#### **Abstract**

In recent years Machine learning and CNN are the thriving technology across the world. In this proposed project, the objects i.e. fruits represented on the image can be identified by using the machine learning model with the proper training using plenty of images. When we have a large number of training images, the deep learning model is used to predict the image accurately among the other images. The deep learning model and Machine learning algorithms help in fruit identification and also to predict the fruit name. The image recognition for fruits identification is slightly complex when the image gets overlapped and also when it gets stacked, that issue is sorted in this project by using various layers in the CNN and also by using large datasets to get high accuracy. In this project, Convolution Neural Network (CNN) is used to predict the name of the fruit given in the image. In this project, the model is well trained where the image of the fruit is considered as the input of the model while the label of the fruit will be the output of the model. If the training for the Convolution neural network model is done successfully, the model/system will able to identify the fruit and predict the name of the image. The already existing projects have fewer layers in CNN and the fruits used for prediction are also comparatively less. In this project, many layers are included in the CNN model also the number of fruits used for the training is also high. The dataset is collected from the popular website named Kaggle. Python is the scripting language used in this project due to its efficacy. Tensor flow and Keras are the two platforms that support the Python programming language. This CNN architecture helps to identify fruits with different structures, colors, and shapes. A high number of datasets are used for training to get perfect results. The accuracy rate of this project is more than 95%. The fruits in this project can be recognized using their shape, size of fruits, and also by different features. This project describes how the CNN and Machine learning algorithm is used to identify the fruits.

**Keywords**: Computer vision, machine learning, CNN, Kaggle, network, datasets, Tensorflow and Keras.

## Chapter 1

#### 1.1 Introduction

This project explains fruit recognition with the help of recent technology and also highlights the benefits and goals of the proposed method using datasets. In agricultural areas like the food industry, packaging, marketing, etc., The recognition of the fruits plays a major role. Classification of the fruits and sorting the fruits based on their quantity is time-consuming. In order to rectify this, the recent technology, a deep neural network is used here to segregate the fruits. This helps to recognize and predict the fruits based on their shape, size, and other features with high accuracy. In this project, Convolution Neural Network CNN is used for image identification. The recognition of fruit helps in many industries like harvesting, sales industries to segregate the fruits by identifying the fruits. In the harvesting industry it helps to identify the fruit type without much intervention by humans and it auto segregates the fruit after harvesting and in the sales industry, it helps to identify the fruit for calculating the price of the fruit even though many fruits stack together. Previously the image processing method is used to identify the fruit.

Tensorflow and Keras are used as the supporting language for Python. Each layer of the CNN is followed by Rectified Linear Unit Layer (RLUL). Kaggle is the open-source website used to obtain the datasets. In this project, the dataset consists of 15 varieties of fruits along with 4000 images. This will helps to identify the image of the fruits and label the fruits based on their shape and size using this recent technology. In this method, the networks are trained to identify the fruits like apples, orange, bananas, etc based on the pixel datasets. However, it is difficult to identify the images due to overlapping and complexity, the deep learning model is well trained in order to identify the image and predict their name with high accuracy. The segregation of fruit and weighing individually is time-consuming and it needs much work. When it gets automated using the fruit recognition, a lot of time gets saved along with the less human work.

The machine learning algorithm's subset deep learning is used in this project. The data which contains high model abstraction can be collected by this Deep learning technique. In this method, the models can understand the details from the picture/Text and this helps to analyze

better. The deep learning technique brings high accuracy than manual prediction. The advantage of the convolutional neural network over other networks is that it will notice the structure of the image while processing of the image is ongoing. This will helps to identify the image based on their accuracy and this will show that the image recognition is achieved successfully (Sakib, 2019). The CNN opts in this project since the image structure gets noticed even at the time of processing the image and also to come out of the errors based on the deep model, the deep belief algorithm is included. In this method, there are plenty of hidden layers and the values can be related and improved. This model needs less time for training and the Deep belief model gets included along with the CNN to get the benefit. The datasets collected from the common source Kaggle, More than 4000 datasets are used in this project for training and more than 15 variety of fruits with different structures, shapes, and colors are used. (Harsh, 2020) The color needs to be the same while the fruit segregation must vary. Tensor flow is used to implement, train and test the network of the paper. This is the open-source from google for solving various machine learning computations with graph support. In this paper, the tensor flow serves as a supporting platform for fruit recognition. Thus fruit recognition with a machine learning algorithm provides better output with high accuracy. In this project, Convolutional Neural Network helps to identify the fruits based on their size, shape, and other features. This paper gives a brief introduction, the aim of the paper, objectives, benefits of fruit recognition using the CNN method and research questions will be discussed and also the background analysis of this network and the drawbacks of the existing system and solution to that also discussed below.

#### **1.2 Aim**

The aim of the proposed project is to recognize the fruit effectively and identifying its name by using the convolutional neural network and Deep learning model.

## 1.3 Objective of the project

The objective of the fruit recognition is as follows:

> To collect various fruit images for processing the image and classification

- > To extract features to classify the fruits based on the features and to create the algorithm to reduce complexity
- ➤ To perform the CNN based testing, training using a deep learning model and the accuracy is analyzed.

#### 1.4 Research Ouestions

- ➤ How the convolutional neural network helps in feature extraction and why it is the best network?
- ➤ How the fruit images are classified and identified?
- ➤ How the accuracy of the process is obtained or calculated?

### 1.5 Background

The purpose of fruit identification helps in many industries to enhance the business effectively. The fruits identified can be used for billing effectively by pricing the fruit automatically, the matured fruit identification can help to harvest effectively, the fruit segregation can help to classify fruits in the sales industry without human intervention, etc. In this project, the various researches on fruit recognition using image processing and deep learning are reviewed. The image processing used for the fruit recognition is done under five major steps: Collecting the datasets, Pre-processing the images, Categorizes the image, Extraction of the feature and then the segregation of the fruit. The fruit extraction may get complex in image processing since some fruits may hold similar features. The number of fruits used in the previous projects is also less (Horea Muresan, 2018). The convolution neural network also used in many projects previously but the number of layers in the network is less and this could be the reason for less accuracy which is less than 87% (S.Arivazhagan, 2010).

### 1.6 Problem Statement

The fruit recognition using the image processing and CNN with the help of feature extraction like color, the shape gives the results less than 80%. The previous projects include only a few fruits for the recognition which may result in less accuracy when new fruits get

included and also the less number of fruits may yield less accuracy and the convolution layer that included in the previous projects are less and that also could be the reason for less accuracy compared to the proposed project's accuracy which is 95%. The recognition rate can be increased by increasing the number of fruits in the dataset collection. The flexibility and functionality are increased by including more features together while extracting the fruit image.

## 1.7 Report structure

The report structure includes the review of various resources under the literature review where it is obtained from multiple relevant articles and recent research papers which has fruit recognition approaches. Then the research concentrates on the methodology that includes the tools needed for this project and the research includes the methods used in the project and the achieved output from the methodology would be elaborated. The project flow would be explained in the format of the diagram and after the methodology selection, the implementation of the project using the python code is included. The result and coding would be analyzed in the final evaluation which includes the testing. The results finding and analyses would be explained. The future recommendation includes the difficulty or error that needs to be rectified in the future project. The conclusion consists of the overall results of the project.

# Chapter 2

## 2.1 Introduction

This includes the multiple resources and research related to the fruit recognition approaches like using color, shape, size, image processing, etc. The latest articles would be obtained and would be reviewed to understand the currently existing system, the problems, background, methods used, advantages, restrictions, and the research the work area of the project.

#### 2.3 Literature review

## Recognition of Fruits using Image processing:

The author (Nayak,2019 ) proposes the method based on texture, color, and shape to recognize the fruit effectively since in the food industry, it is more important to identify the fruit based on their quality because nowadays persons are more conscious of health. A variety of fruits are available in the market, but identifying the good fruit is a more risk-able task. In order to short this, the natural lighting method is used. Particular fruit is recognized by image segmentation methodology. In this article, a fruit recognition paper is implemented by using the MATLAB image processing toolbox. This consist of four processes namely pre-processing, Extraction of feature, Segmentation and Recognition. This paper can be used for both real and non-real time application. In the case of non-real-time application, pre-processing is used to browse the image, then from the image, features are extracted by using GLCM (Grey Level Cooccurrence Matrix), RGB and Color Histogram in the second stage. Then for the further process, the image from the RGB is converted into a Grayscale image by the system. In the image, the distribution of colors like red, green, and blue can be represented in terms of the color histogram. The extracted features are given as input SVM classifiers. Then the output "fruit name" is displayed.

