VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JNANA SANGAMA”, BELAGAVI - 590 018

A PROJECT REPORT

on

“FACE MASK DETECTION SYSTEM”

Submitted by

ABHIJITH MALLYA	4SF20CI002
HITHESH SHETTY	4SF20CI024

In partial fulfillment of the requirements for VI Sem. B.E. CSE(AI & ML)

DIGITAL IMAGE PROCESSING MINI PROJECT - 18AIL67

Under the Guidance of

Mrs. CHAITHANYA LAKSHMI.M

Assistant Professor, Department of CSE(AI & ML)

at

SAHYADRI

COLLEGE OF ENGINEERING & MANAGEMENT

An Autonomous Institution

Adyar, Mangaluru - 575 007

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SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
(ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

CERTIFICATE

This is to certify that the Digital Image Processing Mini Project - 18AIL67 entitled **"Face Mask Detection"** has been carried out by **ABHIJTH MALLYA (4SF20CI002), and HITHESH SHETTY (4SF20CI024)**, the bonafide students of Sahyadri College of Engineering & Management in partial fulfillment for the award of Bachelor of Engineering in Computer Science & Engineering (Artificial Intelligence and Machine Learning) of Visvesvaraya Technological University, Belagavi during the year 2022-23. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The DIP project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said degree.

Guide	**Project Coordinator**	**HOD**
Mrs. Chaithanya Lakshmi.M	Mr. Gurusiddayya Hiremath	Dr. Pushpalatha K

External Viva:

Examiner's Name | Signature with Date

1. ....

2. ....

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DECLARATION

We hereby declare that the entire work embodied in this Digital Image Processing Mini Project - 18AIL67 Report titled **"FACE MASK DETECTION"** has been carried out by us at Sahyadri College of Engineering and Management, Mangaluru under the supervision of **Mrs. Chaithanya Lakshmi.M** for the award of **Bachelor of Engineering** in **Computer Science & Engineering(Artificial Intelligence & Machine Learning)**. This report has not been submitted to this or any other University for the award of any other degree.

ABHIJTH MALLYA (4SF20CI002)

HITHESH SHETTY (4SF20CI024)

Dept. of CSE (AI & ML), SCEM, Mangaluru

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It is with great satisfaction and euphoria that we are submitting the Project Report on **"Face Mask Detection"**. We have completed it as a part of the curriculum of Visvesvaraya Technological University, Belagavi for the award of Bachelor of Engineering in Computer Science & Engineering (Artificial Intelligence & Machine Learning).

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ABHIJTH MALLYA (4SF20CI002)

HITHESH SHETTY (4SF20CI024)

Abstract

The project involves building a face mask detection system for real-time compliance monitoring. The system is designed to detect whether a person is wearing a mask or not in realtime through a video feed, using a machine learning model built from scratch with collected data. The system's scope is vast and can be customized to meet the specific needs of various settings, such as hospitals, schools, airports, and public transportation. The system's implementation involves collecting data, pre processing the data, training the machine learning model, and integrating the model with a web application..The project's objective is to promote compliance with mask-wearing guidelines and help prevent the spread of the virus in real-time. The system's longterm implications in various settings, such as security purposes in airports, make it a versatile and valuable tool. The project also provides an opportunity to explore and experiment with machine learning techniques and their practical applications in real-world scenarios.

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Chapter 1

Introduction

The Face Mask Detection System built using ML tools such as OpenCV, TensorFlow, and MobileNetV2 has emerged as a crucial technological solution in the fight against the global COVID-19 pandemic. Widespread use of face masks has become an integral part of preventive measures, and the automated detection of mask-wearing individuals has garnered significant attention. This project report presents an in-depth analysis of the development and implementation of a Face Mask Detection System utilizing ML tools.[1]

By leveraging the power of OpenCV[2], an open-source computer vision library, and TensorFlow, a popular deep learning framework, this system aims to accurately identify whether individuals are wearing face masks or not. The project utilizes MobileNetV2, a state-of-the-art deep learning architecture, for efficient and high-performance image classification tasks. This combination of ML tools enables real-time analysis of visual data and provides an effective means of enforcing mask-wearing protocols in various settings.

