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Face Detection Method with Mask by Improved YOLOv5

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Abstract: ***Facial recognition has become a major challenge today as more and more individuals wear masks to avoid contracting the COVID-19 virus. The rapid spread of the COVID-19 pandemic has made it necessary for people to use a face mask, especially in public places, to prevent the spread of this disease. Therefore, recognizing faces and distinguishing a person's identity has become a problem that cannot be easily recognized, as many researches have proposed finding solutions to detect faces. But faces wearing a mask were not accurately detected, so in this research it was proposed to use a deep learning algorithm, which is the improved YOLOv5, which is a YOLO model that is characterized by accuracy and speed compared to YOLO models a deep learning algorithm. The YOLOv5 algorithm is proposed here from YOLO Network to detect and recognize faces with and without wearing a mask. It is an advanced and fast system for detecting faces in real time. As we reviewed most of the experiences with previous versions of YOLO, we noticed that YOLOv5 is a better model than previous YOLO models at detecting faces while wearing a mask, but needs to improve accuracy. As face detection is of great importance in various fields in terms of security in all public places and requires accuracy in detection. It is known that there is very little data available on images of wearing masks. So the training and evaluation was performed on the dataset available on Google Colab to the improved YOLOv5 algorithm in this paper.***

Keywords: YOLOv5, Object Detection, Detection Algorithm, Wear Masks, Deep Learning.

1. INTRODUCTION

The world is now moving towards the rapid development of artificial intelligence and deep learning; Object detection has become an important research direction in many fields in artificial intelligence. In recent years, with the emergence of Covid-19, the continuous progress of target detection algorithms and research in the field of face detection has become very effective [1].

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However, these proposed algorithms still suffer from problems related to inaccuracy and efficiency and need to be further improved. To address object detection problems, deep learning methods of deep neural network are more effective in correcting object detection. With the presence of Covid-19, and everyone is urging people to wear a mask and prevent the spread of the virus, there are many algorithms that detect faces and it was necessary to search for a mechanism to distinguish People refrain from wearing a mask or not wearing a mask in public places. There are two types of object detection algorithms: the CNN algorithm, which is good, and the other algorithm model that is better in terms of accuracy and speed is the YOLO algorithm. The main goal of this research is to find a more accurate technique than its predecessor in recognizing faces using deep learning, which is the YOLO algorithm. While the main goal of the invention of YOLO was to achieve higher accuracy in a short time for detecting multiple objects [2], the YOLO (You Only Look Once) algorithm proposed by Joseph Redmon and Ross Girshick. The speed of detection in this way is considered one of the fastest algorithms at the present time, but there is a shortcoming in the accuracy of detecting small targets, so many models of the YOLO algorithm have appeared and have been constantly improved. Therefore, many applications use the YOLO model to detect objects with higher accuracy. It was found that the YOLO algorithm YOLOv5 is the best among the models, but according to the research conducted, it needs improvement. Therefore, the improved YOLOv5 will be used to improve the accuracy and speed in detecting the faces that are a model [3].

Problem Background

Facial recognition has become extremely important from a security standpoint in public places, especially when wearing a mask. It is the first step for face recognition, face analysis and detection of other facial features. At the critical time that the world has gone through in light of the Covid-19 virus disease, and with people being required to wear a mask, it has become necessary to find a new and improved technology to recognize faces by wearing a mask in all applications in public places, including stations and airports, from a security and health standpoint. A type of YOLO algorithm will be used, which is YOLOv5, as inaccuracies in the algorithm have been noted [4]. Masks are still worn in all public places, which requires precise detection technology. In this research, the improved YOLOv5 algorithm will be proposed using the deep learning method [5], as it has been proven to be the most powerful algorithm for face detection at present [6]. Since the YOLOv5 algorithm is very easy to train and infer on individual images and video feeds, the ease of transfer and use of weights It is faster and lighter than the rest of the previous YOLO models, but it also needs improvement [7] [8].

Problem Statement

Become necessary to distinguish the faces of those wearing a mask or without a mask, very important at the present time, especially when the Covid-19 pandemic came suddenly and affected life directly and caused the death of many people in all countries of the world, so it was necessary to wear a mask to limit the spread of the epidemic. By adhering to it, it is now necessary to find methods for detecting faces with high accuracy with deep learning algorithms. The goal of this

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research is to improve the performance of face detection and recognition in terms of accuracy and speed. The YOLO deep learning algorithm was used in this research. There are problems with slow detection speed and low accuracy of various target detection algorithms in YOLO models. This paper proposes to use a target detection algorithm based on the improved YOLOv5 model [9] [10]. To detect faces in photos and videos. Through deep learning, Python programming and using the improved YOLOv5 algorithm, we can improve and accelerate the process of distinguishing faces whether wearing a mask or not, while comparing it to the old version.

