International Journal of Innovative Research in Engineering
Volume 4, Issue 2 (March-April 2023), PP: 616-619.
www.theijire.com **ISSN No: 2582-8746**

Fruit Quality Classification using Artificial Intelligence

Bharath Reddy C[1], Anisa Khanum[2], Dr. John Peter T[3]
[1,2]Students, Dept of CSE, Sambhram Institute of Technology, Bangalore, India.
[3]Prof & Head, Dept of CSE, Sambhram Institute of Technology, Bangalore, India.

How to cite this paper:
Bharath Reddy C[1], Anisa Khanum[2], Dr. John Peter T[3], "Fruit Quality Classification using Artificial Intelligence", IJIRE-V4I02-616-619.

Check for updates

https://www.doi.org/10.59256/ijire.2023040235

Abstract: *Consuming good, healthy and quality fruit is the utmost requirement of the consumer. Hence, automation in food industries is growing in recent times. Because it is impractical for humans to manually inspect the fruits as it requires a large number of labors as well as requires a lot of time and effort. This paper proposes a system which is capable of detecting and classifying the fruits as affected or not based on surface using YOLO-v4 model. As this system is automatic, it cuts down the traditional/manual method of fruit inspection, which takes a lot of time, labor and effort. This system will not only save the cost of labors but will also give a high accuracy.*

Key Word: *quality, YOLO-v4, Object detection, Tensor Flow.*

I.INTRODUCTION

Fruits are essential for balanced diet and good health. Fruits are good sources of vitamins and minerals withoutwhich human body cannot maintain proper health and develop resistance to disease they also contain pectin, cellulose, fats, proteins etc. Importance of fruits in human diet is well recognized. Man cannot live on cereals alone. Fruit growing is one of the important and age old practices, practiced in India since ancient times.

Cultivation of fruit crops plays an important role in overall status of the mankind and the nation. The standard ofliving of the people of a country is depending upon the production and per capita consumption of fruits. Fruit growing have more economic advantages. [1]

The fruit industry plays a vital role in a country's economic growth. They account for a fraction of the agricultural output produced by a country. It forms a part of the food processing industry. Fruits are a major source of energy, vitamins, minerals, fibre and other nutrients. They contribute to an essential part of our diet. Fruits come in varyingshapes, colour and sizes. Some of them are exported, thereby yielding profit to the industry. Fruit sorting and gradingare performed before export. This determines the quality of the fruits which is an important factor in the food processing industry. Nutritionist advocates 60-85g of fruits and 360 gm. Classification of fruits by processing and preparation methods could be especially important in cultures where there is reliance on a limited number of local crops and the processing techniques alter the composition so as to limit the intake of critical food components. For populations that have access to a wide variety of fruit and a range of processing and preparation methods, these methods are not likely to be useful as classification terms.

Quest for increased performance and reliability has made it imperative to develop techniques for utilization of resources to make informed decisions. [2]. Hence, automatic inspection of raw ingredients as well as end products in food industry is getting more consideration in recent times. The ultimate goal is to produce a high quality productby means of an efficient, rapid and non- destructive production process. In previous years, attempts have made fornon-destructive investigation of products from agriculture and food industry. Presence of worm damage and other defects has been determined in a non-destructive way. Current standard inspection methods are still unable to detectmany defects. For the food industry, prior work has established the fact that images are very useful for assessment of ingredients as good or bad. In fruit inspection, the key objective is, not to pass the defected/affected fruit to the consumer. A method is required which may identify and separate the infected or damaged fruits from the healthy ones in an automatic way. For quality assessment, several kinds of features have been extracted from images. Hence,our work proposes to develop a system that is capable for automatic detection of fruits and quality inspection.[3][4][5][6][7]

II.LITERATURE SURVEY

Xiaochun Mai et al. [8] have used classifier fusion strategy in region proposal stage to improve localization of proposal candidates for small fruits. Classifier fusion combines classification of classifiers learned from low level and high-level features, which further increases reliability of object classification for small fruits. Experimental results demonstrate that their proposed model is feasible for detecting small fruits. They have also explored the effectiveness of this strategy in fast R-CNN to improve classification of objects, and can use this strategy in both region proposal network and fast RCNN. Secondly, deep learning methods have been shown to be effective on limited dataset for fruit detection. In order to guarantee detection performance under various types of fruits and variant environments, a bigger dataset would have worked. Moreover, there are some mis-labelling and annotation errors in ground truth, which results in uncertainty. Hence, based on existing detection methods, they have designedan annotation correction method to find errors in annotation and reduce errors.

