Fruit Classification Comparison Based on CNN and YOLO

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Abstract Today, agriculture has become more of science than art. The demand for fresh produce is growing, while availability of field workers is diminishing. Also, Farmers keep investing in land, irrigation, and labor, and much of the fruit is left hanging on the trees because there are not enough people to pick it when it is ripe. Automation in the agricultural field using modern information and Communication Technology can increase the efficiency, reliability, and precision; and reduces the need of human intervention. Thus, to meet solution to this problem is by reducing the costs for farmers and increasing the yield of crops which can be achieved by classifying of fruit by using modern technique in the field of Deep Neural Networking that involves CNN, YOLO etc. which provides a helping hand to farmers to optimize their farming patterns and boost yields by allowing them to grow taller fruit trees that can be harvested by classifying based on the condition of fruit and saving significant labour cost. In conclusion, the proposed methods are highly acceptable and recognizing the necessity, and unresolved classifications.

Keywords: Automation, Deep Neural networking, CNN, YOLO and classification.

1. Introduction

Automation in the agricultural field using modern information and Communication Technology increased the efficiency, reliability, and precision; and reduced the need of human intervention. Robots used for agriculture are known as Ag-bots. Recognizing fruit that are ready for harvesting are becoming most difficult task in agricultural field. Which causes loss for agriculturalist in labour-less area, where the fruit gets over ripe and destroy. However constructing online fruit classification system can enhance the growth of fruit which requires high skilled labours to check the condition of the fruit and labour accidents and conflicts in deciding the condition of fruit can be resolved with high classification accurate device that gives good prediction of fruit, so the main aim of this study is to provide method for fruit classification on different network models that improve the efficiency in terms of accuracy in identifying the fruit condition and position and enhance the idea of user to extend the production.

The paper is organised into following sections, section 2 provides a review on object detection and classification with both pros and cons in it. Section 3 provides the overall block diagram of different

algorithm that need to perform and section 4 deals with software that planned to implement on different algorithm to enhance the result. And regarding results of the research algorithm with respective results are exhibited and section 5 provides conclusion and future scope for the study.

2. Related work

A traditional method which uses texture feature and colour for fruit classification which is done by Support Vector Machine (SVM) which is based on statistical and Co-Occurrence features from wavelet transform. It has three processes like pre-processing, feature extraction and texture feature the proposed model has an accuracy of about 95.3% [1]. The proposed model uses six convolutional layers with pooling layer and fully connected layers, which is better than three state of the art approaches- voting based, vector machine, wavelet entropy and genetic algorithm. It has an accuracy of 91.44% [2]. Among the fruit there are several changes because of similarity in shape, edge feature and colour. The proposed model gives a Pure Convolutional Neural Network (PCNN) with minimal number of parameters. The PCNN consists of seven layers (convolutional) also the proposed model involves Global Average Pooling (GAP) layer which is every effective. The proposed approach using PCNN with GAP provides superior performance and overcome overfitting problem and has the accuracy of 98.88% [3]. Dataset has been prepared for training, for which the image is acquired using Charged Coupled Device (CCD). K-means algorithm is used to segment an image and polygon fitting method is implemented to define boundaries in case of overlying fruits [4]. A classification of three green vegetables of different size, which involves software like Tensorflow, YOLO algorithm from darkflow is presented in [4], which is a version of Tensorflow in Opencv and preprocessing is done with drawing bounding boxes for vegetables manually, YOLO is used to detect and classify and achieved 50% accuracy in image detection and 70% in video.

Double track method which involves classification Neural Network using different matrix. 1st classification of fruit with background and 2nd classification based on image with ROI (Region of Interest), both results are aggregated and predict the class member with certainty factor, and here CNN classify fruit in whole image, YOLO for detects object in whole image and again CNN classification with single object [5]. Real time object classification has gained more popularity and innovations, a simple approach YOLO takes at object detection and paper gives background of CNN and also gives types of object detection algorithm like CNN- classification based algorithm and YOLO- regression based algorithm [6].