Research Goal

The main objective of the research is to improve the algorithm of a type of YOLO, it will be to explore the current techniques for detecting faces using deep learning and applying the fifth improved version of the YOLO algorithm to improve the accuracy and speed of face detection, which is the YOLOv5 algorithm.

Scope the Study

The importance of this research paper in distinguishing faces, especially when wearing a mask. There have been many previous studies on face detection. But we need an improved algorithm for detection while wearing a mask. This can be attributed to its ability to improve the performance, accuracy and speed of face detection based on the use of the detection algorithm optimized to YOLOv5. The research will be limited to improving the deep learning algorithm by using the Python programming language.

Literature Review

Automatic identification of people has become more important with wearing a mask in the context of the spread of Covid-19. In order to prevent the spread of this disease in public gatherings, it has become necessary to use a face mask, especially in hospitals, so it was necessary to find techniques to detect people wearing a mask or not.
We will explain in a brief literary review the most important basics of detecting and identifying objects.

A- Object Detection

1. Classification, which is to structure the image into a certain type of information, with a predefined category) String) or instance ID to describe the image.
2. Detection, the classification task is concerned with the whole. Compared with classification, detection gives the understanding of picture foreground and background. The output of the detection model is a list, and each item of the list used a data group to give the category and position of the detected target (commonly used coordinate representation of rectangular detection box.
3. Segmentation, which is a pixel-level description of an image, which gives meaning to each pixel category instance and is suitable for scenes requiring high understanding.

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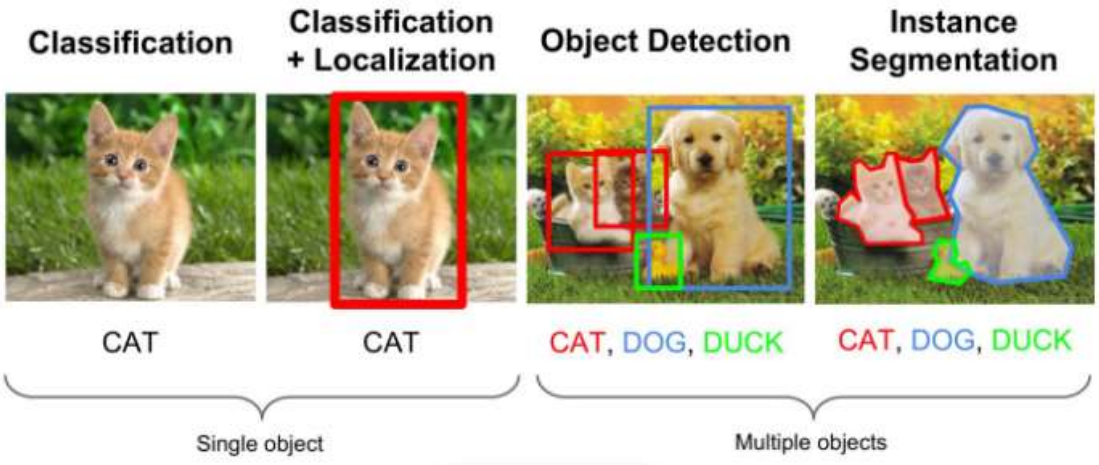

Figure 1 Comparison between image classification, object detection and instance segmentation.

B- One-Stage and Two-Stage

The CNN convolutional neural network is one of the first networks used to discover and identify objects based on the region [11] and it is Two-Stage [12], where the CNN algorithm has been improved many times, including R-CNN, Fast-RCNN, and Faster-R. CNN where good performance was achieved, and with this it had many disadvantages, including (1) the training takes place in several stages, (2) it consumes a large volume and takes a long time, the discovery of objects is very slow compared to other algorithms [13] [14], so you need To improve detection speed. After that, an algorithm was found. The one-stage network is represented by the YOLO chain network, where the one-stage object detection algorithm is fast and can accomplish the task in real time, which has achieved high efficiency for object detection [15].

