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An Enhanced and Reliable Face Mask Detection Using Deep Learning and OpenCV Python

[1] *M. Tech., Dept of CSE, Sri vasavi institute of engineering and technology. AP, India,* thotaammulu1998@gmail.com
[2]*M. Tech., Dept of CSE, Sri vasavi institute of engineering and technology. AP, India,* ahmed.cse2016@gmail.com

Abstract:- **In the background of the COVID-19 pandemic, institutions such as the academy suffer a great deal from practically closed globally if the current situation is not going to change. COVID-19 also known as Serious Acute Respiratory Syndrome Corona virus-2 is an infectious disease that is released from an infected sick person who speaks, sneezes, or coughs by respiratory droplets. This spreads quickly through close contact with anyone infected, or by touching objects or surfaces affected with a virus. There's still currently no vaccine available to protect against COVID-19 and preventing exposure to the virus seems to be the only method to safeguard ourselves. Wearing a facemask that covers the nose and mouth in a public setting and often washing hands or the use of at least 70% alcohol-based sanitizers is one way to avoid being exposed to the virus. Amid the advancement of technology, Deep Learning has proven its effectiveness in recognition and classification through image processing. The research study uses deep learning techniques in distinguishing facial recognition and recognize if the person is wearing a facemask or not. The dataset collected contains 25,000 images using 224x224 pixel resolution and achieved an accuracy rate of 96% as to the performance of the trained model. This study is beneficial in combating the spread of the virus and avoiding contact with the virus.**

Keywords-Deep Learning, Neural Network, OpenCV python, object detection yolov3

I. INTRODUCTION:-

According to the World Health Organization (WHO)'s official Situation Report – 205, corona virus disease 2019 (COVID-19) has globally infected over 20 million people causing over 0.7million deaths. Individuals with COVID 19 have had a wide scope of symptoms reported – going from mellow manifestations to serious illness. Respiratory problems like shortness of breath or difficulty in breathing is one of them. Elder people having lung disease can possess serious complications from COVID-19 illness as they appear to be at higher risk. Some common human corona viruses that infect public around the world are 229E, HKU1, OC43, and NL63. Before debilitating individuals, viruses like 2019-nCoV, SARS-CoV, and MERS-CoV infect animals and evolve to human corona viruses. Persons having respiratory problems can expose anyone (who is in close contact with them) to infective beads. Surroundings of a tainted individual can cause contact transmission as droplets carrying virus may withal arrive on his adjacent surfaces. To curb certain respiratory viral ailments, including COVID-19, wearing a clinical mask is very necessary. The public should be aware of whether to put on the maskfor source control or aversion of COVID-19. Potential points of interest of the utilization of masks lie in reducing vulnerability of risk from a noxious individual during the "pre-symptomatic" period and stigmatization of discrete persons putting on masks to restraint the spread of virus. WHO stresses on prioritizing medical masks and respirators for health care assistants. Therefore, face mask detection has become a crucial task in present global society. Face mask detection involves in detecting the location of the face and then determining whether it has a mask on it or not. The issue is proximately cognate to general object detection to detect the classes of

objects. Face identification categorically deals with distinguishing a specific group of entities i.e. Face. It has numerous applications, such as autonomous driving, education, surveillance, and so on This paper presents a simplified approach to serve the above purpose using the basic Machine Learning (ML) packages such as TensorFlow, Keras, OpenCV and Scikit-Learn.

1.1 Importance of Face Recognition

Face Mask Recognition generally measures the unique patterns of a person's face by comparing and analysing facial contours. It is not only used in security and law enforcement but also used as a way to authenticate identity and unlock devices like smart phones and laptops. Now-a-days, we are observing many smart phones and laptops having a Face Mask Recognition system to unlock the device.

1.2 Problem Definition

Face Mask Recognition is one of the most widely used feature in many fields. It is used in providing security to data, Fraud detection of Passports and Visas, Track attendance, detecting the criminals etc.