The project report [3]focuses on the comprehensive understanding of the system's development process, including data collection, preprocessing, model training, and evaluation. It highlights the utilization of advanced ML techniques to extract features from images, classify them based on the presence or absence of face masks, and generate accurate predictions. The performance of the system will be assessed using standard evaluation metrics, such as accuracy, precision, recall, and F1-score, ensuring its reliability and effectiveness.

The findings and insights presented in this project report[4] hold significant implications for public health and safety. The Face Mask Detection System serves as a valuable tool for authorities, law enforcement agencies, and organizations in enforcing mask-wearing policies. Additionally, the report discusses potential applications and future prospects of this system, paving the way for further advancements in the field of ML-based face mask detection.

1.1 Purpose

The purpose of developing the Face Mask Detection System using ML tools such as OpenCV, TensorFlow, and MobileNetV2 is to provide an efficient and automated solution to ensure compliance with face mask protocols. The system plays a vital role in mitigating the spread of infectious diseases, particularly during the ongoing COVID-19 pandemic. By accurately detecting individuals who are not wearing masks, the system aims to enhance public health and safety in various settings, including public places, healthcare facilities, transportation hubs, and workplaces.

1.2 Scope

The scope of this project report revolves around the development and implementation of the Face Mask Detection System using ML tools like OpenCV, TensorFlow, and MobileNetV2. It encompasses various aspects, including data collection and preprocessing, model training and evaluation, and the practical application of the system. The report will delve into the utilization of ML techniques for feature extraction and classification, focusing on the detection of face masks in real-time scenarios. Additionally, it will discuss the system's potential applications in public places, healthcare facilities, and other relevant settings. The scope of this project report is limited to the analysis and evaluation of the Face Mask Detection System and does not cover broader topics such as face recognition or advanced computer vision algorithms.

1.3 Overview

The Face Mask Detection System built using ML tools such as OpenCV, TensorFlow, and MobileNetV2 is an automated solution designed to identify individuals wearing face masks. Leveraging computer vision and deep learning techniques, the system analyzes visual data in real-time, accurately determining the presence or absence of masks. This project report provides a comprehensive overview of the system's development process, including data collection, preprocessing, model training, and evaluation. It highlights the utilization of ML tools to enhance public health and safety by enforcing mask-wearing protocols in various settings. The report [5]also discusses potential applications and future prospects of this ML-based face mask detection system.

Chapter 2

Literature Survey

The coronavirus has created a health crisis globally. The most efficient technique to counter the virus is wearing a face mask. Many people wear the mask just for the sake of it and often are complacent on the way they wear their mask. This could further lead to the spread of the virus. The major spread of this virus is due to the lack of consciousness and carelessness of the people [6]. The existing methods are not efficient and have insufficient robustness. There are limited datasets also available to train this data [7].

In the paper [8], they have used a Multi-Task Cascaded Neural Network(MTCNN) to get the object of interest. Their dataset was trained using the LeNet Algorithm for efficient training. There was good prediction for faces with masks and relatively lower prediction for unmasked faces due to the variety of features present on the face.

In [9], the YOLO object detection is being used. It focused on face mask recognition as well as maintaining a certain distance in crowded places. The created model is employed in public places as it has good precision, not many heavy components and is time efficient.

The model suggested in [10], uses Support Vector Machine (SVM) with a soft-margin. The dataset used in this is the Face Mask detection dataset. Here during the process of evaluation, a confusion matrix is used to evaluate the performance. The model has 91.7This model can however detect the face but cannot specify the extent to which the person is correctly wearing the face mask. It detects the face mask presence and gives a 'mask' or 'no mask' classification only. It is however much faster than deep learning models.

In the approach given in [11], a bounding box was generated around the facial features of the individual. This was used for classification into the 'mask' and 'no mask' categories. This paper suggested sending an email to the unidentified person cautioning them to wear the face mask at all times. It mainly uses deep learning and computer vision to achieve the required output.

In the method proposed in [10], MobileNetV2 pre-trained classifier is used for the purpose of classification. A Kaggle dataset with real world persons with masks is used. The various steps were training the model, validation, and then finally testing of the model. This model provided a large percentage of recognition and could be scaled to public places for generating awareness.