C- YOLO

You only look once" for short is called YOLO The YOLO model was first described by Joseph Redmon et al. Using either a picture or a video input, this technology operates in real time to detect the type of item and its position. The idea of a neural network is used by the YOLO algorithm to identify objects. Bounding boxes are applied, and a CNN (Convolutional Neural Network) is utilized to decide how to arrange things. The phrase "You Only Look Once" refers to the capacity to identify whole visual objects in a single run. A unique neural network approach called YOLO (You Only Look Once) aims to recognize objects in real-time environments [16]. YOLO algorithms are quite popular because of their better efficiency and quicker detection times. YOLO may be used for a variety of functions, including the recognition of people, animals, parking spots, traffic signals, etc. It may be used to identify traffic signals, parking meters, people, and animals, among other things. [17].

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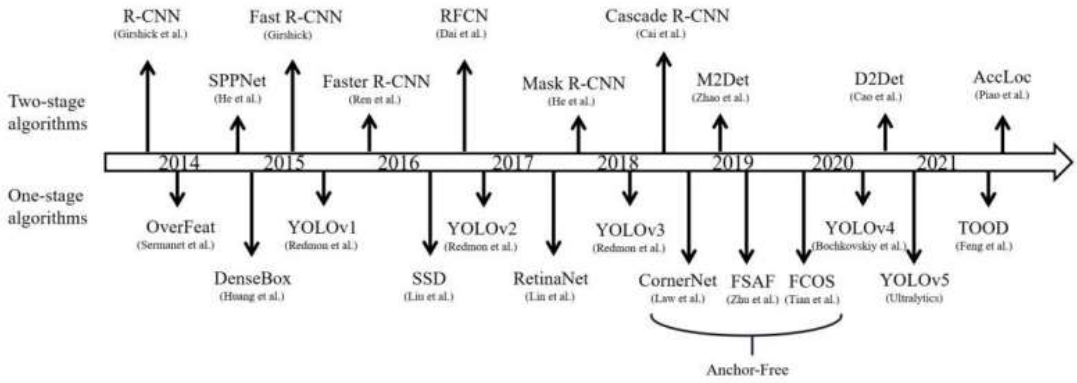

The YOLO algorithm series has recently shown encouraging results in a number of object detection subfields [14]. Many researchers have used small and big variants of the YOLO method to address detection problems such as the general object problem. The YOLO method and many model variations—including updated versions of the YOLO approach like YOLO v1, v2, v3, v4, and v5)—were used where the mask was used to verify whether or not it was authentic [18]. Many scientific experts have been seen and contacted, despite the fact that the majority of research studies just identify faces and very few of them distinguish between faces that are wearing masks or not. Although YOLO is currently the fastest algorithm, it is not as precise as other techniques [19]. A deep learning system has been used to identify things in anything, including traffic footage, robots, drones, and even driving scenarios, by training the network on different item classes.

Advantages of YOLO Algorithm

The YOLO algorithm has the following benefits [20]:

a) The aptitude to understand object representation

The YOLO model is better at detecting objects in real-time scenarios due to its enhanced capacity to learn object representation. Both object location and object class identification can be done on .the same network

b) Increased Precision

Better real-time item detection accuracy is provided by the Yolo algorithm. YOLO models provide more accurate microscopic item identification.

c) Faster Object Recognition in Real-Time Situations

Quick object recognition is the primary benefit of the YOLO method. items may be Smaller .detected more rapidly, like traffic lights, etc

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d) A Single Network
Object classes are recognized and their distinct locations may be found using a single network. Thus, it is feasible to improve forecast accuracy by modifying just one network.

e) The larger Framework
YOLO is the most widely used model because it offers the best accuracy for item detection in both creative and original photos.

d) Change Rate
Frame rate is highly suitable for real-time applications, as each frame processes at a pace of 150 frames per second for smaller networks and 45 frames per second for larger networks.