## Fruit image Recognition using K-NN and SVM Algorithm:

The researcher ((Zawbaa, 2014) explains the method that recognizes the fruits by identifying the fruit types. The work involves image classification and identification of fruit based on the size, shape, and texture. In this article, pre-processing, classification, and feature extraction are the three stages involved. In order to reduce the index color, the size of the image is resized into 90\*90 pixels, which takes place in the first stage. Next in the second stage, the feature extraction, SIFT (Scale Invariant Feature Transform), shape, and color are used to extract the image of each dataset. Finally, in the Classification phase, the K-NN K-Nearest Neighbourhood algorithm and SVM Support Vector Machine algorithm is used to identify different types of fruits. This process carries the above model and demonstrated on the dataset

containing 178 images of fruit. Thus this will provide fruit name with a high rate of accuracy. This will helps the people to identify the fruits in an easy manner

## Color and Texture feature Fruit recognition:

The study explores that Computer vision and machine learning are playing a vital role in food industries nowadays. This article will helps to monitor, sort, and pick the fruits that will ensure production in a faster manner. The main aim of this paper is to investigate the methods like auto-harvesting and categorize the fruits based on their color and texture. (Jana, 2017). This article will propose a new approach that will overcome the issues in the previous method. The proposed method will account for different fruits according to their types. The main motivation of this paper is to provide the result with high accuracy and efficiency. In every paper, the first stage of classification of fruits is pre-processing which is done in order to make a separation of the fruit from foreground to background. From the segmented image, the feature of texture from the Grey Level Co-occurrence Matrix and the color feature from the statistical layer are extracted. These two combine in a single feature. A support Vector Machine is trained by a feature combination of GLCM and statistical descriptor. Once the training is completed, the model is ready to find the unlabelled image of the fruit. This method is also suitable for embedded-based paper and single-board computers.

#### CNN Based Fruit recognition:

The research explains that the fruit is recognized using Convolutional Neural Network CNN model. (Hou, 2016). For every process, the image should be extracted, in this paper, the image is extracted from the selective algorithm, and the region of the image is obtained from the fruit image entropy. This is considered as the input of the Convolutional Neural Network. The process will be started after proper training of the network. The final decision is made only after the fusion of the region by using a voting mechanism. The achievement is done after doing the work in a better manner. The application of this method in the supermarket helps to find a variety of fruits, fruit stacks, etc, and also made multiple training to identify the fruit types. After successful training, this network will be remarkable over the fruit recognition stacked based on weighing scale

## DNN and Efficient Net Architecture:

This paper proposes that many techniques have been proposed in the past years for the recognition of fruits by using computer vision technology. (Chung, 2019). While comparing with other algorithms Deep Neural Network DNN will provide promising results in identifying fruits. Many types of DNN classification are proposed to identify the fruits. Issues in recognizing fruits may depend on size, shape, texture. In this paper, the network is designed to find a single fruit. This article gives a brief explanation about the Deep layer in identifying the image of the fruits. This paper will explain the application of this method. In this article, a brief explanation of the Convolutional Neural Network CNN and also EfficientNet is discussed. This provides the accurate output for Fruits classification of about 360 dataset. EfficientNet architecture is highlighted briefly in this section. Best accuracy is found throughout the model work. In the future, the model will be utilized to find an image of different varieties of fruits

#### Fruit detection within the tree:

The paper explains that the Hardcoded feature Extraction algorithm is used to detect the fruit within the tree by video or image processing. This algorithm has shown high accuracy. Even though it shows high accuracy, the hardware is still intensive and not applicable for real-time applications. This article gives an explanation of a deep convolutional neural network that is based on a detector of a single stage. This technique will eliminate the hard feature based on shape, size, and texture. (Bresilla, 2019). Then this architecture takes the image as input and then divides it into the grid, represented as AXA where A is used to define the fineness of the grid. The image recognition and localization algorithm are fixed on each cell of the grid. This will helps to identify the image based on their feature. This architecture gives 90% accuracy. This model is also designed with a feature to accommodate the error rate. The speed taken for the processing is also high that will be apt for real-time application. In this paper, we have discussed fruit recognition using deep neural network technique by using a single-shot detector YOLO.

## Retail application using machine learning:

This paper gives a brief explanation of identifying the fruits and also vegetables in the retail shop with the help of the image attached with the system. The system attached with the image will help the customer to label or identify the fruits and vegetables along with the price rate according to the weight of the fruits and vegetables. (Femling, 2018). This new approach is

proposed in order to reduce the interaction between the system and the human, to speed up the time for identification, and to improve the usability of the graphical interface comparing with the manual features. The hardware designed for this paper is Raspberry pi, a camera to capture the image, display to view the result. In order to classify the object, various convolutional Neural Network has been trained and tested to provide high accuracy. Heuristic evaluation is used to test the usability of this network and this shows accuracy and user friendly compared with other technology. This system evaluated two CNN architectures namely Inception and MobileNet. This classifies 15 types of fruits and vegetables

## Multiple Fruits Grading:

The scholar explains that the fruit product challenge includes the approach for the classification and grading of fruits. Among these, identifying a fruit based on quality is one of the major challenges. This article represents the system to analyze four varieties of fruits and also ranks the fruit based on their quality. The first algorithm shows the color of the image like red, blue, and green. The second algorithm (Bhargava, 2019) shows the background of the image which is detached by the split and merge algorithm. After this, color, gesture, geometrical features are extracted. In order to evaluate the fruit type and quality, geometrical features are most widely used. Then in order to evaluate the quality algorithms like K- Nearest neighbor K-NN, SVM Support Vector Machine, SRC Sparse Representative classifier algorithm, and Artificial Neural Network ANN algorithm is used. The accuracy of the quality evaluation is detected for four algorithms. Finally, SVM is considered more effective and the output is considered as more comparable with other techniques.

### Faster RCNN based fruit detection:

This article presents the detection of fruit using a deep convolutional neural network. The main aim of the paper is to provide high, accurate, fast, and reliable output in the detection of fruits, because fruit detection acts as a vital element in the platform of agricultural robotics, in the estimation of fruit yield, and also in harvesting. Recent research (Sa, 2016) over the deep neural network states that it led to the development of a new approach called Faster Region-based CNN (Faster R CNN). Most of them adopted this model because the task can be

performed with the images obtained from the Color that is RCB and Near-Infrared (NIR). In previous research, RCB and NIR are the fusion methods used to detect. This leads to proposing a Faster CNN model which is more effective than prior work and scores F1 Grade. Bounded Box annexation is used for additional accuracy. This model concludes by showing the result of detecting seven fruits which takes four hours for both annoying and training. Thus future results show the annotation of fruits can be done by utilizing Amazon mechanical Truck which is an algorithm and other outsources to achieve high accuracy.

## Fruit detection and sorting:

Recent research of this paper explains that humans are so busy with their personal works, all want to do work with accuracy, less time along low cost. This method is proposed to satisfy their needs. Related to this, counting the fruits takes more time and requires manpower. In order to reduce the effort of the user, the algorithm is developed in computer vision to reduce the manpower. In order to avoid this problem, the algorithm like automatic fruit detection and counting of fruit is essential. (A, 2019). This provides high accuracy. In order to achieve good object detection, counting of fruits, classification of fruits various algorithms and extraction features are introduced. Proper training should be given for the algorithm to provide accurate output. In this paper, Raspberry pi is the hardware used for fruit detection along with the camera. This paper provides a deep explanation for the detection of fruits in trees, sorting of images is based on the color and shape of the fruit. Image taken from the online or videos can be considered as input, pre-processing of the image is done with the help of computer vision designed with python. The result not only helps for sorting, identifying, and classification of fruits it also helps in fruits overlapping and recognition of fruits. There are many areas available for the researchers to explore new innovation in terms of fruit detection

## Accuracy observation using CNN:

The paper says that the computer vision, detection of fruit using Deep Convolutional neural network CNN is the most promising feature. By using recent technology, the identification of fruits is done through images. Due to complexity and standard similarity, fruit identification and classification is more difficult. In this article, the fruit detection using the CNN

model is discussed. This proposed technique uses deep learning for identification. In this method, four layers are used for observation. The network is well trained and tested. Fruit recognition faces various challenges based on the size, shape, and texture (Sakib, 2019). The main problem faced by this fruit recognition is image segmentation. The features of this method are read using a sparse autoencoder (SAE). Thus this paper states the identification of fruits using the CNN algorithm. The accuracy is generated by passing through the hidden layer. Convolutional Neural Network CNN is similar to Artificial Neural Network ANN. The input for this algorithm is an image represented in pixel it passes through the hidden layer and output is obtained. Thus this experiment gives the name of the fruit image with accuracy.

