Fruit Ripening and Disease Identification for Precision Agriculture using CNN

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***Abstract*—Agriculture has a major role in the economic development of our country. Productive growth and high yield production of fruits is essential and required for the agricultural industry. Farmers having large plantations face difficulties in identifying the time of harvest of the crops, presence of diseases, pests or rodents destroying the crop etc. Checking each plant manually is practically not possible and is a time-consuming process which requires a great amount of manual labor. This project aims to implement a system which makes the above mentioned tasks easier. The initial aim of the project is to identify the time of harvest of fruits and few diseases associated with these fruits using CNN thereby reducing the manual labor as well as time and expense involved in monitoring large plantations. The project can be extended to integrate it along with a quadcopter to capture the video of the plantations.**

Keywords—Agriculture, CNN, Fruit Ripening, Disease Identification

I. INTRODUCTION

India's 70% of the population depends on agriculture. Agriculture has a major benefaction towards economic development by providing food and raw material to non-agricultural sectors. Agriculture needs a lot of man work. It consumes a lot of time for the farmers for manual sorting and examining of fruits from harvest till its growth period. Manual sorting doesn't give adequate results every time, so it needs an efficient smart farming techniques which can used to get better yield and growth with less human efforts. The quality and quantity of agricultural products has significantly reduced due to plant diseases. These diseases can be detected using image processing techniques. The agricultural practices in India date back to the Indus Valley Civilizations and even before that in some parts of southern India. India is considered to be having the second rank worldwide in farm products. Agricultural exports also add to the Indian economy. Agriculture is still an important sector in the Indian economy. India is the second-largest producer of agricultural products and is the largest producer of ginger, okra, banana, mangoes, and pineapples. There are many difficulties faced by the upcoming Indian farmers which include the determination of time of harvest of the crops, labor cost for harvesting, determination of diseased crops, etc. Mechanical harvesting systems and automatic harvesters were proposed and investigated in plantations. These techniques help to harvest fruits efficiently thereby reducing the cost of harvesting to about 35%-40% of the total production cost. Those farmers having large plantations face various difficulties during their agricultural routines. These difficulties include identifying the time of harvest of the crops, protecting the crops from pest attacks, preventing the outspread of diseases in crops, determining the moisture content of the soil, etc. The usual measures taken against these problems include the use of pesticides, insecticides, etc., and the use of manual labor for inspecting the growth of the crops and attacks on the crops by rodents. Checking every crop manually is practically not possible and is surely 2 a time-consuming process that demands a great amount of manual labor. Hence, there arises a need to automate the various processes in the agricultural sector. With this, it is possible to increase crop productivity, reduce cost, and provide a better estimation of yield. Modern technologies like robotics, sensor networks, image processing, etc. have been investigated in the literature to employ in this sector. The major issue in crop management is to detect the time of harvest of fruit and also to determine the number of fruits ready for harvest. A novel automated fruit ripening detection technique is proposed after analyzing the various existing technologies.

II. RELATED WORKS

Fruit Ripening based on color - RGB color space is a combination of Red, Green, and Blue spectrum components to produce multiple color space models. The main purpose of the RGB color model is for the sensing, representation, and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography. Each 14 RGB color component represents a value from 0 to 255. Each pixel in an image will have these three-color components to produce one combination of the color. Each pixel in an image also will contain information about the coordinates of the pixel on the image[1]. Various image processing steps like feature extraction, segmentation, edge detection, are done and

Fruit Ripening Identification based on thermal imaging - Some green fruits do not change their color from green to yellow when being ripe. As a result, ripeness estimation via color and fluorescent analytical approaches cannot be applied. In this article, we propose and show for the first time how a thermal imaging camera can be used to two-dimensionally classify fruits into different ripeness levels. Our key idea relies on the fact that the mature fruits have higher heat capacity than the immature ones and therefore the change in surface temperature overtime is slower[8].

Fruit Ripening identification using RGB color space and fuzzy logic - This is a general approach developed to estimate the ripeness level without touching the fruit. The two techniques has been used for this purpose are - color image segmentation and fuzzy logic technique. Four images of a single fruit have been clicked from four directions and separate desired part from each image using color image segmentation. Now

calculate mean values of primary colors (Red, Green and Blue) of segmented parts and give it as input to FIS (Fuzzy Inference System) editor 1. FIS editor 1 gives decision whether this part of fruit is ripe, under ripe, about to ripe, about to overripe or overripe. The same operation is applied on remaining three images. These four outputs have been given to FIS editor 2. This editor gives decision whether the whole fruit is ripe, under ripe, or overripe[3].