Basri et al. [9] have presented a system that classify fruit with an accuracy level of 88% (Mango), 83% (Limes), and 99% (Pitaya) and with an average computation cost of 0.0131 m/s. They have tracked and calculated fruit sequentially without using additional sensors. Additionally, they have also checked the defect rate on fruit accurately using the video streaming camera. The datasets are taken in the field areas then trained using the FRCNN Framework using the Tensor flow platform. Faster R-CNN is one model that has proved possible in solving complexcomputer vision problems with the same principle and have shown incredible results at the beginning deep learning revolution. This algorithm has provided a solution for solving cases of fruit quality detection in real time using multi-classes. They would have used the tracking video system to calculate the quantity of fruits on the conveyor runway. This would have also track and calculate fruit sequentially without using additional sensors and check thedefect rate on fruit using the video streaming camera more accurately and with greater ease. Also, they would haveexperimented and made an Android Apps to integrate with the analytic system.

Hasan Basri et al. [10] have experimented by classifying fruit using Google's model architecture, the convolutional neural network has distinguishable depth wise using Mobile Net's. They have proved that the Faster R-CNN can build a training model rapidly and classify of fruits using width multiplier with checking the rightness level shrink size and latency. They have used the Mobile Net model on Tensor Flow platform and has achieved the accuracy score of about 99%. This method is very appropriate for developed the process of sorting multi-fruits in real-time to maintain the quality of the fruit. The dataset of fruits, in this method is very appropriate for developing a sorting machine for classification multi-fruit in real-time with the camera and detecting moving fruits above the sorting machine for ensuring the quality of the fruit fresh. Only Mangoes and Pitaya fruits were used for classification. More fruits would have been used for classification, this would have also improved the accuracy, and would have filled up 1% gap.

Linjuan Ma et al. [11] have introduced a fruit detector based on fruits-360, fruit-360 is dataset to perform the experiments, which contains 38409 images of fruits spread across 60 labels and 75 classes of the fruits dataset andhas applied Faster R-CNN, which is the state-of-the art detection framework. Fruit detection is of great significancein the agriculture, which can improve labour efficiency and market price competition. More tools and framework would have been used. They would have improved the performance of our deep network to detect more fruits and meet the needs in our actual life.

III. METHODOLOGY

In this research, we proposed a system that can detect and classify apple, orange and guava as defected or not based on surface of the fruit. We have implemented three things in this project, first is that it classifies the fruit in one of the 6 categories as 'good Apple', 'rotten Apple', ' good orange', 'rotten orange', 'good guava' and 'rotten guava'. Secondly, it shows the percentage of the Healthy or Bad fruit. Finally, it uses web cam for live detection and classification of the fruit. In web cam, we hold the fruit in front of the camera and it detects the fruit as one of the 6 category and also shows the percentage of classification.

3.1. System Design

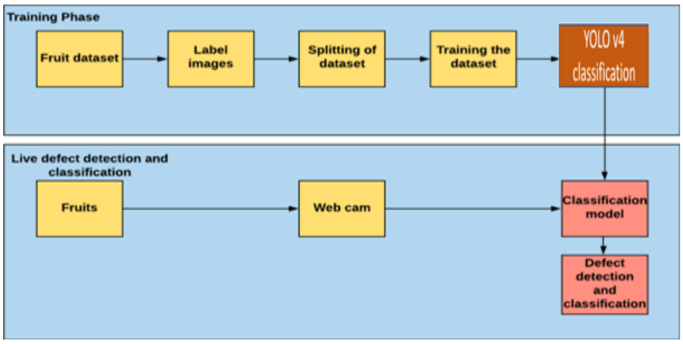


Fig 1. system design

3.2. YOLO-v4 Object Detector

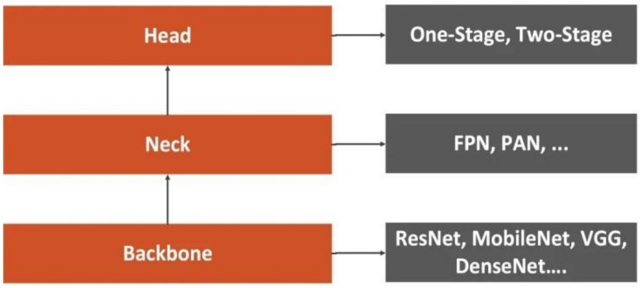
Object detection is useful for understanding what's in an image, describing both what is in an image and where those objects are found. In general, there are two different approaches for this task –