Face Mask Recognition system is being used by some organization to track the attendance of the employees. The system collects and records the facial fine points of the employees in the database. Once the process is done, the employee only needs to look at the camera and the attendance is automatically marked in the Face Mask Recognition attendance system.

The project develops a novel CNN model which is used for Face recognition. The face that is detected and recognized using this CNN model will be provided the attendance based on the time at which the person faces the camera.

1.3 Objective

The main objective of the project is to build a custom CNN model that can recognize the faces and post the appropriate attendance into the database for the designated periods based on the timings of the college hours.

II. Related Work: -

The existing system for Face Mask Recognition uses some built-in datasets and some built-in architectures. Even though some custom data sets have been prepared and used they have been using the architectural models that have been already present. Some of the models that have been used in the existing systems are:

- Local Binary Histogram Pattern (LBHP)
- Fischer Face Recognition
- Eigen Face Recognition

1. Local Binary Histogram Pattern (LBHP)

In the LBHP approach for texture classification, the occurrences of the LBHP codes in an image are collected into a histogram. The classification is then performed by computing imple histogram similarities. However, considering a similar approach for facial image representation results in a loss of spatial information and therefore one should codify the texture information while retaining also their locations. One way to achieve this goal is to use the LBHP texture descriptors to build several local descriptions of the face and combine them into a global

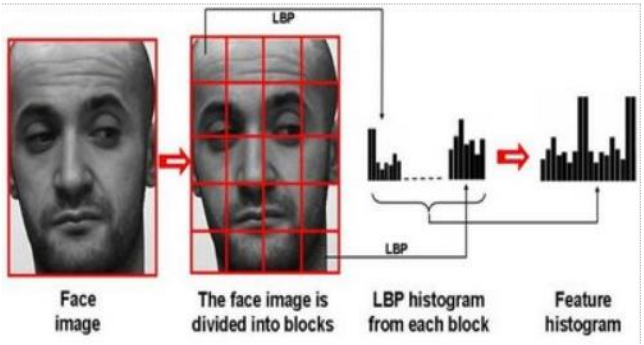


Figure 2.1: Face Description with Local Binary Patterns

description

The facial image is divided into local regions and LBHP texture descriptors are extracted from each region independently. The descriptors are then concatenated to form a global description of the face, as shown in Fig. 2.1

This histogram effectively has a description of the face on three different levels of locality: the LBHP labels for the histogram contain information about the patterns on a

pixel- level, the labels are summed over a small region to produce information ona regional level and the regional histograms are concatenated to build a global description of the face.

2. Fischer Face Recognition

The input generally given to a Face Mask Recognition system is always an image or video stream and the output is an identification of the subject or subjects that appear in the image or video. Fisher Face is one of the popular algorithms used in face recognition, and is widely believed to be superior to other techniques, such as Eigen face because of the effort to maximize the separation between classes in the training process. Image recognition using Fisher Face method is based on the reduction of face space dimension using Principal Component Analysis (PCA) method, then apply Fisher's Linear Discriminate (FLD) method or also known as Linear Discriminate Analysis (LDA) method to obtain feature of image characteristic.

The Fischer Face method learns a class-specific transformation matrix, so they do not capture illumination as obviously as the Eigen faces method. The Discriminate Analysis instead finds the facial features to discriminate between the persons. The Fischer Face is especially useful when facial images have large variations in illumination and facial expressions. The example of Fischer face representation is illustrated in Figure