## Recognition of fake food image:

This article gives a detailed study about the mixture of both validation and establishment of fake food tests with new technology. The new technology will automate the collection of data and also the analyses. (Mezgec, 2019 ). In this method, to find fake food, technology like matching food, deep learning, and standardization of food is used based on natural language processing. The previous method is similar for all the processes because both segmentation and classification of food take place at the pixel image level. To know its performance, the accuracy and interaction that had to mean during the union of the pixel are measured. Firstly, in food matching, food items in the image are described and then compares the recognized image with the compositional data regarding both name and their descriptors name. Thus the final report of the food matching provides a result with an accuracy of 93%. Further research is doing over automated dietary assessment and also research on food choice. This method overcomes the former research by its pixel accuracy. Nasco food model which is also known as Replica – food model is most commonly used for Dietary assessment and also for educational purposes. Because of its complexity, the results of this method have not performed well. In order to overcome the issues, the new method of deep learning is implemented. This method is more effective for image recognition. It also helps to validate the food image many times. The method that is contributed in this paper are fake food buffet, image recognition of fake food, preprocessing of the image, training of deep learning finally food matching. Thus an advanced method for food recognition is developed and food images are collected using the FFB method.

## Pure CNN – Fruit recognition Framework:

The proposed method explains that this article describes the automation that has emerged in various fields like Agriculture, education, harvesting of robots by using the methods like machine learning and also the computer vision. Among them, these machine learning also plays a vital role in fruit classification (Kausar, 2018). This is quite complex because they found similarities in shape, the color of the fruit, size, and texture of the fruit. In order to identify the fruits with more accuracy, the method called Pure Convolutional Neural Network CNN is developed. This technology is developed with fewer parameters. CNN is composed of seven convolutional layers. Each convolutional layer is followed by strides. Global Average Pooling GAP layer is developed in order to reduce the overfitting, and also to give an average for whole map features. This layer is verified to be more effective. This method is demonstrated over fruits with 365 datasets. This paper also gives a brief explanation of the fruit recognition with 98% accuracy. The methods that take place in this papers are Pre-processing, P-CNN, training, matching. Pre-processing has to be done before every start because it provides accuracy. The result fruit name along with the predictor is obtained by using the P-CNN method which is more accurate in the market.

### Food image Classification:

The proposed paper says that the classification of food images (O'Leary, 2018) is one of the features of Computer vision, which is most commonly used for image detection and content retrieval. Nowadays, more researches are conducted in this area in order to classify different types of the food image. This paper investigates about one of the main domains called food image classification. This method is helpful for Restaurants and in intake calculators of dietary. For this accomplishment, Deep Convolutional Neural Network is introduced in two ways. Transfer learning and re-training of Deep Convolutional Neural Network is done. Next, the image is extracted from CNN's pre-training in order to train the convolutional classifiers. In this paper, a new database is introduced based on the guidelines of the Australian diet. By comparing the other methods, the most accurate method is introduced in this paper. This gives accurate results when compared to the existing method, but the training time taken is comparatively low than the existing one.

## Image Classification with frequency Domain Layers:

The paper explains the importance of machine learning which plays a major role in the automated field. Great improvements (Stuchi, 2017) were shown in both performance and accuracy of computer vision and also in signal processing systems and applications. A variety of techniques have been emerged in this field lie deep neural networks but the frequency domain has not shown thoroughly. In this paper, a detailed study is made on the new technology of extracting the features by using Fourier analysis. This proposed Fourier analysis technique combines with the deep architecture in order to provide better image classification with high accuracy. Experiments are performed well with the computational field that was performed with the liveliness of the face detection problem, this has provided better results comparing with the existing Replay- attack database protocol. This paper discusses how the frequency domain helps the deep neural network to improve performance in the network area. This results in the image classification can be done through the frequency domain layer.

## Hyperspectral image classification:

The paper includes the remote sensing method and explains that deep learning has gained more attention in research years. (Mahmoudi, 2018).

In deep learning, the convolutional neural network is the best approach in the application of visual recognition. Google Net and VGGNet is a pre-trained model for image classification. This model is considered a pre-trained model because of its dimensionality and it requires less sample to be trained. This new technology shows CNN architecture that can be used for two real hyperspectral that is real-time application data sets. By calculating the orthonormal basis that relates to the correlation matrix, the issues over-dimension can be overcome. This will reduce the dimensionality of the image and also increases the signal-to-noise ratio. This overall method is performed by subspace feature extension. This paper describes the combination of both the framework like Convolutional Neural network CNN architecture and the subspace feature to provide more information and design CNN, this will limit the sample for the training. The feature which is generated by the subspace and CNN framework will provide regression of this method. This feature provides better performance by using original and conventional data based on a recent approach. The result shows 98% accuracy by the performance shown in an Indian university

## Feature extraction using CNN and Deep learning technique:

This article details the extraction feature of images by using the Convolutional Neural network CNN and deep learning technique. (Jogin, 2018). Moreover, image classification is basically done by identifying the shape and geometry of the object which is surrounded by the human. This image classification is done with four processes like pre-processing of the image, segmentation of the image features extraction, and finally classification. The proposed method is faster and provides better accuracy while comparing with the past method. This new technology will be used for many applications like Features of security, authentication, face recognition, medical areas, identification of traffic, etc. The identification of images can be done with various techniques. Among that machine learning is the most used method for image identification. This algorithm has been developed years ago, but it has not implemented in a better way due to computational power. With the help of a deep learning algorithm, the image is represented in a better way by proper training of the network. In the first layer, the CNN gets revolution by the shapes and then in the deep layer, it will make to learn the extracted features and finally provides accurate result. This technology has emerged as the fundamental keys for understanding the cortex visual in the terms of humans and animals in the computer vision field. Thus this paper features the image that has been extracted using a convolutional neural network. This performs better in deep learning. The deep learning algorithm is used for various applications and results show accuracy and this method is almost accepted by many researchers. This network has certain drawbacks like training is less, computational power is lagging emerged during network scale. These issues can be overcome by the research done in the future with a better result

#### Convolutional neural network review:

The author did research and found that in the existing method, the application of the CNN technique for fruit identification (Naranjo-Torres, 2020) is not considered the best approach. In this paper, the advantage of using CNN over the previous method is discussed. In this study, we are able to study details that are applied in three applications. In the first application, CNN is applied directly to identify the fruits based on their names. This first approach is applied in markets, supermarkets, retail shops, and also for wholesalers. The second one is identifying the quality of fruit which is used to identify the damage on the internal and external damages that occurs in the fruit, to know its maturity degree, and also used to identify the disease or to know

the nutrition in the fruits are in normal level. The final application is known as fruit detection that is used in orchards for fruit harvesting, it estimates the location for harvesting fruits. The approach of CNN may vary for different applications. THE new CNN approach is developed by pre-training the CNN by modifying various layers and parameters. This provides an accuracy of about 100%. It also found to be better in the area of robotic harvesting.

## High-quality fruit recognition:

The main aim of this paper is to identify the fruit images using different datasets. The name of the fruit is mentioned as Fruit 360 and can be obtained from the resource Github and Kaggle. To obtain a good and best classifier, the dataset should be of high quality. The image dataset contains objects and also noisy backgrounds. If we change the background, the classification of the image will be identified incorrectly. Next deep neural network should be trained properly to identify the image. (Mureşan, 2017). This part is considered as most complex because the main target of this paper is to obtain the classifier and identify the object from the image. This will suit the current trend that is working in the required field. In this, counting of fruits and recognizing of fruits from the image is represented by using the Auto counting method. In this article, the target is fruits that are identified based on their shape and color according to the plant canopy. The main motive of this paper is to identify the pepper fruits in the greenhouse. The deep learning algorithm is used in this field to identify the fruits. Convolutional Neural network comes under Deep learning algorithm. These networks consist of a convolutional layer, pooling layer, and fully connected layer. A deep belief network is a model that is composed of hidden layers. This model is very important because it reduces the training time and improves the quality. The successful output of image classification and recognition is obtained by using the artificial neural network ANN.

