



INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact Factor: 6.078

(Volume 7, Issue 3 - V7I3-2039)

Available online at: <https://www.ijariit.com>

Mulberry leaf disease detection using YOLO

Monalika Padma Reddy
monalika.6671@gmail.com

Visvesvaraya Technological University, Belgaum, Karnataka

Deeksha A.
deekshaarun1523@gmail.com

Visvesvaraya Technological University, Belgaum, Karnataka

ABSTRACT

Many states in India have taken up sericulture as an important agro-industry with good results. The mulberry leaf is the most important economic component in sericulture since the quality and quantity of the leaf have a direct impact on the cocoon bearing. Leaf disease diagnosis and classification in mulberry plants can be useful to framers and researchers to identify and classify diseases. It is an interesting technique that aids in managing the pathogens within the fields automatically and effectively at a minimal cost. Many mulberry diseases usually have symptoms on the leaf during the early stages of infections. These can be easily analyzed and classified using images. This paper proposes a model for implementing mulberry infection detection using Convolution Neural Networks (CNN) and You Look Only Once (YOLO). The proposed model identifies and classifies mulberry leaf diseases effectively. The image is divided into several grids before the image processing. The speed and accuracy of detection and classification are relatively high.

Keywords - Convolution Neural Networks (CNN), Mulberry, Mulberry diseases, You Look Only Once (YOLO)

1. INTRODUCTION

Agriculture plays a major in the economic growth of a country. It has always been a backbone for human survival ever since the evolution of mankind. Every country, however big or small has a small part of the population involved in this field which severs the most basic means of survival- food. Agriculture can often be termed as a science of farming or practice of farming which usually involves the cultivation of the soil for growing crops. To increase productivity, the use of pesticides and chemicals to increase productivity has adverse effects on soil, water, and air. Plants such as mulberry have a high risk of crop failure. Many states in India have taken up sericulture as an important agro-industry, which is a valuable foreign exchange earner for the country. The mulberry leaf is the most important economic component in sericulture since the quality and quantity of the leaf have a direct impact on the cocoon bearing.

Mulberry (as shown in Fig.1.) is a fast-growing, deciduous, dioecious, perennial woody plant that thrives well under a variety of climatic conditions. The ideal temperature is usually between 24 - 28°C. It is cultivated usually in the Indian subcontinent, the Middle Eastern part of the world and southern parts of Europe. Silkworms feed only on mulberry leaves and fresh mulberry leaves must be fed to them.



Fig.1. Mulberry Plant

Mulberry is susceptible to a variety of leaf diseases caused due to Fungi. Leaf spots and Powdery mildew some examples of fungal infections mulberry crop is prone to (as shown in Fig.2). This will have a dire effect on the quality and quantity of the yield produced. The early detection of the diseases is important because this harms the yield of the crop in terms of quality and quantity.



Fig.2. Leaf spots and Powdery mildew infections of mulberry leaves

The traditional approach for disease detection is through the naked eye. It is not feasible because it is expensive and requires expert observation and continuous monitoring on a large scale. To overcome the setbacks of the traditional method, a need for having an automatic detection and identification of the leaf disease is needed which is user-friendly and cost-effective.

The proposed model uses YOLO for the detection of leaf disease. Object detection is implemented to detect the disease accurately and effectively. Using the YOLO object detection, all the infected parts of the leaves will be detected and a bounding box will be drawn around it and CNN will be used for the disease classification. Fig.3. shows the leaf disease detection using YOLO. The accuracy and the speed for the detection and classification of the disease are relatively higher.

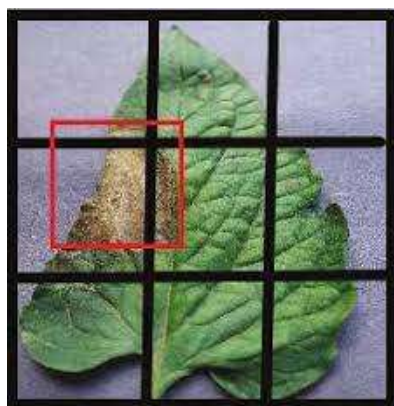


Fig.3. Leaf disease detection using YOLO

1.1 Problem Statement

The traditional approach for leaf disease detection and identification is through the naked eye. This method is not feasible because it is quite expensive and requires an in-depth knowledge of the diseases mulberry leaves are prone to and experience.

