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Assessment of Mango Fruit Maturity Using Image Processing Technique

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Abstract - In agriculture science, automation increases the quality, economic growth and productivity of the country. The export market and quality evaluation are affected by assorting of fruits and vegetables. The main characteristic of fruits and vegetables is its appearance that impacts their market value, the consumer's preference and choice. Although, the sorting and grading can be done by human it is inconsistent, time consuming, expensive and easily influenced by surrounding. Hence, a fruit grading system is needed. In recent years, various algorithms for sorting and grading are done by various researchers using computer vision. Here, we have used a deep learning algorithm called Convolution Neural Network (CNN). The algorithm helps in analysing and extracting the features from the images. The algorithm was tested with 250 images of mango. The images of mango were then labelled using LabelImg software. The model was then tested with the various images of mango, videos of mangos, and in a real-time environment with an accuracy of 80% to 95%. This paper presents a detailed overview of image preprocessing, segmentation, feature extraction, and classification based on the qualities color, size, and shape of the fruit.[3]

***Key Words*:** Agriculture Science, Computer vision, Fruit grading, Convolution Neural Network, Image analysis, LabelImg.

1.INTRODUCTION

Mango is one of the world's favorite tropical fruits with increasing production trend every year. The fruit is cultivated in the largest area i.e. 2,021 thousand ha and the production is around 12.5 million tons, contributing 40.1% of the total world production of mango. India exports mango to over 40 countries worldwide. Total export of mangoes from India is 79.06 thousand tons. India exports mango to over 50 countries worldwide. Its physical appearance affects its value in the market so, it is important to observe proper handling of fruits after harvesting. In general, the colour of the fruit indicates its maturity and the presence of defects. [1]

In recent years, many types of research have been done on fruit quality detection by using computer vision technology. Fruit categorization have changed from traditional grading by humans to automatic classification over the past few years. Many companies are moving to automated classification in many crops such as grading on peaches, olives, oranges, etc. Here, we have used a deep learning algorithm called Convolution Neural Network. The algorithm helps in analyzing and extracting the features from the images. The algorithm automatically identifies the maturity of mango fruit using the image processing technique. This framework can be applied in various areas like manufacturing companies, where mango juices are produced and in supermarkets.

The rest of the paper is organized as follows: Section 2 is Materials and Methods which describes how the images are preprocessed, trained, and how the GUI is implemented. Section 3 describes our detailed methodology. Section 4 is Model Evaluation which describes various metrics used for our model as well as various methods used along with its result, to reach our desired model. Section 5 is Result and Discussion which describes the risk involved in our model. Section 6 concludes the paper and provides some direction to future scope.

2. MATERIALS AND METHODS

A. Preprocessing:

Initially, a large amount of images of mango is collected from various sources. This image are then label using LabelImg software as shown in fig.1 which specifies the position of the mango in the image and also whether it is a good or a rotten one.

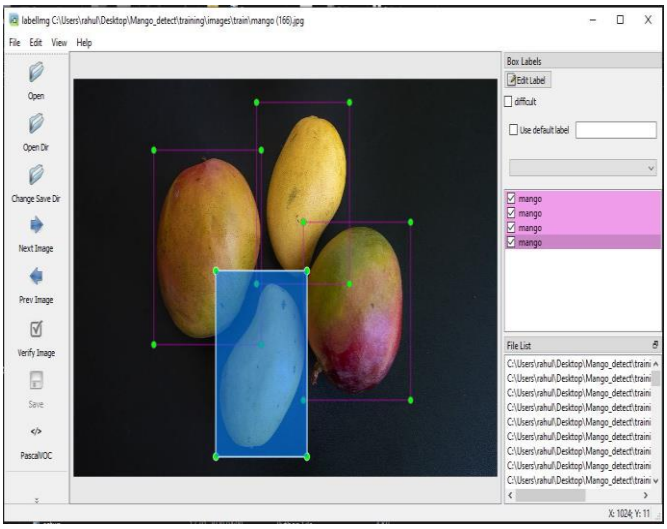

Fig.1: LabelImg Software

B. Training:

For training the model, we have used supervised learning algorithm. Here, we have used CNN (Convolutional Neural Networks) to train the model.

C. Implementation:

For the purpose of implementation, a simple GUI was created which consist of three buttons: Real-Time, Image and Video as shown in fig.2. Real-Time button when clicked will enable the webcam of the system and take the output of that webcam as input. The output is then shown on a tkinter window. But when the Image or Video button is clicked a new window for media selection will open.

