**International Journal for Rapid Research in Engineering Technology & Applied Science**
Vol IX Issue IV April 2023
ISSN Online :- (2455-4723)

# Indian Fruits Recorgization And Saturation Enhancement Using Deep Learning Method

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## ABSTRACT

Nowadays in agriculture industry exporting the fruits to other countries in bulk quantities is a difficult task. In this field farmers need manual inspection. Our system helps the farmers to pack their fruits as soon as possible by detecting the fruits and vegetable and identifying the disease this helps the farmers to save their time and they can delivery fruits and vegetable as soon as possible. We use CNN algorithm for fruits and vegetable detection and disease identification. Using neural network the image is segmented which is followed by extraction of some features from the segmented image finally fruits and vegetable image is identified and labeled.

Keywords— agribusiness science, CNN algorithm.

## I. INTRODUCTION

Food is one of the most fundamental needs for human life and existence. The agricultural sector works day and night to fulfill the food-related needs of the human population. Further, agriculture also plays an important role in the economic development of countries [1]. The related sectors are always looking for improvements of all kinds in all stages of agricultural activity. Over the last century, more and more technology has been adopted, transformed, and optimized in pursuit of increased yields [2]. Some of the recent examples include techniques of smart

agriculture using artificial intelligence and machine learning methods [3,4], precision agriculture using information and communication technologies augmented with blockchain technology [5], and the use of biosensing technology [6]. Fruits are considered an important part of the human diet and their cultivation and production is a significant part of the overall farming activity.

## CRITICAL REVIEW OF DEEP LEARNING TECHNIQUES EMPLOYED

An accurate, reliable, and low-cost image-based system for strawberry detection which uses convolution neural networks was proposed by Lamb and Chuah (2018). Single Shot Multibox Detector (SSD) neural network framework was used for implementation as the fruit detector. A sparse, three- layer convolutional layer was used as a classifier which was modified in numerous ways to enhance precision and speed.

## II. DATA PRE-PROCESSING AND DATA AUGMENTATION

In this step, after acquiring the dataset, it is extracted with the help of a user-defined function "extract_dataset" using the zipfile library. To understand the distribution of the number of images in each category, 131 categories along with its number of images was printed. To verify images in each of the 131 categories are correct and to check their quality, random images from each of the categories are plotted using the matplotlib library (Figure 3). There was no need to divide the dataset into train and test sets as the acquired dataset already had two separate folders for train and test sets.

### FRUIT CLASSIFICATION

A lot of fields and industries have seen the intervention of machine learning and taken advantage of its powerful automation and power to increase efficiency and reduce cost and effort needed. As a result, these areas have had their basic operations revolutionized. Although there have been a few areas that have seen more research and work done by artificial intelligence, there are a few other areas that are also beginning to pick up. One of these areas is Agriculture.

## III. MACHINE LEARNING ON THE FIELD

Machine learning applications on the field feature the application of big data. Modern farms are now being equipped with multiple sensors to gather data in real time and give situational awareness of what is happening on the field. This helps the farmers to know precisely what is happening on the field rather than just making guesses and making decisions based on hypothesis. Figure 3.1 shows an example of machine learning on the field to determine the ripeness of fruits on a tree.