Chapter 3

Methodology

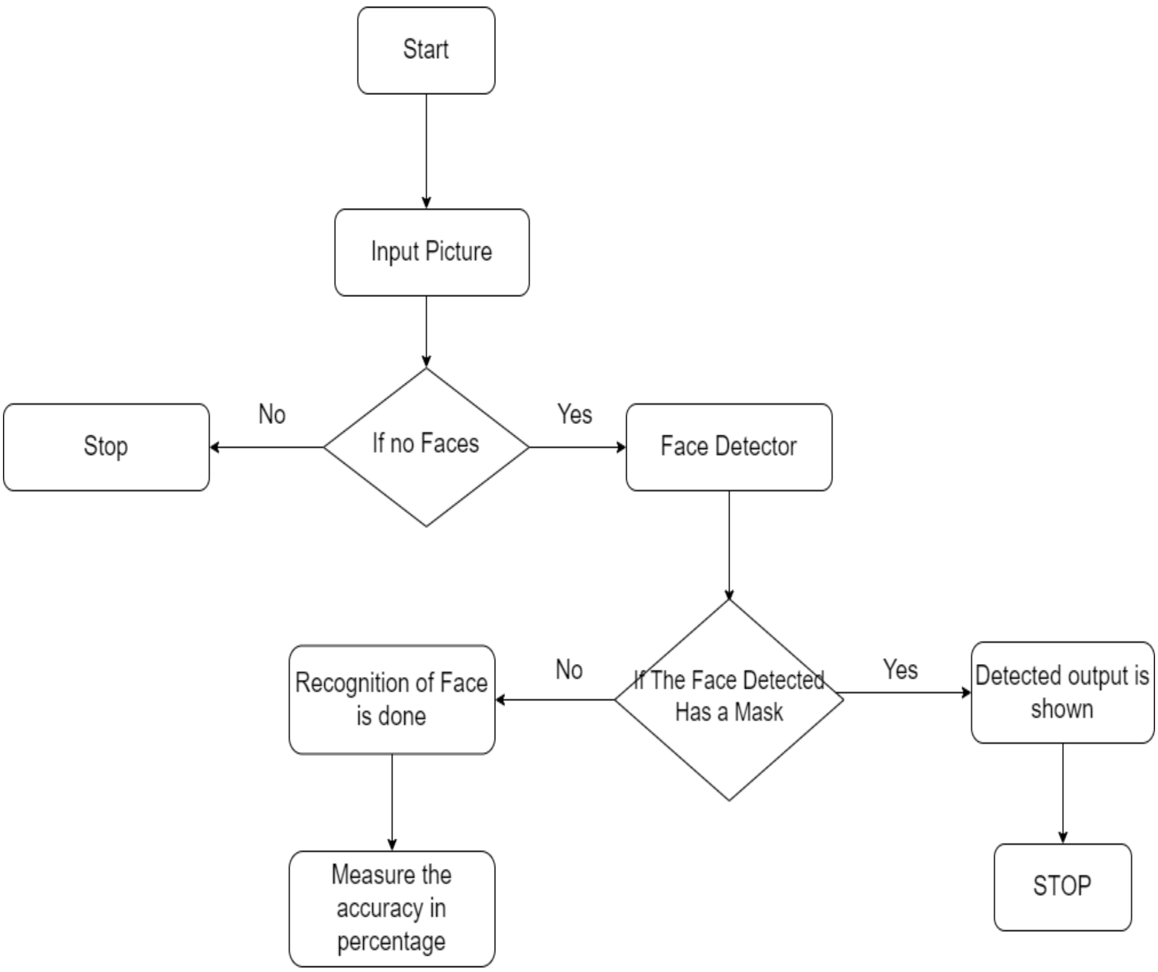

Figure 3.1: Flowchart for face mask detection model

The above diagram 3 gives a brief description of how the entire working mechnanism of face mask detector works.It serves as the roadmap for the operation of the model

3.1 Algorithm

Step 1: Load the Images dataset belonging to 2 classes by reading the path.

Step 2: Label the dataset into 2 Categories - “With Mask” & “Without Mask”.

Step 3: Perform pre-processing of the Image Dataset.

Step 4: Execute splitting of the dataset into training and testing set and carry out data augmentation on chosen dataset

Step 5: Build the Face Mask Recognition Classification Model on Training set using feature extractor MobileNetV2.

Step 6: Evaluate the model by performing testing.