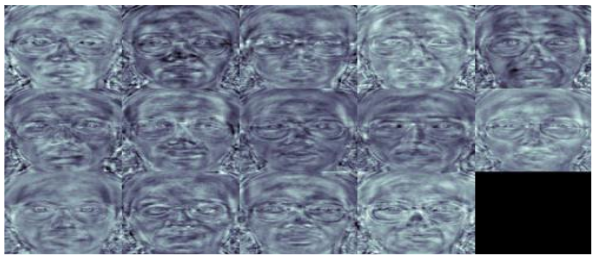


Figure Fischer Faces

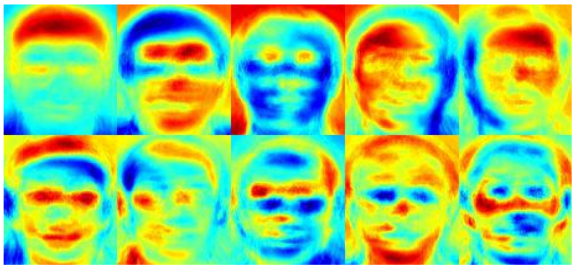


Figure Eigen Faces

3. Eigen Face Recognition

An Eigen face is the name given to a set of eigen vectors when used in computer vision problem of human face recognition. The eigenvectors are derived from the covariance matrix of the probability distribution over the high-dimensional vector space of face images. The eigenfaces themselves form a basis set of all images used to construct the covariance matrix. This produces dimension reduction by allowing the smaller set of basis images to represent the original training images. Classification can be achieved by comparing how faces are represented by the basis set.

A set of eigenfaces can be generated by performing a mathematical process called Principal Component Analysis (PCA) on a large set of images depicting different human faces. Informally, Eigen faces can be considered a set of "standardized face ingredients", derived from statistical analysis of many pictures of faces. Any human face can be considered to be a combination of these standard faces. For example, one's face might be composed of the average face plus 10% from eigen face 1, 55% from eigen face 2, and even −3% from eigen face 3. Remarkably, it does not take many eigen faces combined together to achieve a fair approximation of most faces. The example of Fischer face representation is illustrated in Figure.

Proposed System

The project proposes a pipeline to build a Deep Learning model for Face Mask Recognition which is motivated by the state-of-the-art architectures in Computer Vision. The contributions of the project are:

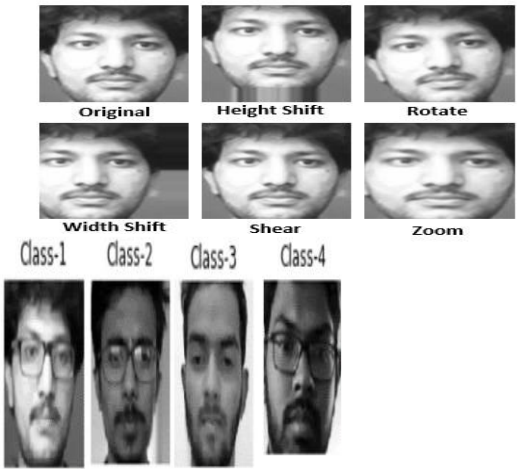
- Develops a novel Deep Learning model to detect and recognize the human faces.
- Develops a web application to post the attendance using the novel Deep Learning model developed.
- The process flow to develop a new face dataset is proposed which is fatherly used to train the Deep Learning model.

The result of the project will be the provision of attendance for the corresponding period after recognising the face based on the time at which the person's face has been captured.

II. Related Work:-

The data for Deep Learning is a key input to model that comprehends from such data and learns the features for future prediction. Although, various aspects come during the deep learning model development, without which various crucial tasks cannot be accomplished.In other words, data is a backbone of entiremodel development without that it is not possible to train a machine that learns from humans and predict for humans.

So, the project also focuses on the creating the data set of human faces for face recognition. The data is collected through an automated program which takes the faces of the humans, stores and transforms into a dataset. The dataset



contains the human faces at different *lighting conditions* and *angles*.

The Figure illustrates the process flow of the data collection as follows:

- Identify the location of face in the video frame.
- Extract the face image and convert into gray scale image.
- Attach the label w.r.t to the class of the image and write into a csv file.

The Figure illustrates the samples of the data based on the classes.