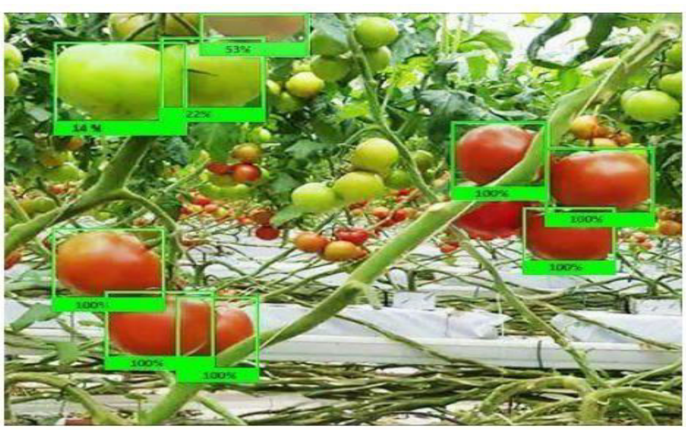



**Fig.3.1 Machine learning applied to determine the ripeness of fruits on a tree.**

Although there have been high expectations for the field of big data, there have also been speculations on how long the field would be seen as valuable. Some researchers have even said that the expectations for big data are inflated and would soon fall out of trend (Fenn et al, 2011). In some countries where smart farming concepts and tools have been adopted, there have been a few failures that have made the current reality to vary from the expected results, but this is mostly based on some errors exposed by structural analysis of the systems

(Lamprinopoulou et al, 2014).

## IV. PROPOSED METHODOLOGY

Artificial Intelligence has been witnessing a monumental growth in bridging the gap between the capabilities of humans and machines. Researchers and enthusiasts alike, work on numerous aspects of the field to make amazing things happen. One of many such areas is the domain of Computer Vision.

In deep learning, a **convolutional neural network** (**CNN**, or **ConvNet**) is a class of artificial neural network (**ANN**), most commonly applied to analyze visual imagery.[1] CNNs are also known as **Shift Invariant** or **Space Invariant Artificial Neural Networks** (**SIANN**), based on the shared- weight architecture of the convolution kernels or filters that slide along input features and provide translation-equivariant responses known as feature maps.[2][3] Counter-intuitively, most convolutional neural networks are not invariant to translation, due to the downsampling operation they apply to the input.[4] They have applications in image and video recognition, recommender systems,[5] image classification, image segmentation, medical image analysis, natural language processing,[6] brain– computer interfaces,[7] and financial time series.[8]

CNNs are regularized versions of multilayer perceptrons. Multilayer perceptrons usually mean fully connected networks, that is, each neuron in one layer is connected to all neurons in the next layer.

The "full connectivity" of these networks make them prone to overfitting data. Typical ways of regularization, or preventing overfitting, include: penalizing parameters during training (such as weight decay) or trimming connectivity (skipped connections, dropout, etc.) CNNs take a different approach towards regularization: they take advantage of the hierarchical pattern in data and assemble patterns of increasing complexity using smaller and simpler patterns embossed in their filters. Therefore, on a scale of connectivity and complexity, CNNs are on the lower extreme.

Convolutional networks were inspired by biological processes[9][10][11][12] in that the connectivity pattern between neurons resembles the organization of the animal visual cortex. Individual cortical neurons respond to stimuli only in a restricted region of the visual field known as the receptive field. The receptive fields of different neurons partially overlap such that they cover the entire visual field.

CNNs use relatively little pre-processing compared to other image classification algorithms. This means that the network learns to optimize the filters (or kernels) through automated learning, whereas in traditional algorithms these filters are hand- engineered. This independence from prior knowledge and human intervention in feature extraction is a major advantage.

A convolutional neural network consists of an input layer, hidden layers and an output layer. In any feed- forward neural network, any middle layers are called hidden because their inputs and outputs are masked by the activation function and final convolution. In a convolutional neural network, the hidden layers include layers that perform convolutions. Typically this includes a layer that performs a dot product of the convolution kernel with the layer's input matrix. This product is usually the Frobenius inner product, and its activation function is commonly ReLU. As the convolution kernel slides along the input matrix for the layer, the convolution operation generates a feature map, which in turn contributes to the input of the next layer. This is followed by other layers such as pooling layers, fully connected layers, and normalization layers. The agenda for this field is to enable machines to view the world as humans do, perceive it in a similar manner and even use the knowledge for a multitude of tasks such as Image & Video recognition, Image Analysis & Classification, Media Recreation, Recommendation Systems, Natural Language Processing, etc. The advancements in Computer Vision with Deep Learning has been constructed and perfected with time, primarily over one particular algorithm — a **Convolutional Neural Network**.