To overcome the setbacks of the traditional method, a need for having an automatic detection and identification of the leaf disease is needed which is user-friendly, cost-effective, and most importantly accurate.

The proposed model aims to detect the infected region of the mulberry leaf and identify the disease. Bounding box is drawn around the infected region. This is achieved by implementing deep learning and computer vision techniques.

2. LITERATURE REVIEW

2.1 Detection of plant leaf diseases using image segmentation and soft computing techniques. Information Processing in Agriculture

In this paper [1], a generic algorithm for image segmentation is presented. Soft computing techniques are used for image segmentation. Here, the images are converted into greyscale, and texture featuring methods such as local homogeneity, cluster shades are also used. SVM classifier and minimum distance criterion are used in image classification.

2.2 Plant Disease Detection in Image Processing Using MATLAB

In this paper [2], plant leaf disease detection is done using K-Means clustering and multi SVM algorithms. The different statistical features energy, sum entropy, covariance, information measure, entropy contrast are being considered, and the GLCM formula is being used. However, the accuracy of the model is relatively low.

2.3 Remote Area Plant Disease Detection Using Image Processing

In this model, [3] plant disease detection in apple (*Malus Domestica*) is done using K-Means clustering and Bayer's classifier. PCA analysis is implemented and the Bayer's classifier is used for the disease detection. Co-occurrence matrix and K-means clustering are used for texture segmentation.

2.4 Groundnut Leaf Disease Detection and Classification by using Back Propagation Algorithm

In this paper [4], the author presents the use of a backpropagation algorithm for disease detection in groundnut. Here, the RGB image is being converted into HSV. Colour generation and description are done for an RGB image using color renovation. Feature extraction is implemented and the Back Propagation Algorithm for disease detection.

2.5 Comparative study of image segmentation techniques and object matching using segmentation

In this paper [5], image segmentation techniques for a comparative study between Edge-based, thresholding K-means clustering, and region-based extraction is being presented. Image enhancement is done and the extracted objects are being compared with the original image and the mean weighted distance of the object. PCA is being used and the correlation between the objects in the images is matched. The result obtained here shows that K-means clustering is better than other approaches.

2.6 Fruit Disease Detection using Color, Texture Analysis, and ANN

In this paper [6], artificial neural networks are used to detect fruit diseases using color and texture. Image segmentation and feature extraction techniques are being implemented. The model was tested on multiple samples and classification of the fruit and the corresponding diseases are being done. The color transformation of the input RGB image is being done and then the green pixel masking and removal are applied using a threshold value. The image is matched with the corresponding training set for the pattern classification.

3. IMPLEMENTATION

3.1 Dataset

The dataset consists of 4000 images of both healthy and diseased mulberry leaf images which are used for model training. In the diseased class, there are subclasses of the diseases such as Leaf spots, Powdery mildew, leaf rust. The model has been trained to distinguish around three different mulberry leaf infections. The Fig.4. shows the dataset for mulberry leaf diseases.

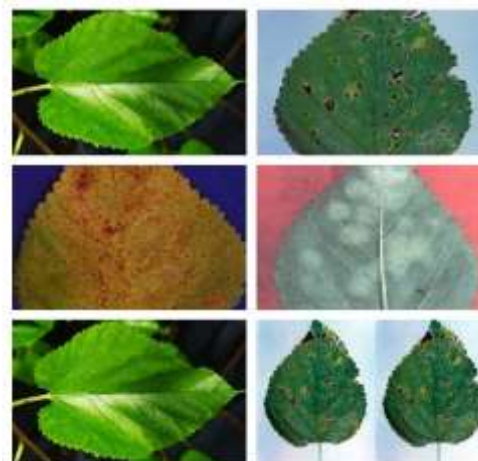


Fig.4. Mulberry leaf disease dataset

3.2 Image Annotations

Image annotation is the task of annotating an input image with labels. The labels are predetermined and chosen to give the model some information about what is present in the image. It marks the features that should be used for training the model, using supervised machine learning techniques. Metadata is being added to the dataset during annotations. It plays an important role in determining the accuracy and precision of the model.



Fig.5. Image Annotation

Image annotation as shown in Fig.5. is used for recognition of objects and image segmentations. It involves using a phrase to label an image. The labels that are being used here are healthy leaves, Leaf spots, Powdery mildew, leaf rust. This is also known as image classification or tagging.