3. Block diagram of proposed system

Figure 1 shows the system architecture of fruit classification, which includes dataset, and training based on classifying the fruit on their morphologic content and Colour, to which module that contains train, test and validation is built followed by processing unit, where the input is divided or framed on processing convenient upon which processing unit detects the object or fruit by localizing the position and display it out with classification specification.

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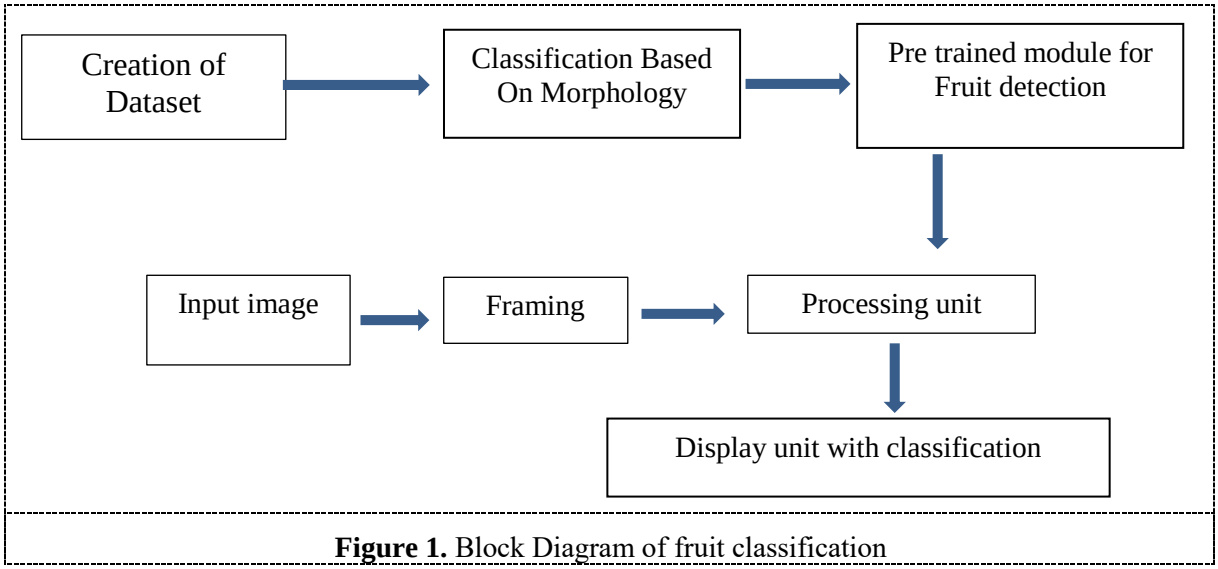

Figure 1. Block Diagram of fruit classification

4. Software description

4.1. Convolution Neural Network

Convolutional Neural Network (CNN) is a feed-forward artificial neural network. It is inspired by the biological visual cortex having small regions of cells. And this architecture shown below in Figure.2 deals with multiple convolution with filter specified, pooling followed by Artificial Neural Network (ANN). In the beginning, when the input is flattened to 1D, neurons formed due to weight with respective image number (grey number) and bais is of bigger size, which is difficult for computation, so using filter operation makes process lighter, where original input is taken and convolved using the kernel of user choice, which then followed by Relu to reduce the nonzero elements and make the process linear therefore speed up for classification. Then to reduce overfitting in ANN, further convolution is carried out with kernel and Relu as used in previous convolution and before feeding into ANN, max pooling is done.