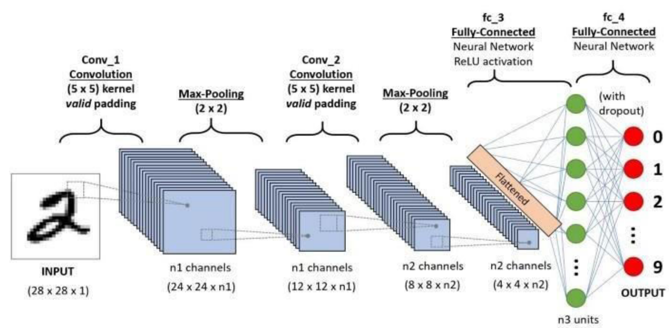



**Fig. 4.1 Convolutional Neural Network.**

A **Convolutional Neural Network (ConvNet/CNN)** is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets have the ability to learn these filters/characteristics.

The architecture of a ConvNet is analogous to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex. Individual neurons respond to stimuli only in a restricted region of the visual field known as the Receptive Field. A collection of such fields overlap to cover the entire visual area.

An image is nothing but a matrix of pixel values, right? So why not just flatten the image (e.g. 3x3 image matrix into a 9x1 vector) and feed it to a Multi- Level Perceptron for classification purposes? Uh.. not really.

In cases of extremely basic binary images, the method might show an average precision score while performing prediction of classes but would have little to no accuracy when it comes to complex images having pixel dependencies throughout.

A ConvNet is able to **successfully capture the Spatial and Temporal dependencies** in an image through the application of relevant filters. The architecture performs a better fitting to the image dataset due to the reduction in the number of parameters involved and reusability of weights. In other words, the network can be trained to understand the sophistication of the image better.

In a CNN, the input is a tensor with a shape: (number of inputs) × (input height) × (input width) × (input channels). After passing through a convolutional layer, the image becomes abstracted to a feature map, also called an activation map, with shape: (number of inputs) × (feature map height) × (feature map width) × (feature map channels).

Convolutional layers convolve the input and pass its result to the next layer. This is similar to the response of a neuron in the visual cortex to a specific stimulus.[14] Each convolutional neuron processes data only for its receptive field. Although fully connected feedforward neural networks can be used to learn features and classify data, this architecture is generally impractical for larger inputs such as high- resolution images. It would require a very high number of neurons, even in a shallow architecture, due to the large input size of images, where each pixel is a relevant input feature. For instance, a fully connected layer for a (small) image of size 100 × 100 has 10,000 weights for *each* neuron in the second layer. Instead, convolution reduces the number of free parameters, allowing the network to be deeper.[15] For example, regardless of image size, using a 5 × 5 tiling region, each with the same shared weights, requires only 25 learnable parameters. Using regularized weights over fewer parameters avoids the vanishing gradients and exploding gradients problems seen during backpropagation in traditional neural networks.[16][17] Furthermore, convolutional neural networks are ideal for data with a grid-like topology (such as images) as spatial relations between separate features are taken into account during convolution and/or pooling.

## V. RESULT AND SIMULATION

This system is built using various methods and features such as:

RGB: It is also referred to as truecolor image which defines Red, Green and Blue color components for each individual pixel. This RGB array is of class double where each color component is a value between 0 and 1. This can be stored along the third dimension of data array.

GLCM (Gray Level Co-occurrence Matrix): It is statistical method that examines the texture that considering the pairs of pixels with specific values. It mainly consists of statistic feature like contrast which measure the local variation, correlation which measure the joint probability, energy which provides the sum of squared elements and homogeneity which measures the closeness of the distribution. Color Histogram: It controls the appearance and behaviour of image. It converts color image into HSV image and preserves the hue and saturation components. The values are extracted and plotted in the graph. The intensity matrix is obtained from the HSI image matrix. This matrix is updated with histogram equalized intensity matrix.