Step 7: Serialise and save the Classification model into the disk

Step 8: Load the Classification Model from the disk and deploy it for Real- Time Detections to detect presence or absence of mask

End

3.2 Steps in training the data

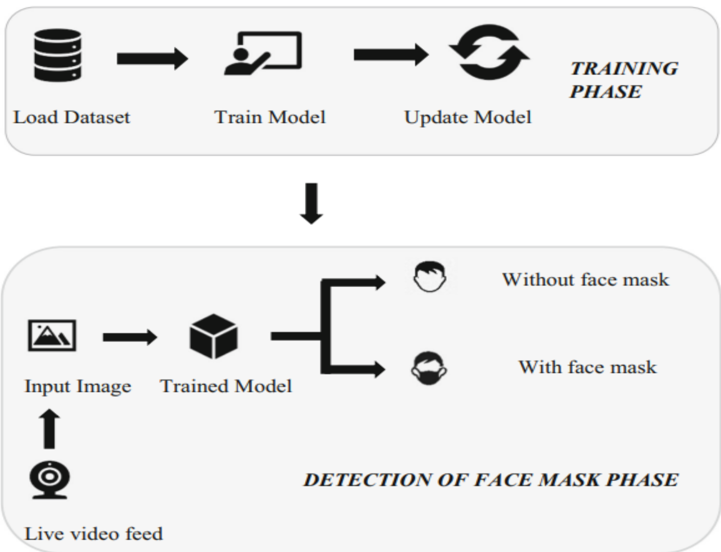

Figure 3.2: Steps in training the dataset

3.2.1 Collection of Datasets

The first step in developing a Face Mask Recogniser Classification Model is acquiring the necessary data. The dataset will be used for train- ing of the data on the individuals who are wearing a mask and who arenot, so that the Mask Recognition model can distinguish the individuals who are wearing masks or not.In this research study, to build this model, the used dataset is ob-tained from the Kaggle which consists of 4000 RGB images, containingtwo classes: with-mask and without-mask. Images of faces with masks are 2000 and images of faces without masks are 2000.

3.2.2 Pre-processing

This phase is conducted prior to splitting the dataset into training and testing sets[12]. Pre-processing involves several crucial steps to ensure high-quality data for the classification model. Firstly, the images are resized to a standardized size to facilitate uniform processing. Next, the images are converted into arrays, a format suitable for numerical computations. This conversion allows the model to analyze and extract meaningful features from the images effectively. Lastly, one hot encoding is applied to the labels, a technique that converts categorical labels into binary vectors. This step is essential as it enables the model to comprehend and classify the data accurately. Consequently, only preprocessed data should be directed into the model to achieve optimal performance.In this study, every image in the dataset is resized into 224 $\times$ 224 pixels. The effectiveness of the training model depends on resized images in the way that, lesser the size of the image, then the model will run greater.The following step is processing all the images present in the data set into an array by using a loop function. In the last step, perform one hot encoding on the labels of the categorised dataset executed in the previous step. And also most of the machine learning algorithms are incapable of dealing with the categorical data directly, as they need numerical values in all input and output variables, including this study's classification algorithm.

3.2.3 Splitting of the Data

In this phase, the dataset is divided into two distinct groups: the training set and the testing set[13]. The training set constitutes 80% of the data, while the remaining 20% is allocated to the testing set. Each batch within the training set comprises a combination of masked and unmasked images. The purpose of this division is to train the model on a substantial amount of labeled data while reserving a portion for evaluating its performance and generalization ability. By employing a well-defined split, the model can learn from the training set and subsequently be assessed on unseen data.

3.2.4 Construction of the Model

The construction of the Face Mask Recogniser Model involves multiple stages. Firstly, a training image generator is established to perform data augmentation, augmenting the training dataset with additional variations of the existing images. This technique enhances the model's ability to generalize and handle different scenarios. The foundational model is built using the MobileNet V2 feature extractor, which provides a powerful base for extracting relevant features from the input images. Model parameters, such as Rectified Linear Unit (ReLU) activation, Softmax activation, and Average Pooling 2D, are added to further enhance the model's capabilities. After the construction, the model is compiled, specifying the loss function, optimizer, and evaluation metrics. Subsequently, the model is trained using the preprocessed training data. Finally, the trained model is saved, allowing for future predictions and usage in real-world scenarios.