The YOLO.txt format is used here. The .txt file will be created in the same directory with the same name as that of the image file. Each .txt file follows the syntax as shown below –

<Object-Class> <x> <y> <width> <height>

3.3 Convolution Neural Networks

Convolution Neural Network (CNN) is a class of neural network, which is widely used in the visual imagery analysis. It was inspired by the Visual Cortex region in the brain. Feature extraction and classification are the two important parts in a convolution neural network. A CNN has input layer, hidden layer and the output layer. Convolutional layers, ReLU layers, pooling layers, and fully connected layers are present in the hidden layer.

Working of convolution neural network is as shown in Fig.6. An image is given as an input to a CNN model. A feature map is created by applying a number of different filters to it. A ReLU function is applied to increase the non-linearity. Pooling is applied to all the feature maps and the pooled images are flattened into a single long continuous linear vector. The single long continuous linear vector obtained at the end of flattening will be given as an input to a fully connected artificial neural network. The features are processed through the network. The model is trained through forward and backward propagation for a number of epochs. The fully connected layer produces the output. YOLO Object detection uses CNN algorithm.

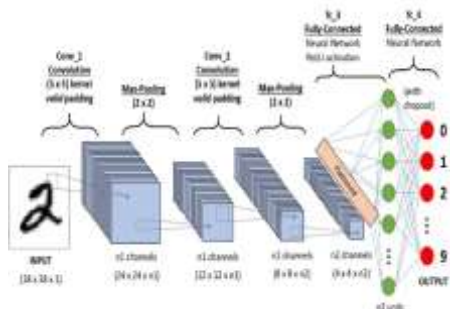


Fig.6. Working of Convolution neural network

3.4 Object Detection

Object detection is the process of identifying and locating a particular class in an image. The output of object detection is variable because the number of detected objects might vary from image to image. The State Of The Art (SOTA) methods can be divided into two types as follows:

- One stage method – The inference speed is prioritized by the one stage methods. Examples of this method include YOLO, SSD and RetinaNet.
- Two stage method – The detection accuracy is prioritized by the two stage methods. Examples of this method include Faster R-CNN, Mask R-CNN and Cascade R-CNN.

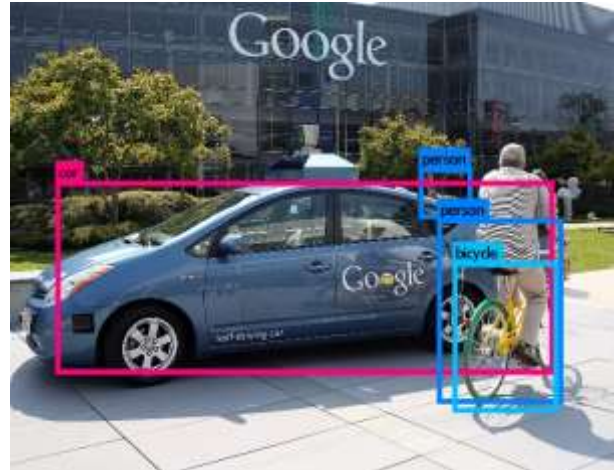


Fig.7. Object Detection

3.5 You Look Only Once (YOLO)

You Look Only Once [7] or YOLO is a family of models that are a series of deep learning models designed for fast object detection. It is based on regression where the localization and object detection take place at once and are commonly used in real-time object detection.

YOLO considers an entire image in a single instance and predicts the bounding box coordinates and class probabilities for these boxes. It can process up to 45 frames per seconds and is faster. The model does not look at the entire image. It considers parts of the image which having a higher probabilities for containing an object.

Input image given to the YOLO algorithm is divided into SxS grid system. Each grid cell on the input image is responsible for object detection and predicts the number of bounding boxes for an object in the image. Each bounding box comprises of five elements (x, y, w, h, confidence score), where x, y are the object coordinates, w, h are the width and height of the object in the input image and confidence score determines the accuracy of the bounding box and the probability that an object is contained in that bounding box.

3.5.1 Pervious YOLO versions: YOLOv1 [7] is the first version of YOLO which uses the Darknet framework and is trained on the on ImageNet-1000 dataset. However, it could not detect small objects if they appear in the form of clusters. The architecture could not generalise the objects if the dimension of the input image and the trained image is different.