Color moments: Color moments are very much useful for color indexing purposes. It considers only the first three color moments as feature in image retrieval applications. It can be used to compare the two images based on color.

HOG feature: The histogram of oriented gradients (HOG) is a feature used in vision and image processing for object detection. The image is divided into small connected regions called cells. Since it works on local cells, it is invariant to geometric transformations.

HSV Feature: The Hue Saturation Value (HSV) represents the color, dominance of color and brightness. Therefore, the color detection algorithm can be used to search in terms of color position and color purity. It is used to detect the pixels.

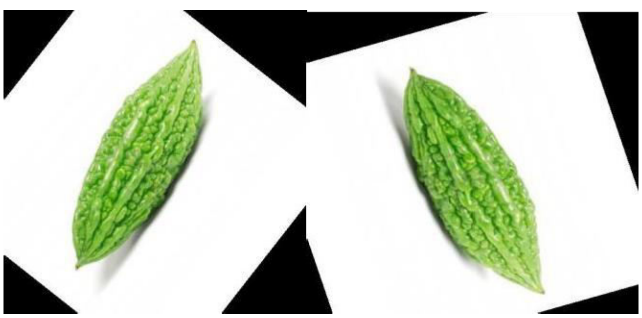
SVM (Support Vector Machine): It is a supervised learning algorithm which can used for binary classification or regression. It is a coordinate of individual observations. It is based on decision planes which defines decision boundaries. It also separated the set of objects having different class. The system is built on two different environments namely using Real Time Fruit and Non-Real Time Fruit.

The project has been tested at Srinivas institute of technology. The above pictures taken show the working of the system where it is able to recognize the fruits using image processing in real time as well as non-real time. The system is thereby able to do all required task which as we stated above. The output of both Non Realtime and Real time after recognition is given below:

**Fig.5.1 fresh_apple**

**Fig.5.2 fresh_banana**

**Fig 5.3 fresh_bitter_gourd**



fruit. It would withal advance Indian agriculturists to do keenly intellective cultivating, which profits to require time to time decisions, which withal protect time and shorten misfortune of natural product due to quality. The driving objective of our work is to upgrade the esteem of fruit quality discovery.**Fig 5.4 stale_apple.**

**Table 5.1 Parameters evaluation.**

| Parameters | Numerical Values |
|---|---|
| PSNR | 53.68 |
| MSE | 0.28 |
| Accuracy | 99.72 |

## VI. CONCLUSION AND FUTURE SCOPE

The proposed project is able to recognize the fruit based on the features like shape, colour, and texture. This increases the knowledge of common people about some rare and unknown fruits. The project is mainly concentrating on reducing human effort and making human life easier. Fruit recognition will be able to reduce the current ongoing problems. It reduces confusion among the particular fruit. Future work that can be added to this project may be the development of a web app. Here the user can use this application anytime anywhere. An image processing predicated solution is proposed and evaluated for the detection and relegation of fruit quality. The proposed system is composed of mainly three steps. In the first step the data is accumulated. In the second step, features are extracted and the machine is trained. In the third step, the trained machine will identify the fruit image and label it. In the fourth step it will identify the disease associated with the identified

### FUTURE WORK

The primary goal is to classify, identify ripeness, and maintain the fruit's quality. When it comes to fruit identification, there are numerous factors to consider, such as shape, size, texture, and colour. These visual characteristics are the most important in identifying a fruit. Generally, Convolution Neural Network architectures like YOLO V4 for performing fruit detection and further the fruit recognition is accomplished by mapping those visual features. YOLO works based on object detection; the number of fruits can be obtained by using image segmentation techniques such as blob detector. Fruit ripeness classification is accomplished through image processing and colour transformation, with fruits classified as ripe or raw based on saturation level. To achieve real-time application, a Raspberry Pi board has been used with an integrated camera to capture live data and output it to a digital screen. Datasets are used to train the model for delivering an effective and accurate output; the model's accuracy increases with the size of the data collection. Different variety of fruits are successfully recognized by using the dataset.

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