Chapter 4

Datasets

4.1 Introduction

The dataset used for training and testing the Face Mask Detection System built using ML tools like OpenCV, TensorFlow, and MobileNetV2 is a carefully curated collection of 3,900 images. Derived from a publicly available dataset on Kaggle, it comprises 1,800 images of individuals wearing face masks and an equal number of images without masks. The dataset captures diverse scenarios, featuring individuals of different ages, genders, and ethnicities, in various indoor and outdoor environments. Augmentation techniques were applied to enhance the dataset's diversity, ensuring the system's ability to generalize and accurately detect face masks in real-time scenarios The dataset employed in this project consists of a total of 3,900 images, sourced from a publicly available dataset on Kaggle[14, 15]. The dataset comprises 1,800 images of individuals wearing face masks and an equal number of images depicting individuals without masks. These images were manually collected and labeled to ensure the accuracy and relevance of the dataset.

4.2 Classified data into masked and unmasked

The dataset includes a diverse range of individuals of different ages, genders, and ethnicities, capturing various real-life scenarios where face masks may be worn or not. The images were captured in different environments, including indoor and outdoor settings, to simulate different practical scenarios for training and testing the Face Mask Detection System.

The images are in various formats (e.g., JPEG, PNG) and resolutions, ensuring a realistic representation of real-world conditions. The dataset was carefully curated to

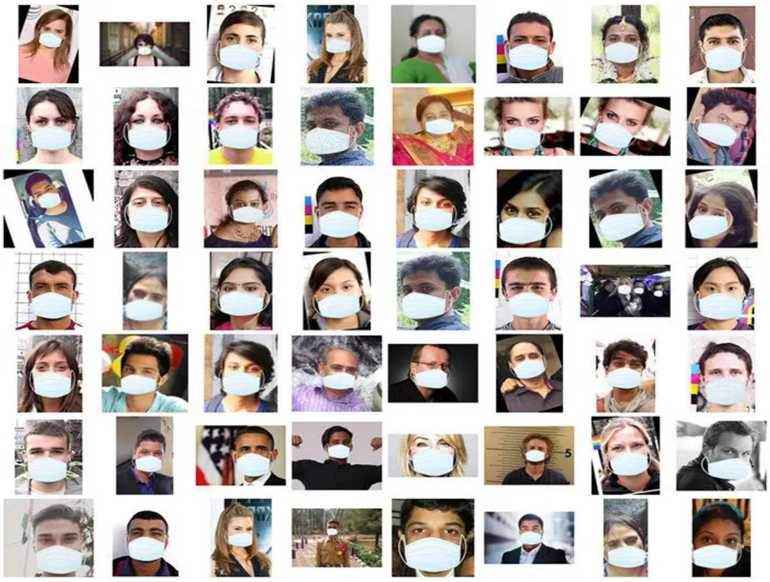

Figure 4.1: Dataset comprising of masked faces

ensure a balanced distribution of images with and without face masks, allowing the machine learning model to learn effectively and make accurate predictions.

Data augmentation techniques, such as rotation, scaling, and flipping, were applied to the dataset to enhance its diversity and reduce over-fitting. This augmentation process helped to improve the generalization capabilities of the Face Mask Detection System, allowing it to perform well on unseen images. The dataset was split into training and

Figure 4.2: Dataset comprising of unmasked faces

testing sets, with a 70:30 ratio. The training set, consisting of 2,730 images, was used to train the ML model, while the remaining 1,170 images were reserved for testing and evaluating the system's performance.

Chapter 5

Results and Discussion

5.1 Results in terms of accuracy value

For the process of face detection, Blob Analysis is used on the acquired image dataset to analyse each face shapes, features; which in- cludes area, length, locations and position of features. These features are extracted and passed to the Face-Net model. It uses deep convolution neural networks(CNN) to train these features to obtain Face detection. It will be the respective object of interest or region of interest in the image. Thus the face will be recognised in the format of a rectangular box known as a bounding box. Finally, the created function will return the corresponding feature positions of Detected Faces such as locations, predictions by implementing blob analysis. The last part of the model is implementation