- **One-stage** object-detection models – In this class of algorithms, there is no selection of interesting ROI in the image,instead of that, it will predict the classes and bounding boxes for the entire image at once. This makes detection faster than two-stage algorithms. Some common examples of such algorithms are SSD, FCOS, YOLO etc.
- You only look once, or **YOLO**, is one of the faster object detection algorithms out there. Just recently, a new versionof it YOLO v4 has been published. My goal here is to describe all the new updates made to this algorithm in this new version. The YOLO v4 paper focuses on developing an efficient, powerful, and high-accuracy object-detection model that can be quickly trained on standard GPU.

Object Detection Models: An Overview

Essentially, the object-detection neural network is usually composed of **three parts**. The authors named them **back bone**, **neck** and **head**

.

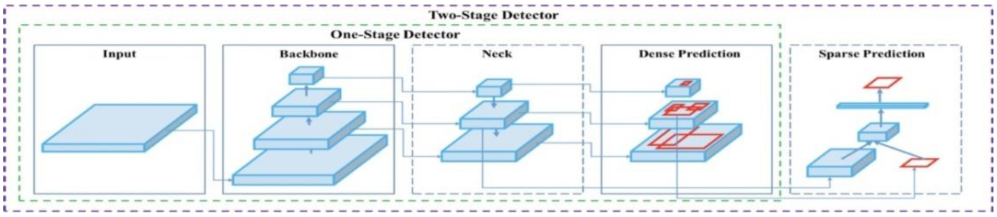


A typical backbone network

Backbone is usually deep architecture that was pre-trained on the Image Net dataset without top layers. These are typically one of common CNN architectures like Resnet, VGGNet, Mobile net etc. YOLO in particular uses a specialized version of backbone called 'Darknet'.

Neck is usually composed of several layers whose goal is to collect feature maps from different stages. Common examples of "neck" are: Feature Pyramid Network (FPN), PAN, SPP, ASPP etc.

Head is a part of the object detection model that is used for the prediction of custom classes and drawing bounding boxes around objects. Based on the type of the head, we can distinguish two types of object-detection models described above. These layers can also be described in terms of dense predictors (one-stage detectors) or sparse predictors (two-stage detectors).



IV.IMPLEMENTATION

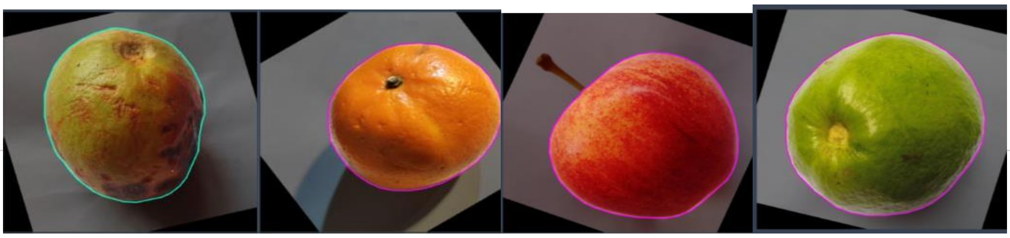
4.1. Data gathering

Data gathering and analysis is the first and most crucial step because it plays an important role for decision support irrespective of type of industry. [13]. In this study, we made our own dataset. We took the pictures of real fruits and performed training on that data. This dataset includes both the clicked pictures of fruits as well as it also consists of some images of fruits downloaded from internet. The dataset consists of 488 images of apple, orange and guava. Out of which 344 belongs to training data and 144 belongs to test data. These images are further categorized in 6 categories such as 'good apple', 'rotten Apple', 'good orange', 'rotten orange', 'good guava' and 'rotten guava'. Following is the table showing all categories of fruits:

Fruit Name	Category	Training dataset	Test dataset
Apple	1. Good apple 2. Rotten Apple	550 553	183 185
Orange	1. Good orange 2. Rotten Orange	297 597	99 199
Guava	1. Good guava 2. Rotten guava	597 597	200 200

4.2. Image Labeling

After collecting the dataset, the next step is to label the images. We crop the images and apply the label from one of 6 categories i.e. 'good apple', 'rotten Apple', 'rotten orange', 'good orange', 'good guava' and 'rotten guava'. To do this we can use various labeling tools available. We have used Roboflow annotate tool to label the images. This labeling is done for each and every image in the dataset. Following figures shows how labeling is done in Roboflow.