#### Fruit recognition in retail stores:

The study says, in the retail stores, the vegetables and fruits payment is to be identified manually. In this paper, the convolutional neural network CNN method is used in order to classify the fruits that will speed up the checking process. The process is designed with three classes that will identify the fruits with or without the plastic bags. In order to increase the accuracy of classification, a new approach is added to the Convolutional neural network

architecture. Single RGB color, histogram, RGB centroids are the input. These are obtained from the K means clustering. This paper shows accuracy for both fruits with or without bags. Customers' purchases are most important to rely on Retail stores. In this paper, a minimum number of training are performed to classify the fruits with better accuracy. Data augmentation is also not exposed to the dataset. (Rojas-Aranda, 2020). This is also like to measure the light-sensitive illumination. Future research can be done to compare the accuracy of CNN architecture against the CNN along with GPU hardware and datasets. In this paper, the data accuracy for different methods is discussed. MobileNetV2 architecture is the model used for this method and trained with two dataset versions. The first image that having fruits without a bag and the second image having fruits inside the bag. The accuracy of the fruit image is higher in the image without a plastic bag. The colors are based on the background that should be taken into account. In the future, the elimination of the background will be processed.

## Instance segmentation for fruit and vegetable feature extraction:

The main aim of this research person is to develop a system that is used to identify fruits and vegetables. (Chandak, 2019). Particular category feature is also obtained along with the fruits and vegetable identification. A conveyor belt is updated over the fruits and vegetables by assumption. The input may be obtained through images, text, or videos. In this project, input is obtained through images. In the first part, the dataset and models have selected. Next, the model is re-trained according to the dataset collected. Thermography, tomography is some of the specific image capturing techniques used in this task to classify the fruits and also to count the number of the fruits present in the dataset. In this process, kaggle 360 dataset is used to extract the data contains 96 fruit classes and contains 103 images in each 96 fruit classes. But later it is clear that the dataset is used only for classifying the fruit image not for counting the objects. In order to count the object, the MS COCO dataset is preferred. Models chosen for this project is YOLO. This technique first split into grids and then classes are assigned when the objects are detected. As a result, overlapping occurs. The accuracy also found to be lower comparing with others. Another issue is that YOLO is best in videos than in images. Image segmentation is another technique used here, this also fails because it is low color contrast. Tried with edge detection, it too fails. After several attempts Mask C – RNN is used. It is single with the best performance for MS COCO Dataset. Detection of the object, segmentation semantic are the two

functions performed by this model. Thus Mask C- RNN shows less loss, less time for every layer.

# Chapter 3

#### 3.1 Introduction

In this portion, the methodology for recognizing the fruits using the CNN. The various algorithms are used for the recognition of fruits are discussed below. The Hardware requirements, tools requirements, and also the representation of the flow chart explains the process flow would also be discussed

## 3.2 Requirement gathering

For the fruit identification using the CNN, the mandatory requirements like hardware, software, and also other requirements including web application framework and the required libraries need to be included.

## 3.2.1 Hardware requirements

The recognition of fruits needs many images to train and identify the exact name of the fruits irrespective of the shape, size, and color[ CITATION ARJOO \I 1033 ]. The hardware requirements required to process the research project include storage of 8GB Ram. The project includes the idea of creating a web application to predict the name of the fruit faster and the intel core i7 Processor is used for this process.

## 3.2.2 Software requirements

The software requirements for the project include the Windows 10 operating system and the coding language used is python 3.6 Version.

### 3.2.2.1 Flask

Flask is a framework in Python and it is segregated as a micro one since it doesn't need any specific tools or libraries and also it helps to create reliable and maintainable applications. It creates a defined structure for the developing application and Flask framework. The flask is a lightweight web application in python and It is selected since it's easy to use and extends the objective aim to create a firm base to the application when it is created. It gives a solid base even it is complex[CITATION SEU98 \1 1033]. This also prevents the duplicate images in the training from entering the system. By using this framework the system can identify any fruit name that gets uploaded to the system.

## 3.2.2.2 Python language

Python is a high-level programming language commonly used to develop the web. Due to the readability and multiple modules support, Python is highly in demand and it also motivates the code reuse and the cost needs to maintain the program is very less comparatively. In this proposal, the python language is planned to use since it creates many web apps and it is one of the popular backup languages. The python application generally used to create the code for identifying the mandatory things that need to be taken. The web server in Python runs the code and also host the website and hence user don't need to install anything to use and they simply need to interact the browser code using the internet.

#### 3.3 Tools used

The tools selected for the identification of fruits name exactly irrespective of the fruit size, shape, and color[CITATION AAR97 \l 1033]. The datasets play the primary role in fruit name training and the datasets are collected from the Kaggle website. For the project development, python is used as the programming language. Keras and Tensor flow are the two libraries used to support the Python programming language. These two libraries are open source libraries and that is also the reason for selection. Jupiter notebook is opted to import Keras library and to test, train the files tensor flow library is used. It helps to denote the graph nodes.

## 3.3.1 Kaggle datasets:

Kaggle is a popular online source that consists of huge datasets. Kaggle is used for extracting the datasets. In this project, the kaggle is taken as a repository source for the identification of fruits. In recent days, Kaggle is considered a public data platform. It is easily available and cost-effective and hence the Kaggle is used as the source for Datasets.

### 3.3.2 Python programming language:

Python is considered a high-level programming language. It supports both object-oriented and structured programming. This language is used often because it is designed as highly extensible. Python has a simple syntax that is similar to spoken language. In this project, python is chosen because of its code readability. This will make the user to the interface without any struggle with the syntax. Python programming language is commonly used within machine learning software like Tensor Flow, Keras, etc. For manipulation of images, a pythonimaging library is used.

#### 3.3.3 Tensor flow:

Tensor flow is an open supply and it can be used by anyone at any time. Tensor flow package is employed in the terms of deep neural networks. Tensor flow is a popular python library and it helps in fast computing numerically and This is one of the foundation libraries which helps to generate deep learning models indirect or through covered libraries that make the process built simply over the tensor flow. Tensor flow program elements are Building process graph. and Execution of process graph. Tensor is used to represent the nodes in the graphical form. Spit folders are used to store the images of different forms.

#### 3.3.4 Keras:

Keras gives the interface for the programming language Python and it is given with the deep neural networks. It also supports Tensor flow by acting as an interface. It is considered a neural network building block. The testing input is supported with the help of Keras, it also trains the datasets which are collected from the Kaggle. The steps involved in the Keras process are,

- > Training and testing data information may be done.
- Layers are outlined that may support the feature.
- ➤ Model is compiled.
- > Train the model.
- Next value or evaluate the trained model.
- Finally gets the prediction.

Keras acts as a supporting layer for Python. In this Keras layer, the layers like dense, dropout, two-dimensional layer, activation layer, and max-pooling layer are extracted. Among those layers, We are using the Dense layer as the important one in this project.

• The dense layer is implemented only when output operation is obtained to be activation. When the output gets activated, the Dense layer is used in this project process.

## 3.3.5 Jupyter notebook:

Jupiter notebook is used in this project since it is one of the open-source web applications. This helps to create and share the documents with others. It helps to generate data in addition to the data visualization, equation of data. Jupiter notebook supports text files, HTML one, etc. Jupiter notebook is used to create documents and edit documents which is displayed from the Python programming language. After saving a file, it gets shared with others. Python is set to be the default one for this proposed project. Due to customization. It supports running on various platforms in Kernel. Jupyter ranks high since it can display even the complex equations of the fruit, It could even provide a chart for the quality of the fruit and a graph of the identified fruit. Python is used in this proposal since the written code can be edited when there is a need for changes. Jupyterlab is the latest product launched by Jupyter, it will help to edit the text and consoles online other than the Jupyter application.

## 3.4 Techniques

#### 3.4.1 Deep learning:

Deep learning is very popular in recent years because of its high accuracy when it is trained with a high number of datasets. That is one of the primary reasons to select the deep learning technique in this project hence a huge amount of datasets can be included to train the system which can lead high accuracy than the previous /existing methods. Deep learning delivered a high level of accuracy when it is tried for mage classification, identification of the object, lost image restoration, classification of the image, etc[ CITATION Sen09 \l 1033 ]. These techniques are used in various neural networks to train machines to automate the tasks done by the visual systems. The primary advantage of the deep learning technique is to resolve the critical issues that need to predict the hidden patterns of the data from the provided datasets and this technique of finding the relationship among the huge number of related variables.