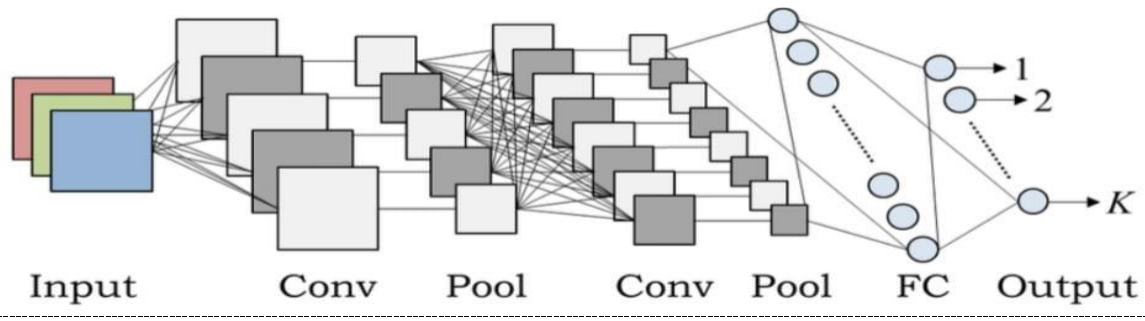

Figure 2. : Architecture of Convolution Neural Network

Here an image of fruit represented as a 100x100 matrix of values, among which 3x3 matrix is taken and slide that 3x3 window around the image for convolution. Then Relu function $R(x) = 0, forall\ x < 0\ and\ R(x) = x\ for\ x > 0$ is carried out to expell all negative values from the matrix of After which, matrix multiply window by 3x3 kernal followed by max pooling of layer 2 is done for 2nd time. As a result, 2D is flattened to 1D value in block and fed to ANN for detection. The fruits detected using this model is shown in Figure 3.

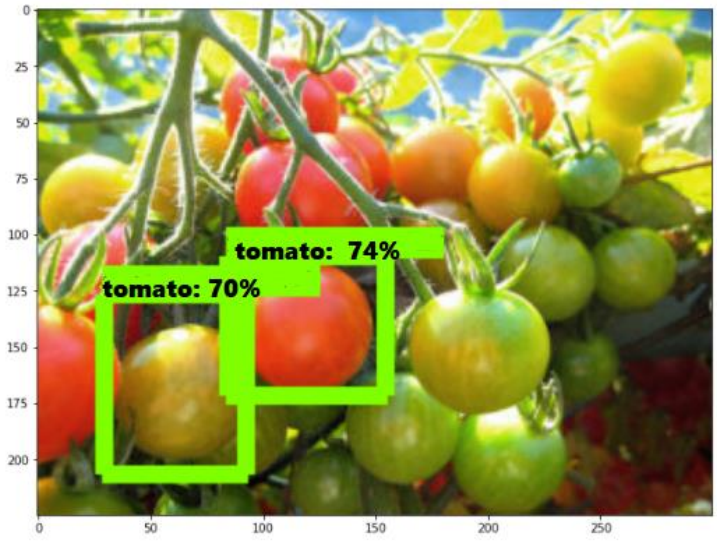

Figure 3. : Fruits Detected using CNN

4.2. You Only Look Once (YOLO)

You Only Look Once (YOLO) algorithm basically works in three steps or techniques, Residual blocks, Bounding box regression and intersection over union. First the image is divided into grids which has dimension SxS next the bounding box is an outline that highlights the object in an image, the bounding box consists of attributes width, height, class and bounding box centre it represents the probability of an object appearing in the bounding box. Intersection over union provides an output box that surrounds the object perfectly. The grid cell is responsible for prediction of outer boxes. The intersection over union output is 1if the predicted output is equal to the real box. The above three techniques are applied to the input image which results in the detection of the fruit. In Figure 4 represents the output of multiple fruit detected, which is represented using vector consist of class, probability and bounded in box with location specified using x-y coordinate and size of the box. And all other fruit in the figure due to loss produced with trained dataset.

