requirement which is demand by the quality control of international trades. Depending on the various features of the cashew nut, they are categorized into different grades. The quality of cashew nut was specified and followed by Cashew Export Promotion Council of India (CEPCI, 2013). There are six categories of cashew nut ranging from white whole to pieces, they are i) White whole, ii) Scorched wholes, iii) Desert wholes, iv) White pieces, v) Scorched pieces, vi) Dessert pieces are obtainable in market (totally 26 grades) [4]. There different grades of cashew nut are shown in the table 1. In global trade white whole cashew nut (W-180, W-210, W-240, W-320, W-450, W-500) are good enough for marketing. Table1 shows the different grades of cashew nut.

TABLE I. THE DIFFIERENT GRADES OF CAHEW NUT

S. No	Categories	Grades	Colour	Characteristics
1	White wholes	W-180, W-210, W-240, W-320, W-450, W-500	White, pale ivory , light ash	Shape
2	Scorched wholes	SW-180, SW210, SW-240, SW-320, SW-450, SW-500	Slightly darkened	May be Scorched
3	Desert wholes	SSW, DW	Light blue, deep blue, deep brown	Over Scorched, immature
4	White pieces, pieces,	B, S, LWP, SWP, BB	White, pale ivory , ash	Spilt or broken
5	Scorched	SB, SS, SP, SSP	Slightly darkened	May be Scorched
6	Dessert pieces	SPS, DP	Blue, brown	Deep scorched, black spotted, speckled

Though there are many inventions in technology the traditional manual grading process is followed in many industries. The manual grading process uses hardware equipments, machines and would be done physically. Fig.1 shows the manual cashew grading process. The manual inspection is tedious, time consuming, inaccuracy, variation etc. To improve the efficiency and accuracy of grading process the computer vision system with various image processing techniques could be used. The features like shape, size, colour, texture of the cashew nut are considered for the computer vision based grading system. The computer vision based grading system consist of steps and they are i) image acquisition ii) Pre-processing iii) Segmentation iv) Feature Extraction v) Classification. It includes hardware phase and software phase. Traditional image processing algorithms and machine learning classifiers are used for feature extraction and classification process.

Fig. 1. Manual cashew grading process

This work organized as follows. In section II an overview of deep CNN was discussed briefly and various applications of CNN have been discussed and compared. In Section III we discussed the computer vision based grading system and also proposed a framework for computer vision based cashew nut grading system using deep CNN. Section IV provides the conclusions and also discussed about the future work.

II. RELATED WORKS

Over past decades the grading and sorting of agricultural products was done manually. Gradually some of the agricultural products grading and sorting are flattering computerized these days. Still Cashew nut grading process is not copiously automated up till now. Since there is an abundant need for cashew nut in the global market more research be supposed to make through on this area. Table 2 shows the comparison of various cashew nuts grading system. There are some research works which concentrated on cashew nut grading and it is briefly discussed in the following section.

- Narendra Veranagouda Ganganagowdar et al., used Artificail Neural Network (ANN) to develop an automated system to recognize and classify a cashew nut by considering 16 morphological features and 24 colour features[3], geometric and colour features[9], texture feature[11].
- In [3] 88.93% accuracy attained by incorporating 16 morphological features and 24 colour features for feature extraction method. To classify and recognize the cashew nut Multilayer Perceptron ANN is used.
- The geometric and colour features are considered for grading white whole cashew kernel in [9].
- The feed forward neural network and gray level co-occurance matrix method are used for classification and texture feature extraction with the accuracy of 90% efficiency [11].
- Using machine vision an automated system was developed for grading cashew kernels in [5]. Several classification algorithms are compared and back propagation neural network classifiers is considered as better one with the accuracy result of 96.8%.
- In [6] feed- forward neural network was used to develop an automated cashew kernel classification for grading process by considering colour features. The 15 different colour features are extracted for the grading process. The automated system classified the cashew kernels into six different grades with accuracy of 80%.
- Mayur Thakkar et al., using WEKA toolbox evaluated the performance of various classification techniques to find the appropriate one for the cashew grading system [7]. With higher classification accuracy of 86%, multilayer perceptron is measured as the viable one.
- In [8] an intelligent fuzzy logic based cashew grading system was proposed and Fuzzy inference system is used for classification phase of cashew kernel. The RGB colour image is acquired and two features (colour and weight) are considered for classification. This fuzzy logic based grading system provides the accuracy of 89%.