#### 3.4.2 Convolutional neural network:

A convolutional neural network is also known as CNN or convents, uses the technique to solve the problem while training the dataset. Really CNN is considered like the superpower in

the deep learning of neural networks. In these networks, the operations are performed using sound, text, videos, and images, etc. Multilayer perceptron MLP is used to provide good results inaccuracy. The training time taken by the CNN is also considered to be reasonable when comparing to the other systems. Moreover, larger datasets with many images will make the parameters increase in their number and that reduces their potential resulting in poor performance. In this method, CNN is used to identify the fruits based on their features. The primary layer used for this model is the dense layer and also many others also included in this project. Each layer performs a specific function and provides the desired output

## 3.4.3 Dense layer

The dense layer is the common deeply linked network of the neural layers. It is the general and commonly used layer and it does the input operation and the output is returned as a result of the operation. Dense Layers' operation produces output when it is inactivated and where the activation is based on the element-based activation thing passed as an argument. These layers are densely connected and through the various connected features of the previous layer where the convolutional layers rely highly on the feature of the very small consecutive fields.

## 3.4.4 Sequential model

The sequential model is the simplest method to build a model in Keras and it permits the creation of a model using various layers. We use the add() function to add multiple layers to the model in our project. The initial 2 layers are the convolutional layers and the sequential layers are correct for the common layers where there is one input tensor and one output tensor. In sequence modeling, the current output depends on the previous input, and the input length is not a fixed one. In this project, applications of the sequence model are discussed. Due to its simplicity and permission to create models easily, It is selected in this project.

## 3.5 Research Concept

For the effective research and implementation of the identification of fruit names exactly, CNN is used with Python as a programming language. This allows the system to identify the fruit exactly irrespective of the color, size, and shape of the project [CITATION Che17 \ 1033 ]. The

research method involves the process of gathering requirements, execution of the python language scrip, testing the images, and displaying the output of the previous actions.

## 3.5.1 Collecting or gathering data

In this step, the hardware requirements, software requirements, and various other needs like Flask framework, python script, etc would be collected. All the data and requirements for the fruit identification application creation would be collected and gathered. The various papers were studied to understand the concept of fruit identification in previous days and the existing ones. The python was learned to code for fruit identification from the provided huge datasets even it has various patterns. The various libraries like Tensor flow, Flask were studied as a part of this project and understood their working process so as to implement in the python's script. Thus, all these details relevant to the project were effectively collected and stored for further processing.

#### 3.5.2 Code execution

The flask framework would be created and the script using python would be written. The functions were imported into the module. This involves the deep learning method as a technique for the implementation and also sequential model execution to get the perfect output as a result. The Keras and Jupyter notebook are utilized in this project along with the Deep learning in CNN to get the codes executed as per the requirements.

## 3.5.3 Testing the trained datasets

The various datasets are gathered and downloaded from the Kaggle. Then after the collection and insertion of datasets to the system, then those datasets are trained well to get the process done and this results in the exact output as required. These trained datasets are ten tested for the results.

## 3.5.4 Output display

If the fruit pictures get uploaded then the system recognizes the name of the fruits even when the fruit is of different color, shape, and size. The download and executed result show the accuracy of the output which is the identification of the fruit name accuracy. This can be stored for future reference when creating the application.

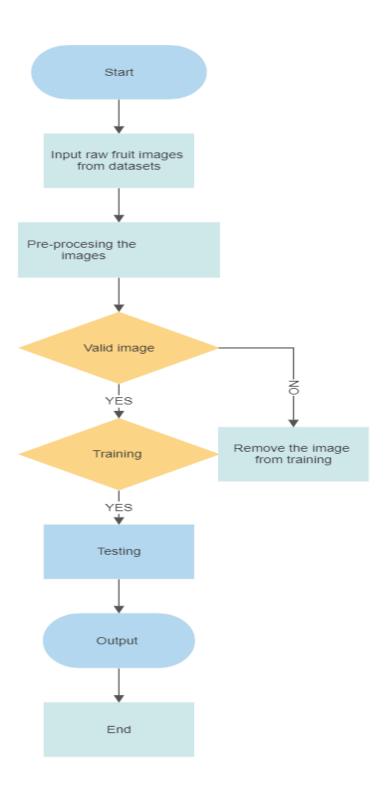
## 3.6.Diagram

The flowchart is generated for the method of fruit identification using the CNN and how it enhances the process of identification of fruit with high accuracy. The dataset needs to be trained and tested to get accurate results at the end.

#### 3.6.1 Flowchart

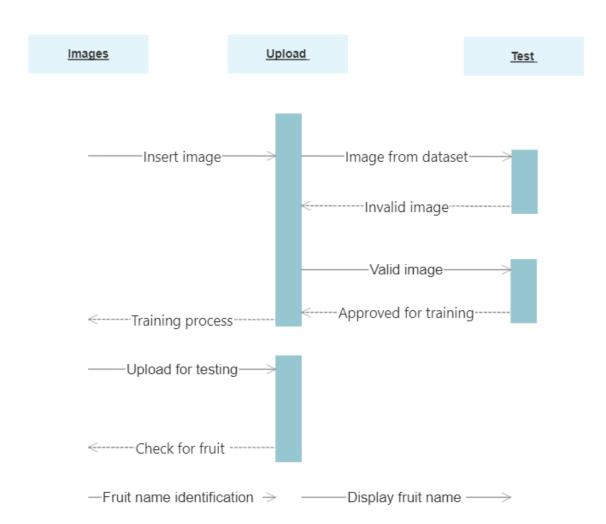
The below flowchart explains the process of fruit recognition using CNN and Python. The process begins with the insertion of fruit images and then the images get pre-processed, Then the image gets trained using the algorithms. After training the images to get trained with the provided datasets. Then it gets tested to get the corresponding output.

# Flowchart



## 3.6.2 Sequence Diagram

The sequence diagram for the fruit recongition is depicted. The interaction is carried out between the images in the sequential order in sequence diagram. The objects involved in the scenario are shown and the sequence of messages are interacted between the specified objects in the image which would process the scenario. This sequence diagram helps to find out how the system functions and interacts with its image objects. The behavior of the future system or the existing systems functions could be viewed through the sequence diagram.



## 3.7 Conclusion

The overall methodology and the mandatory requirements for the fruit identiifcation and recognition. The requirement collection, tools used and the fow chart depliciting the process of fruit recognition are illustrated well[CITATION Woo09 \1 1033]. The research concept and the the process taken on how to find the fruit exactly using the above tools ad techniques along with the Python as programming language. The sequence diagram also designed for the sequence of happenings that would be performed by the system. The functionality of the system and how they are communicated with other object in the system are shown clearly so as to provide better understanding of what actually happens in the system when these process steps are carried out.

# **Chapter 4**

## 4.1 Introduction

Python is used as the coding language i the project and the mandatory functions would be carried along with the imported libraries functions. The flask framework would be built to enhance the applications that are complex. The deep learning algorithm and CNN used to create the project effectively [ CITATION Dew21 \l 1033 ]. The functions and the methodology are created to detect the fruit based on the color, shape and size. The coding created for recognizing the fruits irrespective of the shape, size and color [ CITATION Sen09 \l 1033 ].

### **Design and Analysis**

#### Phases in fruit recognition:

The steps involved in fruit recognition are collection of data, pre-processing the obtained data, extraction of image, classification of image finally evaluation or validation of image. Each stage in this project gives

output based on their requirements [CITATION Jan16 \1 1033]. The flowchart for the fruit recognition is given.

#### Collection of data:

For this project, the data are collected from the open source website "kaggle". Kaggle helps the users to find the data and publish in better way. In this project, 15 fruits images are extracted from the kaggle dataset. The data's obtained from other source cannot give a clear image. After collecting the data's, the images are passed through the deep neural network[CITATION Che17 \l 1033]. It helps to train the system and provide the result with high accuracy. After downloading the datasets, proper library should be loaded in order to compose a data frame. Data frame is formed by using add loop function. From the data framework, the fruit is classified as fruit name, path and label is formed for each 15 fruits. This project is formed by using python libraries namely tensor flow and keras.