The second version of YOLO (YOLOv2) called YOLO9000 [8] is able to detect and classify objects having different dimensions and configurations. It is faster and much accurate when compared to the version YOLOv1 and can detect smaller objects with a greater accuracy. The input size in YOLOv2 was

increased to 448*448 from 224*224. Anchor Boxes were introduced which are responsible for bounding box prediction. Darknet 19 architecture is used in YOLOv2 which consists of nineteen convolutional layers, five max pooling layers and a softmax layer for object classification.

The third version of YOLO (YOLOv3) [9] uses logistic regression for objectiveness score prediction. The predictions made by YOLOv3 are similar to Feature Pyramid Networks (FPN). Darknet-53 architecture is used for feature extraction. It is deeper than Darknet-19 and has cross connections with 3x3 and 1x1 filters and 53 convolutional layers.

3.5.1.1 Working of YOLOv3: The basic working of YOLOv3 is as follows. Image is taken as an input and is divided into grids. Each grid is checked to see if an image is present in it.

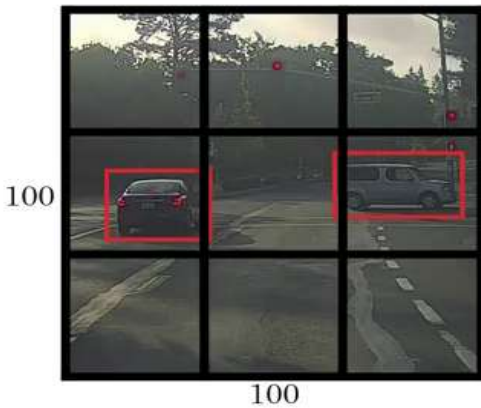


Fig.8. Image divided into grids

The five elements (x, y, w, h, confidence score) are calculated where,

- x = x coordinate of the center of the bounding box inside the cell
- y = y coordinate of the center of the bounding box inside the cell
- w = width of the bounding box with respect to the image
- h = height of the bounding box with respect to the image
- confidence score = Bounding box confidence

Let PC represent the probability of an object present in the grid. X, Y, H, and W represents the coordinates of the bounding box of an object. C1, C2, and C3 represent the classes of objects.

PC
C1
C2
C3
X
Y
W
H

If PC = 0, the classes of objects (C1, C2, and C3) = 0. If PC = 1, the model tries to find if the center of object is available. If multiple bounding boxes are present, the Intersection Over Union (IOU) is used to find the best bounding box.

$$\text{Intersection Over Union} = \frac{\text{Intersection Region}}{\text{Total area of the box}} \quad (1)$$

If the Intersection Over Union (IOU) > 0.5, the highest probability is considered. Once the best bounding box is obtained, convolution neural network can be used for image classification.

3.5.2 YOLOv4: YOLOv4 [10] is advantageous over the previous versions of YOLO in terms of speed and detection performance. The model can be trained smoothly and easily deployed in production systems. The model training can be done using GPU and techniques such as Bag-of-Freebies and Bag-Of-Specials are used to improve the network.

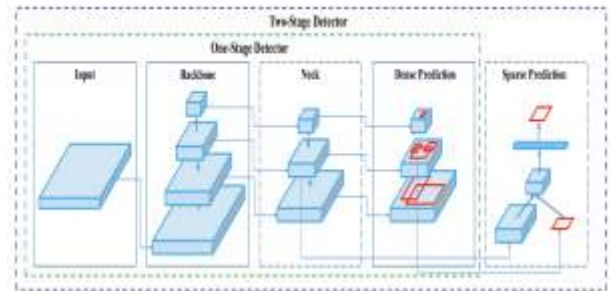


Fig.9. YOLOv4 architecture

YOLOv4 consists of three major components after the input image –

1. Backbone
2. Neck
3. Head

The backbone of YOLOv4 are CSPDarknet53, which is based on DenseNet. The main objective of the backbone is to extract essential features. The Cross Stage Partial architecture is derived from the DenseNet architecture. It uses the previous input and concatenates it with the present input before moving further into the dense layer. This results in different dense layers repeatedly learning copied gradient information.