Data Augmentation

Data Augmentation is a strategy that enables practitioners to significantly increase the diversity of data available for training models, without actually collecting huge data. It can be done by using techniques such as cropping, padding, and horizontal flipping are commonly used to train large neural networks. In order to achieve high accuracy, large volume of training data is required. Hence, data augmentation technique is used to generate new samples by manipulating the existing data. In the current work, synthetic images are being generated randomly, by applying the following operations:

- Zoom
- Shear
- Height shift
- Rotation
- Width shift

The Figure illustrates the samples of the data before and after using data augmentation.

5.2 Data Visualization and Analysis

Data visualization is a technique that uses an array of static and interactive visuals within a specific context to help people understand and make sense of large amounts of data. The data is often displayed in a story format that visualizes patterns, trends and correlations that may otherwise go unnoticed. It is often helps to understand the patterns in the data. Principal Component Analysis (PCA) is used in order to visualise the data in different forms. Here are some of the different visualisations to understand the data.

Pair plot is used to understand the best set of features to explain a relationship between two variables or to form the most separated clusters. It also helps to form some simple classification models by drawing some simple lines or make linear separation in our dataset.

III. Literature Survey:-

Corona virus disease 2019 (covid-19): situation report, 205
AUTHORS:-WHO
The members of the Diagnostic Consortium - WHO, UNICEF, United Nations Development Programme (UNDP), the Global Fund, the Global Drug Facility and other partners have procured and shipped:18 million polymerase chain reaction (PCR) tests to 83 countries, and 4 million sample collection kits to 78 countries. The considerable demand for automated tests (Abbott, Cepheid, Roche) has exceeded available supplies. Much of this demand will need to be filled by manual PCR tests. Consortium members are continuing to work to secure volumes for automated tests for the period September through to December 2020. As per the Essential Supplies Forecasting Tool, the total need for the next 12 weeks is estimated at 22.7 million tests. The Consortium is currently finalizing product selection criteria and will soon be adding additional PCR tests to the Supply Chain catalogue. This should provide countries with more flexibility and choices for procurement.

Corona virus Disease 2019 (COVID-19) – Symptoms"
Centers for Disease Control and Prevention, 2020
Influenza (Flu) and COVID-19 are both contagious respiratory illnesses, but they are caused by different viruses. COVID-19 is caused by infection with a new corona virus (called SARS-CoV-2), and flu is caused by infection with influenza viruses. COVID-19 seems to spread more easily than flu and causes more serious illnesses in some people. It can also take longer before people show symptoms and people can be contagious for longer. More information about differences between flu and COVID-19 is available in the different sections below. Because some of the symptoms of flu and COVID-19 are similar, it may be hard to tell the difference between them based on symptoms alone, and testing may be needed to help confirm a diagnosis. While more is learned every day about COVID-19 and the virus that causes it, there is still a lot that is unknown . This page compares COVID-19 and flu, given the best available information to date.

V. Conclusion:-

In this paper, we briefly explained the motivation of the work at first. Then, we illustrated the learning and performance task of the model. Using basic ML tools and simplified techniques the method has achieved reasonably high accuracy. It can be used for a variety of applications. Wearing a mask may be obligatory in the near future, considering the Covid-19 crisis. Many public service providers will ask the customers to wear masks correctly to avail of their services. The deployed model will contribute immensely to the public health care system. In future it can be extended to detect if a person is wearing the mask properly or not. The model can be further improved to detect if the mask is virus prone or not i.e. the type of the mask is surgical, N95 or not.

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Thota chandrakala is a student of Sri Vasavi Institute of Engineering & Technology, Nandamuru.she is a student of M.tech[CSE] and also received B.tech degree from JNTUK.

Mohammed Ahmed is a Assistant professor in Sri Vasavi Institute of Engineering & Technology, Nandamuru.He Received Master Degrees from different Universities and also Having 13 years of Experience as a faculty and Guide for Different Domain

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