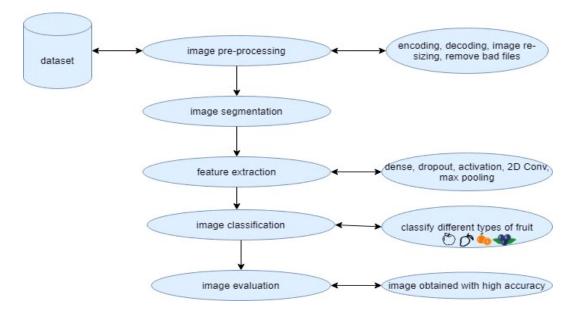


Fig 1: Flowchart for fruit recognition

Above chart describes the flow chart of fruit recognition. Designs based on requirements. Each stage gives desired output based on their constraints.

## Pre-processing of image:

After collecting the datasets, next process to be performed is image pre-processing. In this phase unwanted images that is image with poor quality is eliminated before passing the image through neural network. With the help of pre-processing, the bad quality image is deleted, distortion is eliminated. Pre-processing is an important process that should be used before starting image classification. It is essential

to delete the unwanted images from the datasets. In this phase, the image is first converted into gray scale and then to gray threshold and finally to black and white image by removing all the impurities. Now the collected data is ready to process[CITATION Woo09 \l 1033]. The collected data is encoded then decoded in order to obtain image with high accuracy. Decoded image is passed to the image resizing, in this the original image is re-sized into quarter of its original image, then it is passed through image array convertor in order to convert the image into black and white image, that black and white image is passed to the dimension expander then it starts predicting.

#### Feature extraction of image:

Feature extraction of the image is important for every terms of machine learning, in recognition of pattern and also in image recognition. After pre-processing of the image, next stage to be performed is feature extraction. Feature extraction includes extraction of image based on shape, size and texture. Two important features of fruit recognition are feature extraction and identification of feature. Feature extraction is one of the processes in image classification[CITATION WKJ03 \l 1033 ]. The methods like Histogram of oriented Gradients HOG for extraction of shape, HSV, Color histogram and color histogram for extraction for color and finally GLCM for extraction of texture. In this project, tensor flow has a special feature to map the images. In terms of convolutional network, pooling layer is used to reduce the spatial size of the fruit image. Each image mapped feature is converted into single dimensional array. Extracted fruit image is used for further process and to get desired output.

#### Classification of image:

Next phase in image recognition is classification of fruits, which is important process in the image identification. By using the deep neural network, the classification of fruits takes place. In this project, 15 types of fruit images are classified along with path and label. Proper training is given in order to obtain image accuracy. Here the images are obtained in cluster format. It will categories the fruits in different format. The cluster 1 may indicate the fruit apple, cluster two indicates orange fruit, cluster 3 indicates fruit banana and so on. In this phase 15 varieties of fruits are classified. Thus this phase helps to train the system and get the output which is desired[ CITATION SEU98 \l 1033 ]. The challenge towards image classification is it has to identify different types of fruits and next it has to identify different varieties of fruits among the types. Classification of fruits is quite difficult because fruit 360 dataset consisting many types and varieties of fruits.

#### Image evaluation:

Final stage of the fruit recognition is image evaluation. In Deep neural algorithm, convolution network helps to identify the images by using different layers. Thus final image is obtained by comparing the extracted and tested data with the original fruit image[CITATION AAR97 \1 1033]. Finally, the desired image is obtained in this phase with high accuracy. Evaluation of the images is done after the classification technique. Evaluation gives the final output based on their constraints.

#### 4.1.2 Code Explanation

The sample dataset is imported from the Kaggle dataset. Plenty of sample dataset are imported from the Kaggle. By using large number of datasets for the training and testing large number of datasets provides the high rate of accuracy. Hence the large number of random datasets is collected from the repositories to train the algorithms and that gives the best output compared to the currently existing method to detect fruit.

#### Loading libraries:

```
In [1]: # Load the Libraries
import pandas as pd
import numpy as np
import seaborn as sns
import os
import cv2
import matplotlib.pyplot as plt
import random
import time
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score
from sklearn.model_selection import train_test_split
import keras
from keras import Sequential
from keras.layers import Activation, Dropout, Flatten, Dense, Conv2D, MaxPooling2D
from keras.utils import to_categorical
from keras.callbacks import tarlyStopping, ModelCheckpoint
from tensorflow.keras.preprocessing.image import ImageDataGenerator

Using TensorFlow backend.
```

Fig 2: loading the libraries

The gathered dataset samples are pre-processed using the data pre-processing technique. The image needs to be pre-processed are imported using the **ImageDataGenerator** and the Keras is used as the frame work in this proposal for the fruit recognition. With Keras the cognitive load gets decreased since it follows the methods effectively and it provides easy and reliable APIs which deceases the user actions and it provided the high accuracy in the fruit identification. Keras is easy to learn and reliable source

**Keras** used as an optimizer in this project. Optimizers are used to modify and shape dataset that needs to be trained to the exact form with the datasets and it is used in this project due to the learning rate. Decay rate increase small learning rate which can be used so the loss won't change after the drop to the point .When the model shows perfect accuracy at the time of handling the data and the situation occurs when the model has set of complex rules. The datasets **train test split** function are used to split the

datasets for two different resolutions: Training and testing. The training dataset is to create the model and the testing dataset is to evaluate the performance of the model. The huge number of datasets is imported for the training and also various datasets are used to test the dataset models to give the high accuracy outputs. **Sklearn** (Scikit learn) is a Library function of Python that provides multiple processing features for the data and it is used for the segregation, combination and the sample selection. The **model\_selection** is a process for creating the map for analyzing the data and then this is used for measuring the new dataset. The sample selected properly allows creating accurate outputs when the prediction is completed. The fruit is recognized and then identified using the pattern prediction

In this step, the model has to be trained using the provided samples and then the model is tested against the leftover dataset. When there is a dataset, it has to be split using the Sklearn **train\_test\_split** function.

Pyplot is a set of functions that build Matplotlib work like MATLAB. Every Pyplot function generates few changes to the sample picture. E.g. creating a picture creates a conspiracy location in the image and plot few highlights in the area, adorns the spot with mark. The **random** process is imported from the library, in this method this returns random number as output between 0 and 1. Based on the random number creator function, the random modules functions and also the created float (random) number is between 0.0 and 1.0. Arguments are not needed for the function. The dataset is selected randomly with different fruits with different colors, shapes and sizes. **Import CV2** files from the python library bindings and it is built to resolve the image issues. In the CV2, imread() is a process to load an image from the saved file. If the image is in not readable format due to poor quality of the image, image missing state, if it don't have exact permissions, or if the format is invalid then the output **matrix** will be empty. The python has **OS** module which gives different functions to work along with the operating system. OS is one of the common utility Python modules. This module gives an easiest option of utilizing operating system functionality (dependent). **Import sequential** is a part of the keras framework and it has multiple layers and sequential model is related by fleeting multiple layers to the generator. From the Keras models import the sequential from the layers of keras and then import dense and the activation model.

#### Loading image into the folder path:

```
in [2]: # function which loades the images in the folder path
         def load_images_from_folder(folder,only_path = False, label = ""):
             if only path -- False:
                  images - []
                  for filename in os.listdir(folder):
                       img - plt.imread(os.path.join(folder,filename))
                      if img is not None:
                           images.append(img)
                  return images
             else:
                  path = []
for filename in os.listdir(folder):
                      img_path = os.path.join(folder,filename)
if img_path is not None:
                          path.append([label,img_path])
                  return path
in [3]: # Load the paths on the images
         images = []
dirp = "D:\\siva\\fruits_data\\"
for f in os.listdir(dirp):
             if "png" in os.listdir(dirp+f)[0]:
   images += load_images_from_folder(dirp+f,True,label = f)
                  for d in os.listdir(dirp+f):
                      images += load_images_from_folder(dirp+f+"/"+d,True,label = f)
in [4]: # Create a dataframe with the paths and the label for each fruit
         df = pd.DataFrame(images, columns = ["fruit", "path"])
```

Fig 3: image loaded to the path

load\_image\_from\_folder supports to import images from the dataset folder. Listdir() method in python helps to get all the files and directories in the mentioned directory. This return all the files and directories that are mentioned. After loading the libraries, path is needed for image storage. In order to load the images in the path, the function load image from folder is used. Then the stored images in the path and the data frame is generated for every fruit and named every fruit with the path. The loop is generated for this process. After naming the fruit, then the function returns the path and this loop goes untill the exact identification of all the fruits.