Type	Filters	Size	Output
Convolutional	32	3 x 3	256 x 256
Convolutional	64	3 x 3 / 2	128 x 128
Convolutional	32	1 x 1	
Convolutional	64	3 x 3	
Residual			128 x 128
Convolutional	128	3 x 3 / 2	64 x 64
Convolutional	64	1 x 1	
Convolutional	128	3 x 3	
Residual			64 x 64
Convolutional	256	3 x 3 / 2	32 x 32
Convolutional	128	1 x 1	
Convolutional	256	3 x 3	
Residual			32 x 32
Convolutional	512	3 x 3 / 2	16 x 16
Convolutional	256	1 x 1	
Convolutional	512	3 x 3	
Residual			16 x 16
Convolutional	1024	3 x 3 / 2	8 x 8
Convolutional	512	1 x 1	
Convolutional	1024	3 x 3	
Residual			8 x 8
Avgpool		Global	
Connected		1000	
Softmax			

Fig. 10. YOLOv4 Backbone Darknet-53

Neck consists of several top-down and bottom-up paths that play an important role in collecting feature maps from different stages. It is used to add extra layers between the dense prediction block and the backbone. The Spatial Pyramid Pooling (SPP) block is added in YOLOv4 to increase the receptive field.

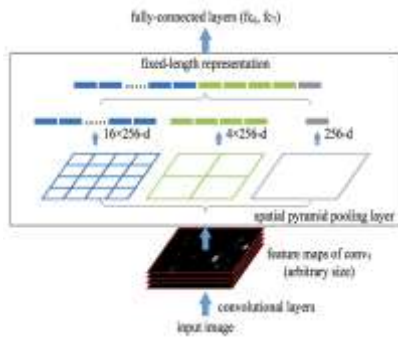


Fig. 11. Spatial Pyramid Pooling (SPP)

Head in YOLOv4 is used for locating bounding boxes and classification. The model detects the coordinates of the bounding box (x,y,w,h) and the confidence score. Bag-of-Freebies is a set of techniques that help in training, by not adding much inference time. Data augmentation, shadowing, dropout and random cropping are some of the techniques used. Bag-Of-Specials is a set of techniques that change the network architecture and augmentation of the inference cost might be bit. It involves specific techniques for activation, non-maxima suppression, parameter aggregation and so on.

3.6. Proposed Model

The proposed model aims to detect and identify the infected parts of the mulberry leaves. If the infected part is detected, a bounding box will be drawn around the image with the corresponding disease.

The LabelImg tool is being used for annotation. The YOLOv4 model is trained for 10000 epochs for 1000 images per class. Three common leaf diseases that the mulberry plant is more susceptible are being detected and identified here. When the infected region is detected and the infection is identified, the pesticides that can be used to cure the infection will be suggested. The proposed system is beneficial to farmers who grow mulberry because automatic detection and identification of the leaf diseases are being done which is user-friendly, cost-effective, and overcomes the major drawbacks of the traditional methods.

3.7 Methodology

The data flow diagram of the proposed model is as shown in Fig.6.

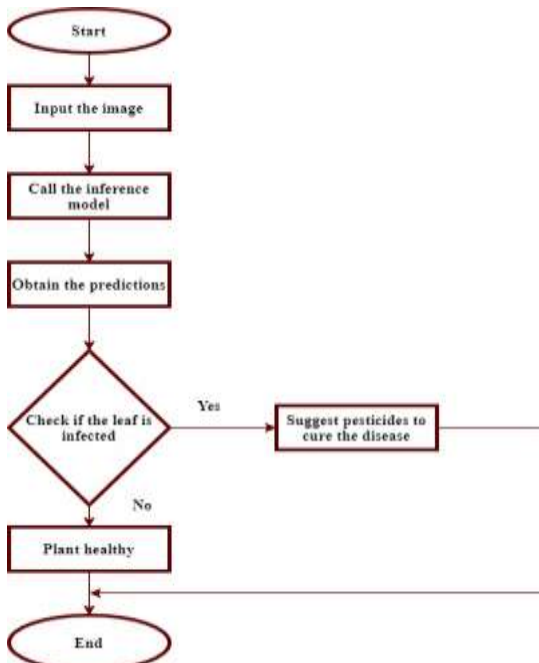


Fig.6. Data Flow Diagram

The steps that are followed for detecting the mulberry leaf disease using YOLO are as follows :

- i Image pre-processing and normalization
- ii Annotating the images
- iii Training the YOLOv4 model
- iv Testing the trained model
- v Evaluating the accuracy
- vi Saving the inference model
- vii Deploying the model using frameworks like Django web Frameworks or Flask