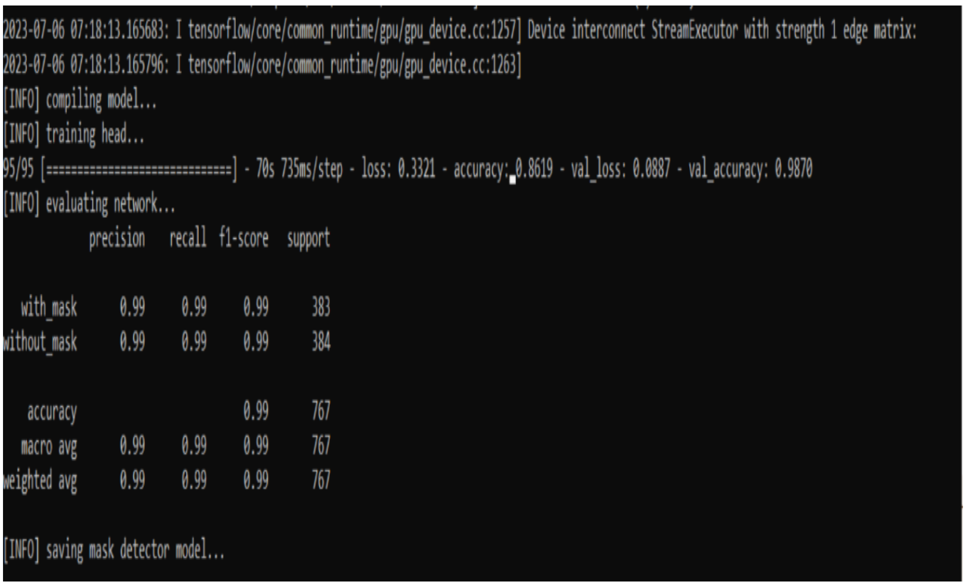

Figure 5.1: Accuracy score along with the f1-score

in real time, which is about loading the previously trained Classification model from the disk and deploying it to give real time face mask detection. Model is employed on live video streams via WebCam. These video streams are made up of frames, that's why the video will be read from frame to frame, then Face Mask Recognition Algorithm performs in a way that face detection is applied on each frame of the video. It goes to the next process only if face is detected, and from the batches of frames contain- ing detected faces, re-preprocessing will be carried out using classifier when a person Identifies the not

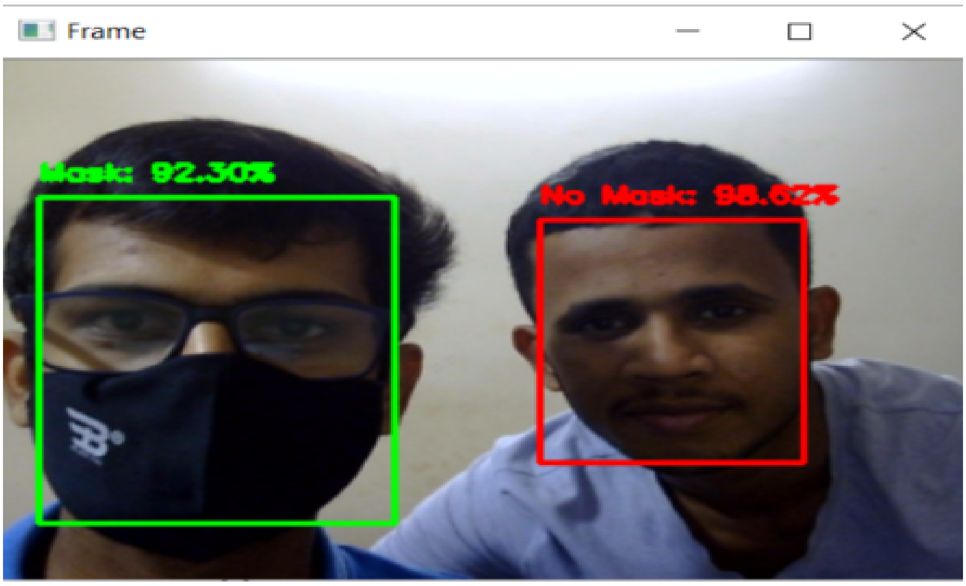

Figure 5.2: Result from live-streaming camera

wearing Mask And those details not in the database it try's Match faces in the database. A bounding box drawn over the face of the person describes weather the person is wearing a mask.