TABLE II. COMPARISION OF VARIOUS CASHEW NUT GRADING SYSTEM

S. NO	Features extracted	Classification method	Accuracy	Ref
1	16 Morphological, 24colour	Multilayer Perceptron ANN and Back propagation	88.93%	[3]
2	color, texture, shape, size	Back Propagation Neural Network	96.8%	[5]
3	Colour	Feed-forward neural network	80%	[6]
4	morphological features	Multi-Layer Perceptron	86%	[7]
5	morphological features	Fuzzy logic	89%	[8]

6	Size, colour	ANN	-	[9]
7	Texture	Multilayer feed - forward neural network	90%	[11]

The literature survey shows the intense close of various research works made in the field of computer vision based cashew grading system. Various features and the classification methods used in computer vision based cashew grading system was focused mainly this study. To improve the evaluation efficiency diverse methods has been recommended by the researchers. By utilizing the information provided well planed proposed framework could be developed.

III. Problem Identifiction

To enhance the grading quality of the agriculture product, new technology should be adopted. Computer vision based approach and deep learning models are non-destructive method, which provides reliable, sensibly precise, less time overwhelming and cost efficient resolution. The traditional grading system involves the following steps image acquisition, image segmentation, feature extraction, classification. For grading cashew nut features like morphological features, texture, and colour are considered for feature extraction. In traditional classification process, the feature extraction should be done before the classification process. To enhance the quality of cashew grading system, optimized model should be proposed.

A. Deep Convolutional Neural Network

Deep learning yields the attention of researchers to work in the field of computer vision. The primary problem of computer vision is image classification which is encountered by multiple layers of deep learning. Along with them CNN is a deep learning model which have been put up like a powerful group of models for image recognition issues. The feature extraction and image classification by using those extracted features would be done by CNN [10]. On the other hand in traditional approach the features could be extracted using some descriptors and would be sent as an input for classification process. CNN is a class of deep, feed-forward artificial neural networks that have successfully been applied to recognizing image. It is also widely used in video recognition, image classification, recommender systems, and natural language processing and speech recognition [12]. The general steps involved in deep CNN are convolution, pooling and fully connected layer. Fig.2 shows the framework of deep CNN.

1. *Conovlution layer:*

   The convolution layer will play the role as feature extractor from the input image and provide feature map as the output[12].

   k_{th} output of feature map $Y_k = f(W_k * x)$ *(1)*

   Where,

   x → Input image

   W_k → Convolution filter

   $*$ → Convolution operator

   $f(\bullet)$ → Activation function

2. *Pooling layer:*
   To achive the spatial invariance for distortions and translations the pooling layers are used to reduce the spatial resolution of the feature maps. Selecting the maximum value within the receptive field is max pooling. Max Pooling operation (Y_{kij})[12] was obtained by the equation for selecting the largest element, $Y_{kij} = \max_{(p,q)\in\Re_{ij}} x_{kpq}$ *(2)*

   where, x_{kpq} → element at location (p,q)

   $\Re_{ij}$ →pooling region

3. *Fully connected layer:* All the neurons in this layer fully connected to all activation node with in the earlier layer. The classification task can be peformed in the last fully connected layer which provides the net output[12].

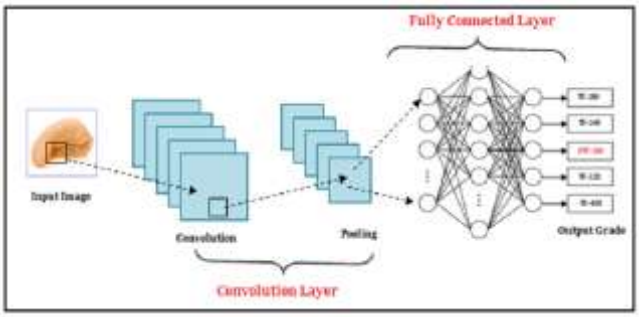

Fig. 2. The framework of deep CNN.

B. CNN in various applications:

- CNN is used for classification of breast cancer image by extracting the patches of the image to train the network. BreakHis dataset image of breast cancer was used for testing by deep learning framework TensorFlow [12].
- CNN used in [13] to to detect the Mangosteen Surface is fine or defect. The performance evaluation achived 97% accuracy in the detection of mangosteen fruit.
- Using image saliency and CNN model fruit and vegetable classification system was proposed in [14]. The image saliency is used to layout the object region and CNN is used to extract the features. The RGB images are taken as input for classification considering size as the features.
- 13- Layer CNN was proposed to classify the fruit categories. Data amplification like image rotation, Gamma correction, and noise injection was used and CNN was trained by stochastic gradient descent with

momentum. 94.94% was the overall accuracy obtained that proposed method [15].