4. EXPERIMENTAL RESULTS

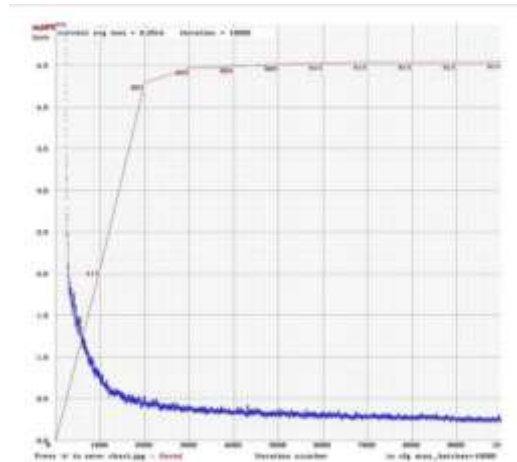


Fig.7. Training Plot

The Fig.7. shows the graph obtained during model training. The graph represents the loss vs epoch. The YOLOv4 model is trained for 10000 epochs for 1000 images per class. The proposed model can identify single or multiple regions of infections. The Fig.8. shows the model prediction for Powdery Mildew Infection.

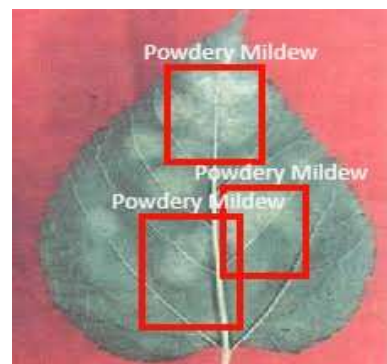


Fig.8. Model Prediction for Powdery Mildew Infection



Fig.9. Model Prediction for Leaf Rust Infection

The model has been trained for 10000 epochs for over 1000 images in each class. Upon increasing the number of images in each class and the number of epochs for training, the model performance will improve. Once the predictions from the model are obtained, the corresponding pesticides will be suggested in case any infections are being detected and identified.

5. CONCLUSION

YOLOv4 is used for the detection and identification of leaf diseases in mulberry crops. It processes leaf images about 45 frames per second in real-time and is much faster and accurate than any other method. The speed and accuracy of detection and classification are relatively high here. Once the detection and identification of the disease are done corresponding pesticides will be recommended by the model.

Sericulture contributes to about 15-20% of the Indian economy and hence, the proposed model will be beneficial to the farmers cultivating mulberry, because it is user-friendly, cost-effective, and overcomes the major drawbacks of the traditional methods.

6. REFERENCES

- [1] Vijai Singh, A.K Misra (2017). "Detection of plant leaf diseases using image segmentation and soft computing techniques. *Information Processing in Agriculture*", 4(1), 41-49.
- [2] Sandesh Raut, Amit Fulsunge (2017). "Plant Disease Detection in Image Processing Using MATLAB". Vol. 6, Issue 6, June 2017. *IJRSET*
- [3] Sabah Bashir, Navdeep Sharma. "Remote Area Plant Disease Detection Using Image Processing". *IOSR Journal of Electronics and Communication Engineering*. ISSN: 2278-2834 Volume 2, Issue 6 2012, PP 31-34
- [4] Ramakrishnan.M and Sahaya Anselin Nisha.A "Groundnut Leaf Disease Detection and Classification by using Back Propagation Algorithm" *IEEE ICCSP conference*, pp. 978-1-4 799-8081-9/15, 2015 .
- [5] Sapna Varshney, S., Rajpal, N., & Purwar, R. (2009). "Comparative study of image segmentation techniques and object matching using segmentation". 2009 Proceeding of International Conference on Methods and Models in Computer Science (ICM2CS)
- [6] Ashwini Awate, Damini Deshmankar, Prof. Samadhan Sonavane "Fruit Disease Detection using Color, Texture Analysis and ANN" *IEEE International Conference on Green Computing and Internet of Things (ICGCIoT)*, pp. 978-1-4673-7910, 2015.
- [7] Joseph Redmon, Santosh Divvala, Ross Girshick, Ali Farhadi, "You Only Look Once: Unified, Real-Time Object Detection", *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2016, pp. 779-788
- [8] J. Redmon and A. Farhadi, "YOLO9000: Better, Faster, Stronger," *2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2017, pp. 6517-6525, doi: 10.1109/CVPR.2017.690.
- [9] Redmon, Joseph and Ali Farhadi. "YOLOv3: An Incremental Improvement." *ArXiv abs/1804.02767* (2018).
- [10]Bochkovskiy, Alexey & Wang, Chien-Yao & Liao, Hongyuan. (2020). *YOLOv4: Optimal Speed and Accuracy of Object Detection*.