#### Dataset shuffling:

```
In [5]: # Shuffle the dataset
from sklearn.utils import shuffle
    df = shuffle(df, random_state = 0)
    df = df.reset_index(drop=True)

In [6]: # Assign to each fruit a specific number
    fruit_names = sorted(df.fruit_names, [t for t im range(len(fruit_names))]))
    df["label"] = df["fruit"].map(mapper_fruit_names)
    print(mapper_fruit_names)
        ['Apples': 0, 'Banama': 1, 'Carambola': 2, 'Guava': 3, 'Kiwi': 4, 'Mango': 5, 'Orange': 6, 'Peach': 7, 'Pear': 8, 'Persimmon':
        9, 'Pitaya': 10, 'Plum': 11, 'Pomegranate': 12, 'Tomatoes': 13, 'muskmelon': 14}
```

Fig 4: dataset shuffling

To randomly shuffle things of lists (list), strings (STR) and tuples (tuple) in Python, use the random module. The mentioned random provides shuffle () that shuffles the basic list in place, and sample () that gives a complete list of randomly shuffled images. After labeling the fruits, the collected data are shuffled. This gives true or false statement. The function says true when the drop is same as given image. Then each fruits and vegetables are assigned with specific numbers. That number will help to identify the fruits as soon as possible. For example: apple is numbered as 0, banana as number 1, carambola as number 2 and so on.

#### Data frame visualizing:

]:		1/2 (2)	50.20	100	
	fruit		path	label	
	0	Tomatoes	D.\sival\fruits_data\Tomatoes\Tamotoes001923.png	13	
	1	Persimmon	D:\sivaltruits_data\Persimmon\Persimmon1773.png	9	
	2	Persimmon	D:\sive\fruits_data\Persimmon\Persimmon930.png	9	
	3	Banana	D'isiva/fruits_data/Banana/Banana02798.png	1	
	4	Banana	D'isiva/fruits_data/Banana/Banana01967.png	1	
	5	Mango	D:\siva\thuts_data\Mango\Mango003044.png	5	
	6	Mango	Disivalfruits_datalMangolMango002999.png	5	
	7	Mango	Dilsivalthuits_datalMangolMango001388.png	5	
		Peach	D'isiva'druits_dataiPeachiPeach002031.png	7	
	9	Pitaya	D:\siva\fruits_data\Pitaya\Pitaya002493.png	10	
1:	bar	t in our dataset (0,8)) = 20)			

Fig 5: visualizing the data frame

The Data frame (df) function selects data by mention of the rows and columns. The df. loc indexer inputs data in a various way than just the indexing operator. It can opt subsets of rows or columns. It can also select subsets of rows and columns respectively. After giving their specific number, resulting data frame is visualized for first 10 rows. The above figure represents the visualization. The visualization is represented in terms of fruit name, path and label. After visualization, fruit types that are distributed in the datasets are plotted.

#### Dataset display:

Fig 6: display the dataset

The imshow function displays the picture of the fruit, but does not store the image data in the MATLAB storage. If the dataset has many images, imshow displays the first pciture in the dataset. When generating a colorbar in a plot with multiple images, it needs to be mentioned which image this color bar needs be generated and it is mentioned as plt. After visualization, 10 pictures from the datasets are displayed along with their labels. The images obtained are used for recognition of the fruit with high accuracy. This image is obtained during the pre-processing stage. Once data is collected from the source kaggle, image is uploaded to the training system that helps to encode the image; obtained image is decoded to open the image in required format. Decoded image is resized in terms of height and weight. Image array converter is used to convert the resized image into black and white image, and then dimension of that black and white is expanded. After the following steps, the process starts to predict the images. These steps take place in the pre-processing stage. It also helps to delete the corrupted images obtained during the dataset collection.

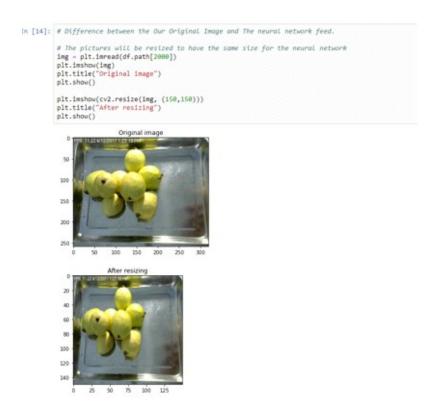


Fig 7: comparison of original and re-sized image

plt. show() begins a loop and looks for the existing figure objects and opens one or many connected windows tat shows the figures. The plt.show() provides the interactive backend. In this part, the original image is compared with the resizing image; the process starts to predict the high accuracy. The original picture is resized in order to have the same size of the deep neural network. Resizing of the image is done with 150X150 formats. This resizing makes half size of the original image.

```
In [16]:
    def create_model():
        shape_img = (150,150,3)
        model = Sequential()
        model.add(Conv2D(filters-32, kernel_size-(3,3),input_shape-shape_img, activation-'relu', padding = 'same'))
        model.add(MaxPooling2D(pool_size-(2, 2)))
        model.add(Conv2D(filters-64, kernel_size-(3,3),input_shape-shape_img, activation-'relu', padding = 'same'))
        model.add(Conv2D(filters-64, kernel_size-(3,3),input_shape-shape_img, activation-'relu', padding = 'same'))

        model.add(Conv2D(filters-64, kernel_size-(3,3),input_shape-shape_img, activation-'relu', padding = 'same'))

        model.add(Conv2D(filters-64, kernel_size-(3,3),input_shape-shape_img, activation-'relu', padding = 'same'))

        model.add(Conv2D(filters-64, kernel_size-(3,3),input_shape-shape_img, activation-'relu', padding = 'same'))

        model.add(Conv2D(filters-64,
```

Import Conv2D, 2D convolution layer generated a kernel that is convolutional with the input layer to create the outputs with tensor flow. When the activation is not any then it is applied to the outputs as well. During the usage of the Conv2D layer as the first one in the model, insert the function argument and find the difference based on the Picture colours. The variation of the image represents the different fruits in the dataset. Max pooling is used when the down samples are inserted by accepting the maximum values through the window mentioned by the pool size for all dimension along with the axis. The window is then changed by strides in every angle. The output got finally has needed information (with the number of rows or columns) when it using the padding option as Valid. The output image is same. More dataset of fruits goes through more training and testing and it results with the accuracy rate is high.

```
print(confusion_matrix(y_test_class, pred))
print("\nAccuracy:", round(accuracy_score(y_test_class, pred),5))

def plot_training(model):
    history = pd.Dataframe(model.history.history)
    history[["accuracy","val_accuracy"]].plot()
    plt.title("Training results")
    plt.xlabel("# epoch")
    plt.show()
```

```
In [20]: def from_categorical(1st):
    lst = lst.tolist()
    lst2 = []
    for x in lst:
        lst2.append(x.index(max(x)))
    return lst2

def display_stats(y_test, pred):
    # Display prediction startist(s
    print(f*rem Result of the predictions using {len(y_test)} test data ###\n^*)
    y_test_class = from_categorical(y_test)
    print("classification Report:\n^*)
    print(classification Report:\n^*)
    print(classification report(y_test_class, pred))
    print("infooffusion Matrix:\n\n^*)
    print(confusion matrix:\n\n^*)
    print(confusion matrix:\n\n^*)
    print(confusion matrix:\n\n^*)
    print("\n\n\curacy:", round(accuracy_score(y_test_class, pred), 5))
```

#### Fig 9: prediction statistics display

After resizing, model supports sequential manner. Layers abstracted from the keras sequential models are activation, flatten, dense, dropout, conv2D and maxpooling. Dense layer is used to interconnect all the layers that return the output as the input for the next layer. Dropout layer is used to remove the unwanted neurons present in the neural network. It will reduce the overloading the images during the training period. Flatten is used to collapse or merge the image into one dimensional array or D array. It automatically extracts the features of the image. Maxpooling is 2D spatial layer which is used to extract exact image feature by reducing the dimension. Pooling is used to avoid over fitting. By using this

original image is converted into quarter the size of original image. Activation is used to increase the non-linear property of the image. After this, activation is connected to the pooling layer.