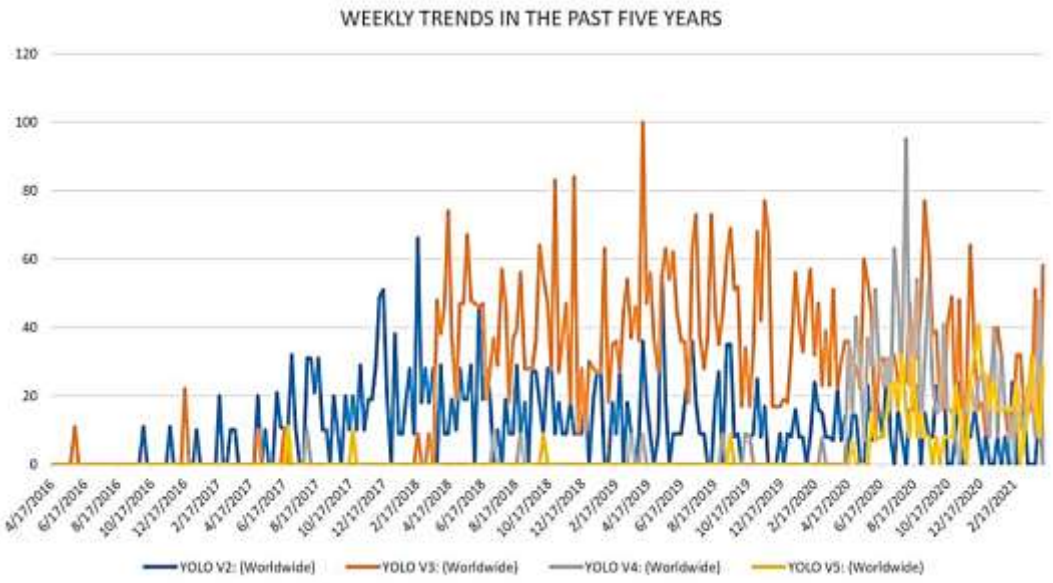

Figure 2 Trend of YOLO models in last few years [2]

The author [21] compared the design and implementation aspects of many YOLO implementations. Prior to employing publicly available data to assess the data outputs in a tabular and graphical manner, the authors expounded upon the primary concept based on the version. The compact form factor and rapid object detection of the YOLO model are well known. YOLO uses regression analysis to determine an object's identity. Based on size, things may be divided into three main classes: massive, medium, and microscopic. Thus, the creation of a generalized model that can categorize all three kinds of objects is necessary. The multilayer YOLO model with different sample values can be used for this type of detection. There are 26 layers in all that make up the YOLO primary structure. Two levels remain as FC (Fully Connected) layers, and the other twenty-four levels are convolution layers. The Yolo model's incorrect placement and worse recall rate are its two main shortcomings. [21] [22] [23].

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Data Acquisition
Data collection and the method of obtaining a set of public data directly from the community. Our database images were collected through extensive research. But to train this improved algorithm, we need 250 images with bounding boxes for each person, so we trained the algorithm using the obtained images.

2. METHODOLOGY

Experiments were performed by training the model on custom datasets with both YOLOv5 and YOLOv5 optimizer independently. In order to consider which one works better in terms of accuracy. Google Colab is a platform that provides a free coding notebook and a cloud virtual machine with storage and GPU. A Tensor Processing Unit (TPU) was used to run the long and complex computation of the experiment on the detection models. All experiments were conducted on Google Colab using Google Chrome. It will be the same samples of data collected and applied to Google Colab, and the same data was trained on both the YOLOv5 algorithm and the improved YOLOv5 algorithm. This method can achieve fast and accurate detection with high efficiency, and a model of face detection while wearing a mask has been proposed by an algorithm named YOLOv5 and improved Ghost-YOLOv5. The model is used effectively and straightforwardly to achieve accurate and fast real-time object detection. The main contributions of this research are as follows: The width factor of the YOLOv5 network is scaled to 0.5, and the Ghost convolution is used to replace the standard convolution of the basic network to achieve a lighter model and improve the detection speed, in this research. It is organized as follows: This principle describes YOLOv5 and the details of the improved algorithm is the Ghost-YOLOv5 model.

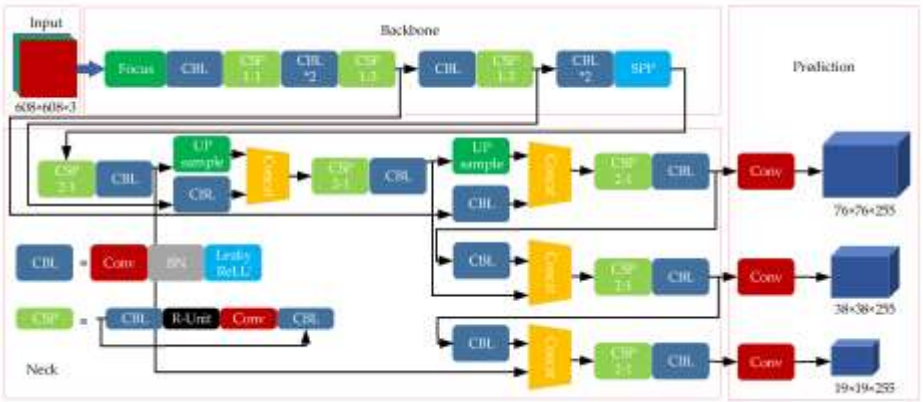

Figure 3 Network structure of YOLO v5

Training and Comparing the Algorithms
Google Colab and Roboflow to run training, validation and testing of the YOLOv5 custom model. Training results of the algorithm were obtained before optimization.