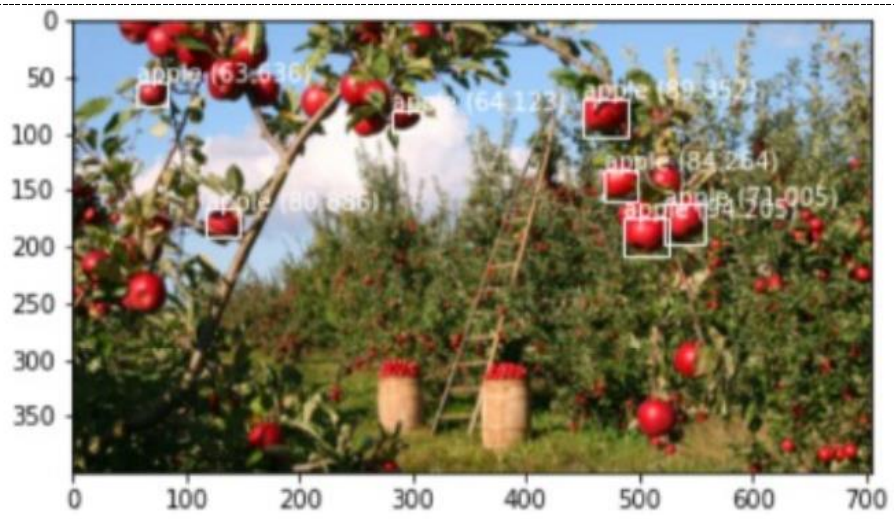

Figure 4. : Fruits Detected using YOLO

4.3. MATLAB

MATLAB is a high-performance language for technical computing. It integrates computation, A color detection algorithm finds pixels in an image that are the same color or color range as a specified color. To differentiate them from the rest of the image the color of detected pixels can then be adjusted. The Figure 5 shows the basic color detection model in Matlab.

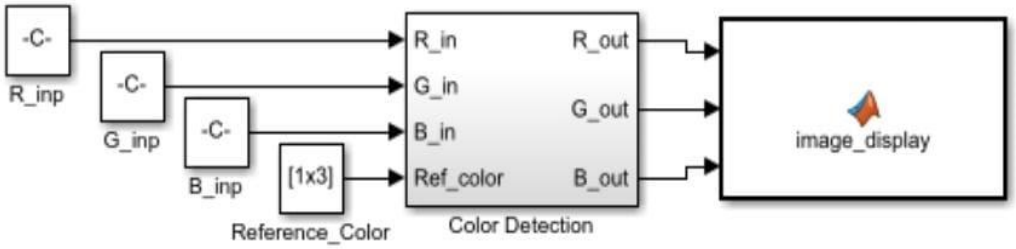

Figure 5. Color detection model in Matlab.

The fruit image is given as source file, which is read using imread() function and stored in the given cluster. Then, Gaussian filter has been created using the fspecial() function which returns a Gaussian filter of the given size let's say, hsize=9 with standard deviation Sigma(sigma=3), that is rotationally symmetric. Use im filter function and apply local smearing using the Gaussian filter which is thereafter, converted from RGB to YIQ values of NTSC image as shown in Figure 6. Using the function imfindcircle, the detected fruits are circled according to their provided radii range and as red tomatoes color range with circle shape are ripen, and green color are unripen, as it can be in Figure 7.