III. METHODOLOGY

The proposed technique is a fruit ripening and disease identification technique. This can then be integrated with a quadcopter which will help to capture the video of the plantations. For this a field of interest is divided into multiple portions with each part having a central coordinate. The GPS location of each part of the field is given to the quadcopter. The quadcopter after deploying from the base station moves to the assigned GPS location. The quadcopter captures video of the plantation and then it is compared with the trained CNN model and prediction is done whether the fruits are ripe, unripe or overripe. Also various diseases seen in the fruits is identified with this technique. After the video capturing of one part of the field is completed the quadcopter automatically moves to the next location and does the same process.

CNN - 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. CNN are composed by convolutional layers where neurons are connected through a convolution function instead of a general matrix multiplication so weights are shared rather than being all connected. As a result, spatial patterns which are invariant to translations, rotations, and other transformations, are obtained. Many current neural architectures used for supervised classification of images are based on the Convolutional Neural Network (CNN) model. 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 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. The objective of the convolution Operation is to extract the high-level features such as edges, from the input image. ConvNets need not be limited to only one convolutional Layer. Conventionally, the first ConvLayer is responsible for capturing the Low-Level features such as edges, color, gradient orientation, etc. With added layers, the architecture adapts to the High-Level features as well, giving us a network which has the wholesome understanding of images in the dataset.

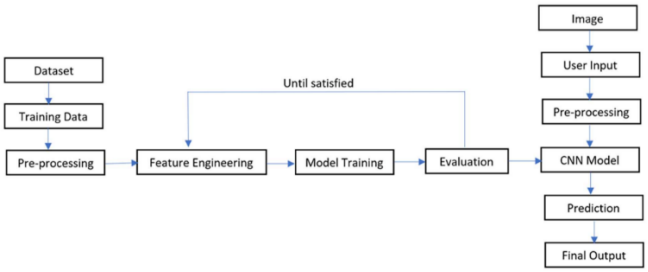

Fig. 1. Block Diagram

IV. RESULTS

CNN model was trained to identify whether bananas are ripe, unripe or overripe and the below results were obtained. Also some of the diseases seen in apple were also identified using the trained model.

Fig. 2. Ripe Fruit

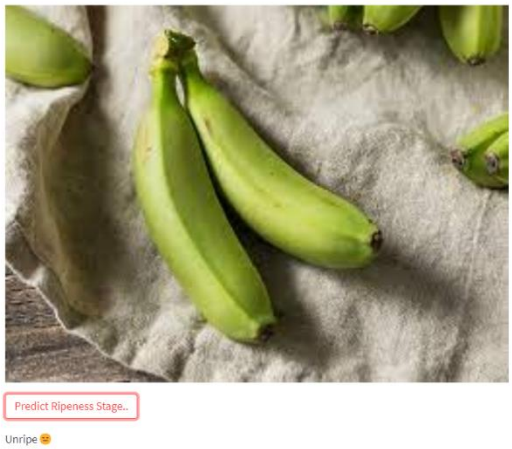

Fig. 3. Unripe Fruit

Fig. 4. Overripe Fruit

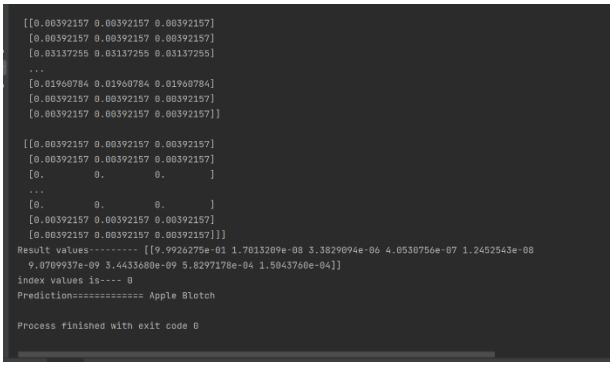

Fig. 5. Apple Blotch

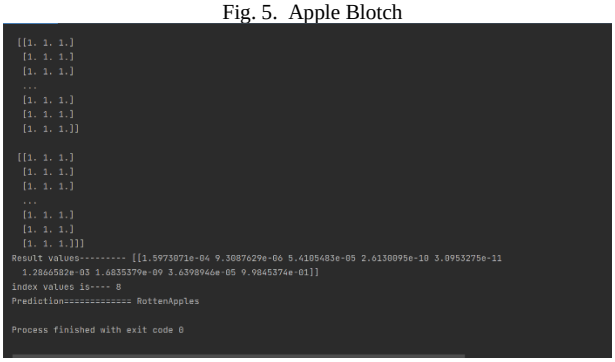

Fig. 6. Rotten Apples

Fig. 7. Apple Scab

V. CONCLUSION

Using convolutional neural networks for fruit ripening identification accurate results regarding the state of fruit was identified. The CNN model is trained to identify the fruits as ripe, unripe and overripe by creating datasets. Common diseases seen in these fruits are also identified using CNN model. As further works this can be integrated with a quadcopter which will capture the video of the plantation thus helping to get timely details regarding the fruits cultivated. This will help to reduce manual labor as well as time and expense in inspecting large plantations.

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