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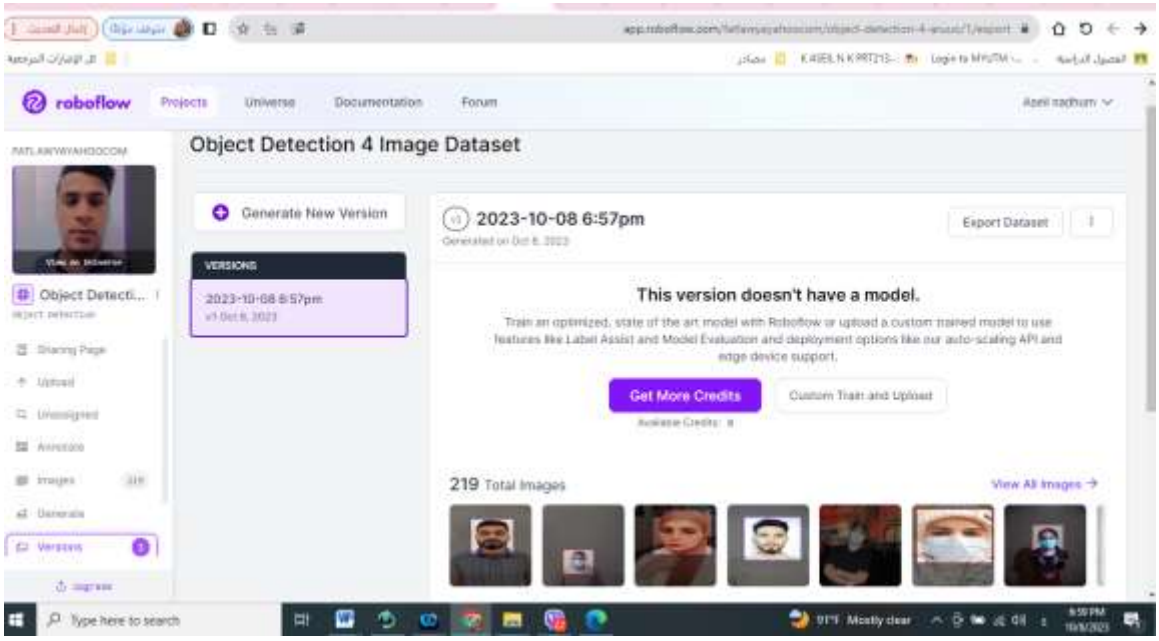

In the screen below you can see for each person below I took only two images with a mask and without mask for that a bounding box file and then you can train these custom data images using Google Colab and Roboflow images Figure 2.