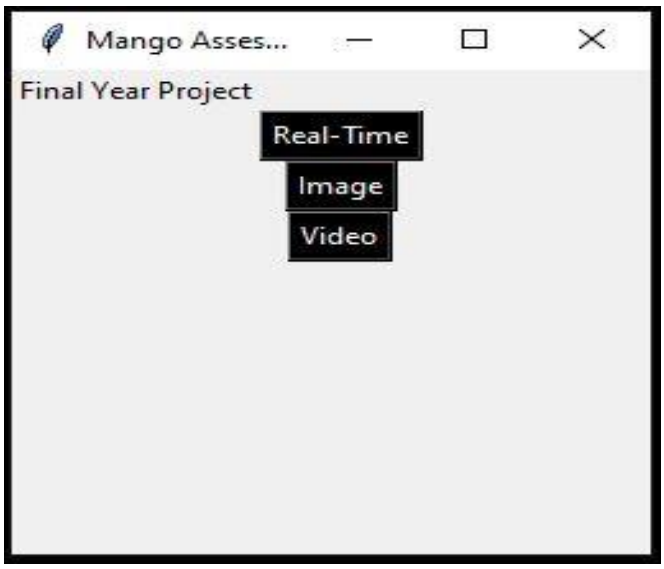

Fig.2: GUI

D. Convolutional Neural Network

A Convolution Neural Network (CNN) is a Deep Learning algorithm which can take in an input image, assign importance (weights) to various object in the image and be able to differentiate one from the other. The role of the CNN is to reduce the images into a form which is easier to process, without losing features which are critical for getting a good prediction. This is achieved with the help of pooling layer which results in extracting dominant features that are rotational and positional invariant. Another benefit of CNN is that they are easier to train.

3. DEVELOPED METHODOLOGY

The diagram shown in Fig. 3 illustrates the methodology of our model. Initially, a large amount of images of mango is collected from various sources. This image are then label using LabelImg software. After labelling the images an xml file is created for every image which has data regarding the position and label of the type mango in a particular image file. Then data of this xml files is used to prepare a csv (comma separated values) file which in turn is used to prepare a record file which will be required to train the object detection model.

For the training purpose, we have used CNN which is a supervised learning algorithm. An image is nothing but a matrix of pixel values so why not just flatten the image (e.g. 3 x 3 image matrix to 9 x 1 vector) and feed it to a multi-level perceptron for classification purpose. However, it is difficult to obtain a precision score while performing the prediction of classes for the complex images which shows the pixel dependencies throughout than the basic binary images. The role of the CNN is to reduce the images into a form which is easier to process, without losing features which are critical for getting a good prediction. Convolution Layer and Pooling Layer are used for successful classification of images. Convolution layer is responsible for obtaining the low level features as well as high level features by introducing more layers in Convolution Network. The output of the convolution layer is Convolved Feature. Pooling layer is responsible for reducing the spatial size of the Convolved Feature. This is to decrease the computational power required to process data through dimensionality reduction. It is useful for extracting dominant features that are rotational and positional invariant. After completing all the above processes we are going to flatten the final output and feed it to the Neural Network for classification purpose.

For the purpose of implementation, a simple GUI was created which consist of three buttons: Real-Time, Image and Video as shown in fig.2. Real-Time button when clicked will enable the webcam of the system and take the output of that webcam as input and which is processed using our trained model frame by frame. As soon as a match for this object is found a bounding box is created around this object. The output is then shown on a tkinter window as shown in fig.4. For the Image or Video when the button is clicked a new window for media selection will open. After selecting the media, it will be processed in the similar manner as done in the case of Real-time and then the output is shown.

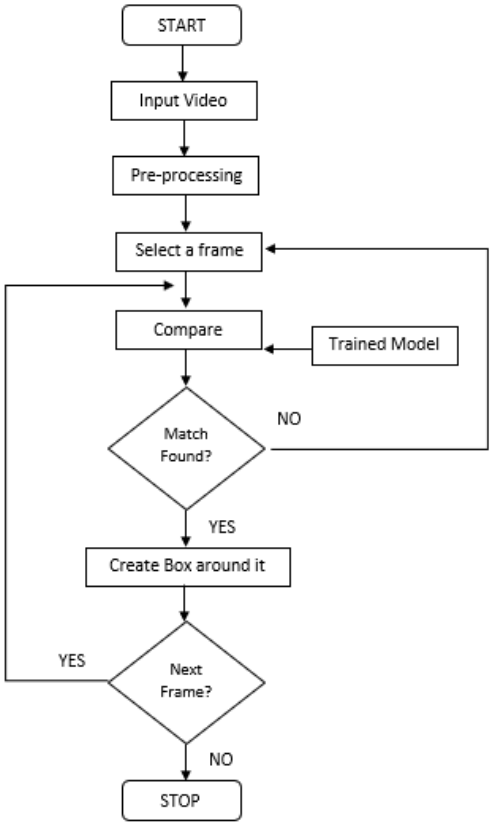

Fig.3: Representative diagram of the developed methodology

4. MODEL EVALUATION

4.1 Evaluation Metrics

Following are the evaluation metrics used for this project:

1. Does the model detect the mango properly?
2. How many mangos can the model detect at a time?
3. How precisely the mangos are being detected.