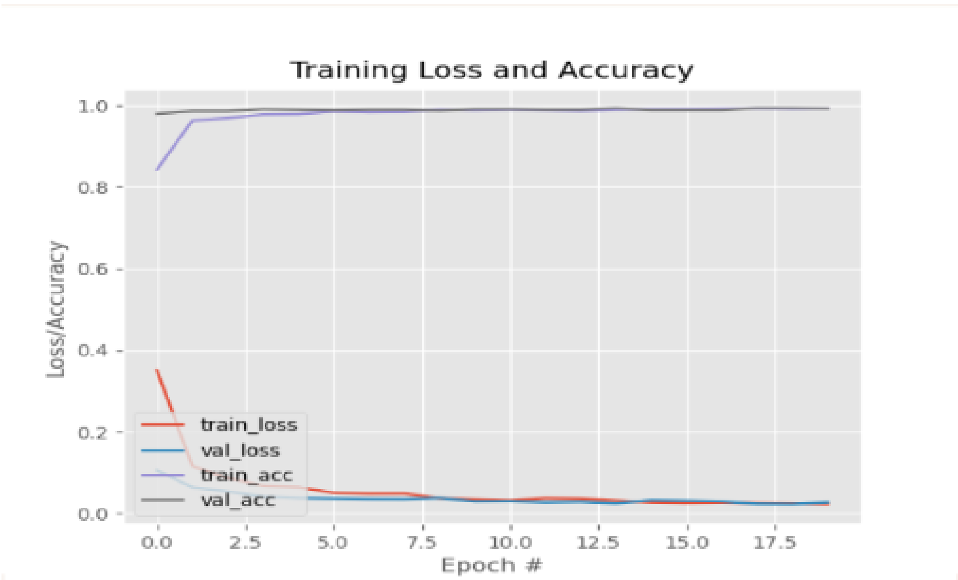

Figure 5.3: Accuracy value Vs Epoch plot

5.2 Discussions

To confirm that the model is predicting effectively, the testing of the model comprises specific procedures. The first process is to make predictions upon the testing data set. Upon defined iterations, loss and accuracy are noted down while training the model. The results in train- ing this model show that accuracy keeps on increasing while loss keeps on decreasing. At some point, where there is stable accuracy then there is no need for more iterations.
Next step is utilising the below mentioned performance metrics to analyse the overall performance of the MobileNetV2 model:

$$Precision = \frac{TruePositives}{TruePositives + FalsePositives} \tag{5.1}$$

$$Recall = \frac{TruePositives}{TruePositives + FalseNegative} \tag{5.2}$$

$$F1{-}score = 2 \times \frac{Precision \times Recall}{Precision + Recall} \tag{5.3}$$

In this study, it is about handling the classification of facial features of people who are wearing masks or not. In the above formula, the met rics parameters are defined as follows:

1. Precision as in equation 5.1 estimates relevant data points such as faces that the model correctly identifies.

2. Recall as in equation 5.2 enables measure of the classifier model correctly identifying the True Positives.

3. F1-Score as in equation 5.3 provides a better measure of the balanced Precision and Recall.

• True positives constitute those numbers of facial features of individuals which were properly recognised as being a part of that particular category of class.

• True Negative means the total number of facial features of individuals which were properly recognised as not being the part of that particular category of class.

• False positive speaks for those sets of facial features of individuals, which are not part of that respective category of class but were falsely identified as being a part of that wrong class set.

Chapter 6

Conclusion and Future work

In conclusion, the development of a face mask detection system using machine learning is an important step towards ensuring public safety and compliance with face mask usage during the COVID-19 pandemic. By leveraging machine learning algorithms, the system can effectively identify whether individuals are wearing face masks in real-time.

The current implementation of the face mask detection system demonstrates the potential of machine learning in automating the detection process. It offers a reliable and efficient means of monitoring face mask compliance, thereby reducing the need for manual inspections and enhancing overall safety measures.

However, there is still room for future work and improvements in this field. Some potential areas for future development include:

1. **Dataset Expansion** : Collecting a diverse and extensive dataset of face mask images to train the model further. This will enhance the system's ability to detect various types of face masks, different facial expressions, and different lighting conditions.

2. **Performance Optimization** : Improving the efficiency and speed of the face mask detection system to ensure real-time processing, especially when dealing with large-scale applications or high-resolution video streams.

3. **Edge Device Deployment** : Optimizing the model to run on edge devices (e.g., smartphones, cameras) for on-device face mask detection, reducing the dependency on cloud-based processing and improving privacy.

4. **Adapting to New Norms** : Updating the system to adapt to changing guidelines and regulations regarding face masks, such as detecting the proper usage of masks (e.g., covering both nose and mouth) or identifying other types of personal protective equipment (PPE).

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