- The diverse models of CNN were built for mammogram and tomosynthesis classification. The optimizing utilization of transfer learning and data augmentation shows the better prospective for detecting cancer automatically [16].
- For hyper spectral image classification Bayesian-CNN was proposed in [17]. The main objective of this model to train the model with small amount of data set. The sparse connectivity and shared weight plays the fundamental part in make CNN as a superlative processing. Number of parameters learned by the network layers would be reduced due to these above mentioned features.

This section mentioned some of the primary aspects associated to the necessary building blocks of CNN. This section also shows the resurgence of deep learning and the considerable offerings of deep CNN to the current pre-eminence over many image classification techniques. The fashionable grow of deep CNN will show the way to examine their classification, performance evaluation, strength, and computational uniqueness, resulting in the discoveries of several challenges in image classification applications [12].

IV. Proposed Work

In this section we proposed an improvised framework for computer vision based cashew nut grading system using deep CNN. The traditional image classification features should be extracted before the classification process. However CNN model will itself extract the feature and represent the features for learning. Figure shows the proposed flow diagram of image classification using deep CNN. The improved framework concentrated the following factors and they are

1) Selective search: To extort effectual information from the regions of the whole image.

*2) Overfitting:*Drop out is used to overcome the dropout probelm.

*3) Max Pooling:*Max pooling is done by selecting the largest element.

4) Rectified Linear Unit (ReLU): To activates the neurons which is beyond certain threshold value, the activation function ReLU is used.

$$\mathrm{Re}LU_{(x)} = \begin{cases} x & x \geq 0 \\ 0 & x < 0 \end{cases} \qquad (3)$$

*5) Pre-trained network:*Transfer learning is also used to transfer the learned knowledge when the training data is small and to avoid the overfitting problem.

6) Stochastic Gradient Descent(SGD): To minimise the loss function SGD is used to optimise the network.

7) Softmax loss: In last fully connected layer of deep CNN the softmax activation function is used due to its simplicity and probabilistic analysis. For every i_{th} input feature x_i which has a corresponding label y_i, the softmax loss can be written as

$$L = \frac{1}{N}\sum_i L_i \qquad (4)$$

where, N is the amount of training data

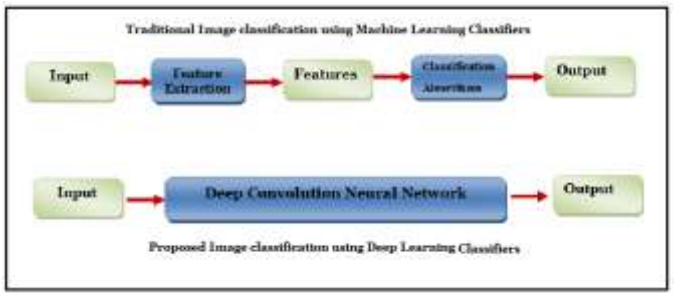

Fig. 3. The Proposed Flow diagram of image classification using deep CNN

A. *Improved Algorithm for cashew grading uisng deep CNN:*

1. Feed the input image
2. Initialise the sequential neural network
3. Perform convolution operation on training images and extract features (Morphological, Texture, colour, weight).
4. Feature maps are comes as the outcome of convolution operation.
5. These Feature maps are passing to the activation function (RELU).
6. Max pooling functions are used to build the CNN network by selecting largest element from respective ROI.
7. Convert all the resultant data into 1D continuous linear vector before last fully connected layer.
8. High level feature interpretation and reasoning would be performed in the fully connected layer for classification.
9. To improve the classification accuracy softmax operator is used.

V. Conclusion and Future Work

Since there is a growing demand for quality of cashew in the global market, an automated grading system is needed. Despite the fact that many computer vision grading systems are implemented, still there is lagging in cashew grading system. Here we proposed the improvised deep CNN algorithm for computer vision based cashew grading system. Since deep CNN has a incredible development in image classification tasks, and also setting trade mark for several image classification challenges. The smart growth of deep CNN will show the way to examine their classification, performance evaluation, strength, and computational uniqueness, resulting in the discoveries of several challenges in image classification applications.

In future to improve the classification accuracy we could try to combine the CNN with Recurrent neural network

(RNN) to encounter the multilabel problem. And we can train these combined networks using reinforcement leaning. So we could deploy any of these frameworks to the any other agricultural products. By using this framework we could implement a computer vision system to detect the infected leaves, crops, fruits, vegetables etc.

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