4.2 Experimental Setup

For this project, the machine had various software's install such as:

1. Python3
2. LableImg
3. Python IDLE

Various Python modules were also used:

1. OpenCV
2. Numpy
3. PILLOW

4.2.1 Description of Data

The data that has been used in this project comprises of various mango images which are labelled using the LabelImg software to indicate the position of the mango and quality of the mango. The labelled data is collected into a csv file which is converted into a records file. This file is used to train the CNN (Convolutional Neural Network) model.

4.2.2 Methodology Used To Perform Experiment

Various different methods were used to develop a mongo detection model. These are few of them:

1) **Cascade Classifier**: Cascade Classifier is a model which is used for object detection. It is trained using a hundreds of positive and negative images. This model is based on edge and line detection techniques.

2) **Yolo model**: Yolo which stands for You Only Look Once is another object detection technique in which various images are taken as dataset. Using these images a Neural Network Connection is created. The weights of the neural are mentioned a .weights file and other details are mentioned in a .cfg file.

3) **Tensorflow model**: In this model various images of mango were label and then used to train a convolutional neural network.

4.2.3 Experiment Result

The results of the all the models trained for this project purpose are as follows:

1) **Cascade Classifier**: As this model used hundreds of positive and negative images of the object without any accurate position of the object, the accuracy of detection was very low.

2) **Yolo Model**: This model had a better accuracy of detection object but it lagged behind in processing speed. This time duration which it took to process a single frame was too high which could not be useful in real-time scenarios.

3) **Tensorflow Model**: The accuracy of this model increases as the training time increases i.e. more the model was trained the accuracy increased. This model also has faster processing speed for a single frame.

5. RESULT & DISCUSSION

The proposed work is an attempt to make a simple and efficient tool for defect identification and maturity detection of mango fruits using image processing technique. Below, the various risks are discussed.

The risk that was involved is:

i. If the mango which has been detected has a defect on the side that is not exposed to the camera, it will be classified as mature or defected.

ii. Sometimes, some mangos can overlap with each other which results in not being detected or defect may not be detected.

In the Future, an optimal solution is needed to overcome this problem by much better technology.

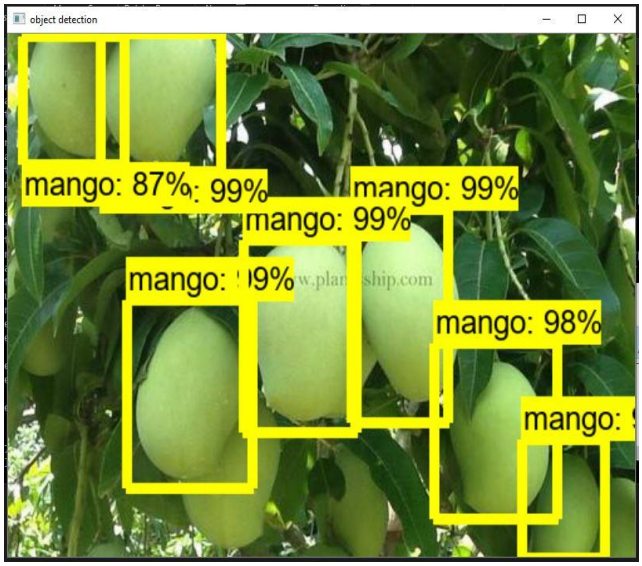

Fig.4: Output

6. CONCLUSIONS

This project describes the working of a object detection model from training to implementing the trained model to detect object, in our case mango, from various media files i.e. image, video and real-time video stream.

Thus, to train and implement a object detection model we initially need a data-set of the objects to be detected which will be consisting images of this objects. Then this images need to be label to specify where the particular object is located. This dataset is then passed and is used to train the model using Convolutional Neural Networks. After a

sufficient amount of time is passed while training the model it can be used to implement to detect various objects.

Thus, Image processing and object detection can be used in various agricultural and industrial field to improve the speed of sorting of fruits which in turn will reduce the production time as well as reducing the labour cost which in turn will reduce the final product cost.

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