4.3. Training

After completing the labeling process, the next step is training the images. For this purpose, first of allsplit the dataset into two new folders ('train' and 'test'). Now copy 25% images of the total dataset into the test folder and copy remaining images into train folder. In our case, we contain the total dataset of 4685 images. So, we copied 1165 images in test folder and 3494 images in train folder. We have used YOLO-v4 model for training. Once, the training is completed now we proceed for testing and results.

V.CONCLUSION

By implementing this system, we can say that YOLO-v4 is the quite fastest model and gives most accurate results. Accuracies for different categories of fruits lies between: 'good apple = (60-75) %', 'rotten Apple = (60- 70) %', 'good orange = (85-99) %', 'rotten orange = (80- 98) %', 'good guava = (80-97) %', 'rotten guava = (70-80) %'. Hence, this system can be very useful in automatic sorting machines where it can detect as well as classify the fruit and their defects. Therefore, it will help in ensuring the quality and richness of the fruit.

References

1. *http://ecoursesonline.iasri.res.in/mod/page/view.php?i d=97351*
2. *Shankar Shankar M. Patil and A. K. Malik, "Corelation based real-time data analysis of graduate students'behaviour" Springer Nature Singapore Pte Ltd. 2019*
3. *Defect Detection in Food Ingredients Using Multilayer Perceptron Neural Network by Ikramullah Khosa andEros Pasero; Department of Electronics and Telecommunication; Torion, Italy.*
4. *P.M Keagy and T.F.Schatzki," Machine recognition of weevil damage in wheat radiograph" Cereal chemistry70 (1993): 696-696.*
5. *P.M Keagy, B.Parvin and T.F.Schatzki, "Machine recognition of navel orange worm damage in X-ray images of pistachio nuts" (1996);140-145.*
6. *T.F.Schatzki,et al. "Defect detection in apples by means of X-ray imaging" Transactions of the ASAE40.5(1997):1407-1415.*
7. *Y.Yin and G.Y.Tian, "Feature extraction and optimisation for x-ray weld image classification" Proc. 17thWorld Conf. on Nondestructive Testing, 2008.*
8. *Faster R-CNN with Classifier Fusion for Small Fruit Detection by Xiaochun Mai, Hong Zhang and Max Q.-H. MengJ., 2018 IEEE International Conference on Robotics and Automation (ICRA) May 21-25, 2018,Brisbane, Australia*
9. *INTELLIGENT SYSTEM FOR AUTOMATIC CLASSIFICATION OF FRUIT DEFECT USING FASTER REGION-BASED CONVOLUTIONAL NEURAL NETWORK (FASTER R-CNN) by aHasan Basri, bIwan Syarif, cSritrusta Sukaridhoto, dMuhammad Fajrul Falah,aDepartment of Informatics Management, Politeknik Negeri Fakfak, West Papua, Indonesia b,c,dDepartment of Informatics and Computer Engineering, Politeknik Elektronika Negeri Surabaya, Indonesia E-mail: hasanbasri@polinef.id, iwanarif@pens.ac.id, dhoto@pens.ac.id*
10. *Faster R-CNN Implementation Method for MultiFruit Detection Using Tensorflow Platform by Hasan Basri, Iwan Syarif, Sritrustra Sukaridhoto Department of Information and Computer Engineering Graduate Program Of Engineering Technology Politeknik Elektronika Negeri Surabaya hasanbasri@pasca.student.pens.ac.id,{iwanarif,sritrustra}@pens.ac.id*
11. *Fruit Detection Using Faster R-CNN Based On Deep Network by Linjuan Ma1, Fuquan Zhang2, Lin Xu3; School of Computer Science and Technology, Beijing Institute of Technology, 100081 Beijing, P.R. China 2 Fujian Provincial Key Laboratory of Information Processing and Intelligent Control(Minjiang Univeristy), Fuzhou, 350121, P.R. China * Corresponding author: Fuquan Zhang, e-mail: 8528750@qq.com. 3 Key Laboratory of Nondestructive Testing, Fuqing Branch of Fujian Normal University, Fuzhou, 350300, P.R.china.*
12. *https://tryolabs.com/blog/2018/01/18/faster-r-cnndown-the-rabbit-hole-of-modern-object-detection/*
13. *Shankar M. Patil and Dr. Praveen Kumar, "Data Mining Model for Effective Data Analysis of Higher Education Students Using MapReduce", IJERMT, 201*