After applying the images to the layer, testing process takes place. Result is obtained by using the prediction taken place in the test. Accuracy of the data frame is obtained. Based on that accuracy, training result is gathered.

### Training the model:

Fig 10: model training

Train and test, the testing data set needs to be selected and the other dataset is taken as the training dataset. The model on the training set fits and then the test set is validated. The validation score retained and sample got discarded. Training is given to the test dataset for accuracy. In order to increase the initial statement of the project, pre-training is given to the deep belief algorithm. Proper training should be given to every network for getting results with high accuracy. Improper training results are displayed in unsuccessful result. In this X train and y train needs to be deleted often in order to free up the storage.

Fig 11: time taken to display the model

**Plotting accuracy** the accuracy rate if plotting and the accuracy of the map or the plan based on the accuracy with the data are plotted and the plotting accuracy on the files varies among certain values and the mean value is 0.25mm and that is taken as plotting accuracy. Accuracy is when the samples fit the training data fine but it can't simplify / make the data predictions accurately. The training dataset is used to train the model while the validation set is used to validate the performance of the model.

**Model accuracy,** the accuracy of the model is noted here and if the classification error is taken into consideration and then the accuracy that can be achieved is 100% and if the regression errors are taken into account then the error rate 0.0 and these accuracy is highly not possible to achieve. The prediction modeling also has prediction errors.

**Epoch** is the number of epochs has to be set manually and the high number of epochs give the best accuracy rates hence the epochs needs to be set in maximum and the based on the error rates the termination training needs to be done and an epoch is one learning cycle where the whole training data set is known and when there is more than one batch then for one epoch two needs to be done.

Images are passed to the deep layer in order to provide training. The time taken to load the image and to provide training in the deep learning algorithm takes up to 1312 seconds. The input of the sigmoid is represented in binary format either as 0 or 1. After successful training, the accuracy of the uploaded image is obtained. Compare accuracy of the obtained image with the validated image accuracy. Thus result shows the distribution of various types of fruits and vegetable images. The outputs are represented in the graphical manner. Network consist of various loss function, the loss in the network can be reduced by using the software softmax and sigmoid cross entropy. Information loss of the images can be reduced by using padding function. Each steps implemented gives a desired output based on their constraints. The output shows 94.75% accuracy.

## 4.5 Result and discussion

The convolutional neural network is used in the fruit recognition is explained in the section. The datasets from the common source are collected from the Kaggle website as a source. The needed libraries are exported to perform this action and the collected data is checked for the pre-processing process to eliminate the corrupted image and then the proper training is given for the model to give high accuracy. Then the data are tested, by showing comparison between original image and resized image [CITATION ARJOO \ 1033 ]. Finally, the result is obtained by testing. In neural network, trained model is uploaded and the images are classified by using the tensor flow libraries.



Fig 12: classification of fruits

Above image represent the recognition of fruits and the stage before identification. The listed images are tomato, persimmon, banana, mango, peach, petya and orange. Each fruit is classified based on their path and label[ CITATION MTB06 \l 1033 ]. The numbers given to each fruit will helps to identify the fruit easily.

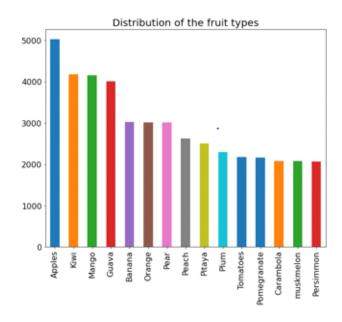


Fig 13: fruit types distribution

The above image represents the distribution of different types of fruits. The distributed fruit varieties are apple, kiwi, mango, guava, banana, orange, pear, peach, pitaya, plum, tomatoes, pomegranate, carambola, muskmelon, and persimmon. From the result, it is clearly noticed that apple reached highest distribution while persimmon, muskmelon and carambola found to be lowest which is in same level.

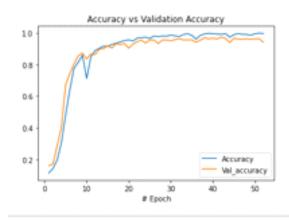


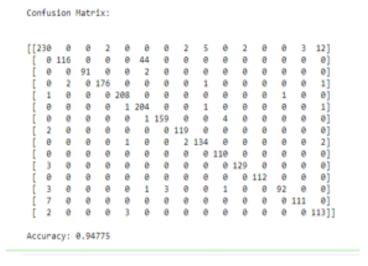
Fig 14: accuracy vs validation accuracy graph

The above images show the graph between accuracy of the original image and accuracy of the validated image. The graph shows range of the image in the form of epoch and accuracy. Blue line indicates the accuracy of the image while orange line indicates the accuracy of the validated image. It represents both loss and accuracy of the image. This results the image recognition with high accuracy and efficiency.

		precision	recall	f1-score	support
	0	0.93	0.90	0.91	256
	1	0.98	0.72	0.83	160
	2	1.00	0.98	0.99	93
	3	0.99	0.98	0.98	188
	4	0.98	0.99	0.98	218
	5	0.81	0.99	0.89	287
	- 6	0.98	0.97	0.98	164
	. 7	0.97	0.98	0.98	121
	8	0.95	0.96	0.96	139
	9	0.96	1.00	0.98	110
	10	0.98	0.98	0.98	132
	11	1.00	1.00	1.00	112
	12	0.99	0.92	0.95	100
	13	0.97	0.94	0.96	118
	14	0.88	0.96	0.91	118
micro	avrg	0.95	0.95	0.95	2220
macro	arrig	0.96	0.95	0.95	2220
weighted	avrg	0.95	0.95	0.95	2220

Fig 16: prediction result

The above image represents the classification report done by using the last 1/20 or 2220 dataset.



Above image represents the confusion matrix in which the accuracy of the fruit recognition is obtained by using CNN model.

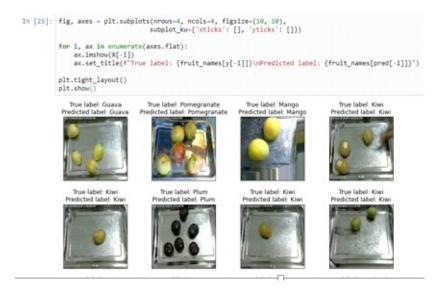


Fig 18: True vs prediction label

Above image represents the difference between the true and predicted label. Thus the classification of fruits with 94.75% is obtained.

# 4.6 Challenges

The major issue faced by fruit recognition using deep neural network is MNIST benchmark. In this project the fruit 360 dataset consist of large number of datasets with different classes of image. Hence the dataset in this project is to be specific. The task is based on fruit recognition. The computer will face a challenge because there is large number of fruits classification in the dataset. Another issue is different types of fruits to be identified, then fruits with different varieties to be identified. Padding is used to neglect the loss. Pooling layer is used to avoid over fitting.

## 4.7 Conclusion

In the proposed project, the fruit recognition is achieved using the CNN and Deep learning approach. There are plenty of methods available to segregate the fruits based on the pattern. The project is to identify the fruits with the accuracy rate high. At the time of deep learning is a huge step in image processing The CNN is analyzed via its layers and among those the important layer is a dense layer.

A dataset is collected from the source kaggle, due tio its clarity and reliability. By using the preprocessing technique, image with poor quality and corrupted can be removed. By using the open source
software Jupiter, the dataset collected for import to the training. Tensor flow library is used for testing and
training the data. By using the neural network, the images are classified using the name of the fruit like
apple, orange, banana etc. Process and methodology discussed in the project helps to know better about
the convolutional neural network[ CITATION JZh05 \l 1033 ]. Design and analysis is done in order to
recognize the fruits with high accuracy. The image structure is identified to predict the pattern during the
pre-processing stage. Google colab is recommended for future to overcome the issues in the fruit
recognition project. Implementation section clearly shows the project steps and methodology followed to
implement the project. Outcomes have been obtained after the successful implementation and results are
discussed in better manner. Much research has been done in order to classify the fruits and researchers
have stated their opinion based on their view prior. But fruit recognition by using deep learning provides
better result. The accuracy of this fruit recognition by using deep neural network algorithm is found to ss
94.75%. This project helps to reduce the intervention of human, less time consuming and will helps to
access the fruits in the supermarket, in agricultural area easily. The results are found with high accuracy.