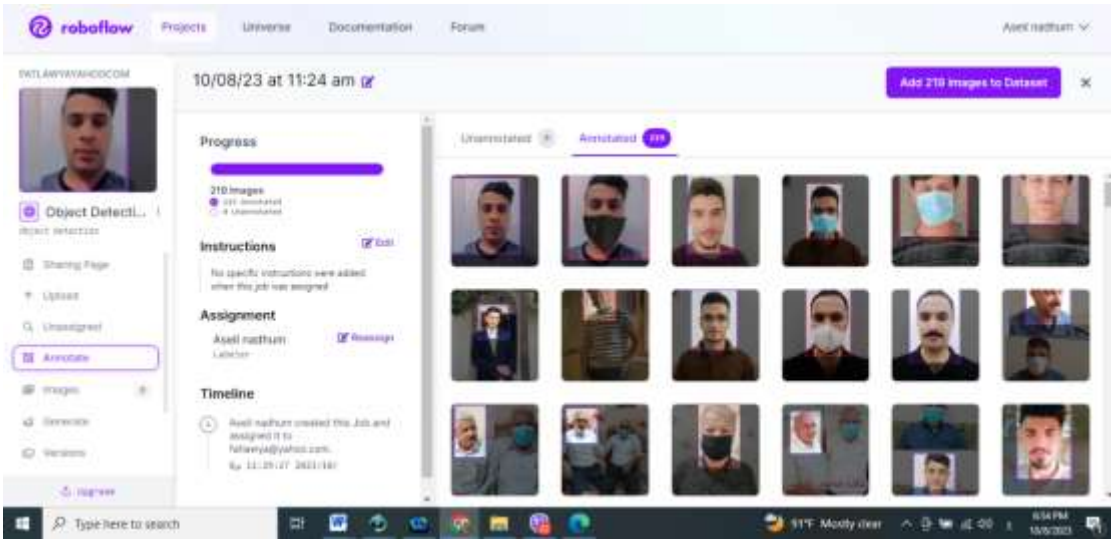

Figure 4 Training images

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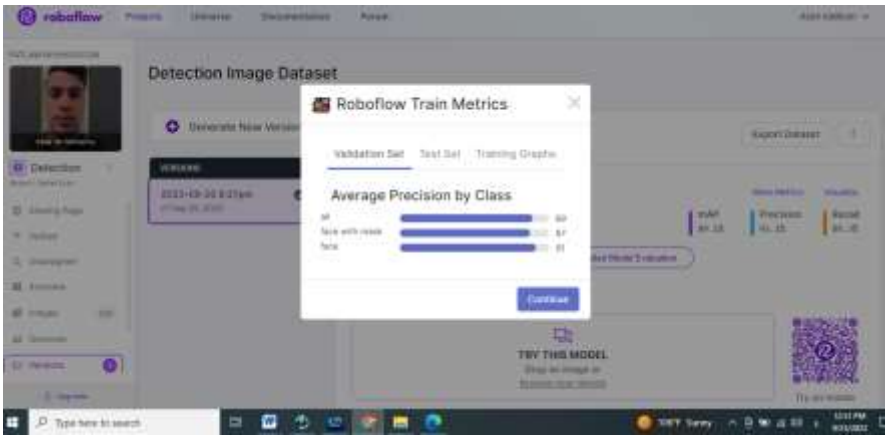

In below screen we are showing YOLOv5 precision, recall and MAP (mean absolute precision) values Figure 4.

Figure 5 Original YOLOv5 model

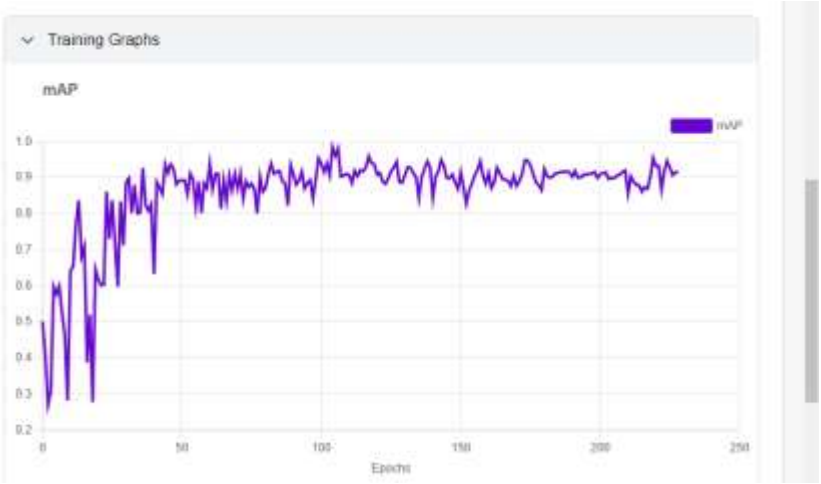

Figure 6 Improving the YOLOv5

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After improving the YOLOv5 algorithm and training images on it, we obtained these results. In the graph above, we can see the MAP starts from 0 and reaches closer to 1, As we obtained better accuracy values than the original YOLOv5 model, we improved this model until we reached an excellent degree of accuracy in detection.

3. CONCLUSION

Research paper results of the YOLOv5 algorithm model and its optimization algorithm. Here the following observations were recorded. First, by training a set of 219 images with and without mask on both algorithms, I found that the improved YOLOv5 is better, faster and more accurate compared to the original YOLOv5 algorithm. The MAP (mean absolute accuracy) values are 89.11 for YOLOv5, while the MAP value for the improved YOLOv5 algorithm is 96.6.

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