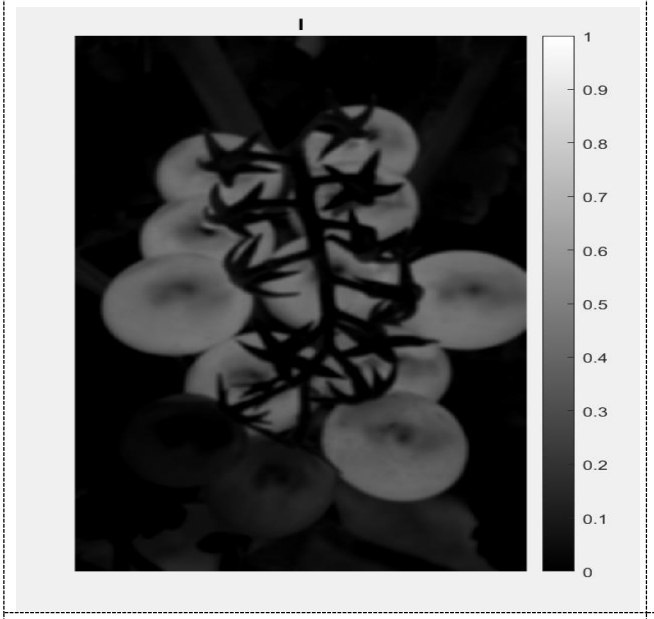

Figure 6. YIQ value image for ripen tomato

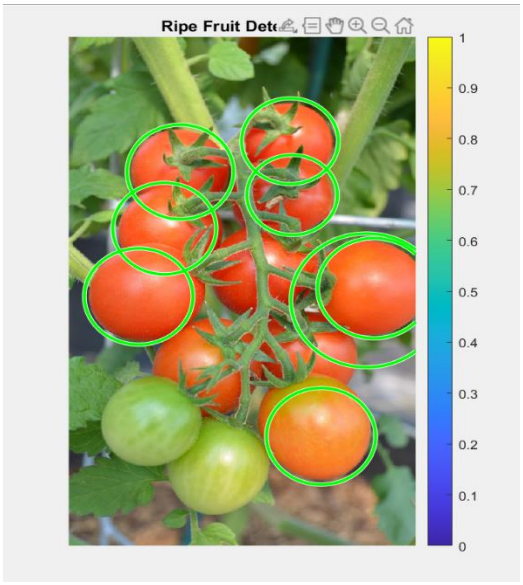

Figure 7. Ripe fruit detection.

5. Result

Fruit detection algorithms are simulated YOLO, CNN and in matlab plathform.

Table 1. Comparison of image processing models.

Models	Accuracy
YOLO	>= 85%
Colour Detection (Matlab)	>≡ 74%
CNN	>= 63%

The Table1 shows the comparison of You Only Look at Once (YOLO) in python, convolution neural networks (CNN) in Python and the colour detection in MATLAB. In YOLO algorithm accuracy achived is 85% and in matlab color detection algorithm using gaussian filter has shown the accuracy of 74 % and in CNN biological visual cortex, accuracy of 63 % is achived.

6. Conclusion

From the above results on the implemented algorithms, YOLO achive maximum accuracy, when compared to other algorithm like CNN and colour detection using mathlab and mathlab implementation is for circle shape fruits only and it is able to recognize all the ripen fruit in YIQ value used. Thereby YOLO hold advantages in classification of objects than any other algorithm and futher image classification can be made using increment in demensions like 3D by keeping much more obective or parameters. Once the simulation classifying the fruit is completed, a camera can be placed on a drone to capture the image of the fruit, classify the fruit and pluck the fruit by using gripper connected to the drone. This work can lead to atonomous drone which can help in harvesting process.

7. References

[1] R.Shantha Selva Kumari and V.Gomathy *Fruit Classification using Statistical Features in SVM Classifier* 2018 *Int. Conf. on Electrical Energy Systems (Chennai)* pp 526 – 529

[2] Siyuan Lu, Zhihai Lu, Soriya Aok and Logan Graham *Fruit Classification Based on Six Layer Convolutional Network* 2018 *Int. Conf. on Digital Signal Processing (Shanghai)*

[3] Asia Kausar, Mohsin Sharif, JinHyuck Park and Dong Ryeol Shin *Pure-CNN: A Framework for Fruit Images Classification* 2018 *Int. Conf. on Computational Science and Computational Intelligence (Las Vegas)* pp 404 – 408

[4] Upulie H.D.I and Lakshini Kuganandamurthy *Real-Time Object Detection using YOLO: A review* 2021 *Research gate publication (Srilanka)* 351411017

[5] Rudnik Katarzyna and Michalski Paweł *A Vision-Based Method Utilizing Deep Convolutional Neural Networks for Fruit Variety Classification in Uncertainty Conditions of Retail Sales* 2019 *Appl. Sci. 9*(19), 3971

[6] Sachin C, N Manasa, Vicky Sharma and Nippun Kumaar A A *Vegetable Classification Using You Only Look Once Algorithm* 2019 *Int. Conf. on Cutting Edge Technologies in Engineering (Barabanki)* pp 101 - 107