Face Identification Under Mask

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Abstract

Consistently, studies have demonstrated that masking facial traits might make identification more difficult. The COVID-19 pandemic's widespread use of face masks has brought to light the urgent need to develop methods for better identifying those who are wearing masks. There are presently no scientific proof suggestions for lineup creation for cases involving masked people despite years of research on face recognition and eyewitness identifications. This project provides a method for identifying people's faces when they are wearing masks. The proposed approach is based on the FaceNet framework and works to improve the performance of both scenarios with and without the use of a mask by altering the face recognition model currently in use. Additionally, feature heatmaps are created to display the bulk of facial image components that are important for identifying faces when wearing masks.

Introduction

The COVID-19 epidemic has had a significant impact on our daily lives, disrupting global trade and travel. It has become commonplace to use a face mask for protection. Many public entities will eventually need people to wear masks in order to use their services properly. Face mask identification is now a vital task to assist the civilized world. Nowadays wearing a face mask is a routine chore for humans. So, we may not be able to clearly identify the people who are known to us in a face mask[4].

In numerous applications, including security systems, credit card verification, criminal identification, etc., face recognition has grown in importance. Even merely detecting faces, as opposed to being able to identify them, can be crucial[8].Although it is obvious that individuals are skilled at recognizing faces, it is not at all clear how a human brain encodes or decodes faces. For more than 20 years, researchers have investigated how to recognize human faces. Due to the complexity and multidimensionality of faces as visual inputs, it is challenging to develop a computational model for face recognition. Face recognition is an extremely complex computer vision problem that might incorporate numerous primitive vision techniques. Extraction of the pertinent elements from facial photos is the first stage in face identification.

Wearing a mask lowers the chance of infection from an infected individual, regardless of whether they show symptoms, in the medical industry. Face mask detection is employed in a variety of settings, including airports, medical facilities, businesses, and educational facilities. Face recognition without a mask is simpler, but face recognition with a mask alone is more difficult since masking makes it more difficult to extract facial features than it would be otherwise. The portion of face covered in mask hides the chin, lips, and nose, among other facial features.The reason for why a masked lineup, as opposed to an unmasked lineup, might boost the identification accuracy of a masked perpetrator is provided by the holistic theory of face recognition.

Many facial recognition techniques have been implemented for regular identification of a human. This project's primary objective is to verify the person's identity when they are wearing a mask. The fundamental concept is to use a camera to identify persons' faces and compare with the trained image. To avoid any unidentified/unauthorized access in an organization, this project may be helpful in restricting access by verifying the person's identity by comparing the person's face with & without a mask.

Related Work

Although face recognition and detection technology are extensively utilized nowadays, it is still considered to be extremely important in everyday life, particularly in terms of individual safety and security. The accuracy and the rate at which the results were discovered were not the same, despite the fact that this has been in use for decades[14]. For facial recognition, a variety of methods have been proposed. The benefits and drawbacks of each are different. Conventional face detection and recognition algorithms are one of these techniques which rely greatly on facial detection and recognition.

In the face detection approach, a face is found in an image that has a different set of attributes. The paper[11] proposes that face detection research requires posture estimation, face tracking, and expression recognition. The task is to recognize the face from the image when only one image is provided. Face identification is challenging since faces are not immutable and can change in size, shape, colour, and other ways. For an opaque image hindered by something else not facing the camera, etc., it becomes a difficult task.

There are two fundamental approaches to facial recognition. The first approach relies on deformable templates and complex mathematics to extract feature vectors from the fundamental facial features, including the eyes, nose, mouth, and chin. Then, important data from the fundamental components of the face is acquired and transformed into a feature vector. Deformable templates were utilized by Yullie and Cohen[15] to extract the contours of facial images.

These issues, according to the authors of this work[12], include the lack of sizably large datasets comprising both masked and unmasked faces, as well as the absence of facial expression in the masked region. Several lost expressions can be recovered and the dominance of facial cues can be greatly reduced using the locally linear embedding (LLE) approach.

The paper[8] proposed an unsupervised pattern recognition method that is independent of excessive geometry and computation. The implementation of a recognition system uses eigenface, PCA, and ANN. The information theory technique is the foundation of principal component analysis for face recognition, which extracts the pertinent data from a facial image as effectively as feasible.

The research[13] argues that the size of the input image is a rigid limitation for convolutional neural networks (CNNs) in computer vision. To get around the inhibition, the common approach is to reorganize the images before fitting them into the network.

Approach

In this research, we put out a technique for verifying human identity by comparing the images of the person when they are with & without a mask. Here, we're utilizing computer vision, a branch of deep learning, to read and write data from the camera.

The AI techniques going to be used are Computer Vision, Image Processing and Neural Networks. We make use of computer vision for gathering, manipulating, analyzing, and comprehending digital images as well as extracting high-dimensional data from the real world to create information that may be expressed as numbers or symbols, such as judgments. In this context, the conversion of visual images into descriptions of the outside world that make sense to cognitive processes and can prompt appropriate behavior. By applying models created with the aid of geometry, physics, statistics, and learning theory, this image understanding can be thought of as the separation of symbolic information from visual data.

To process the visual image to an enhanced version, Image Processing technique is used, where each type of data must go through three general stages: pre-processing, improvement, and display, as well as knowledge extraction.

To comprehend this, deep learning makes use of neural networks. Designing for neural networks concentrates on how the human brain is organized. While humans utilize our brains to look for patterns and distinguish different sorts of data, neural networks are also trained to carry out a similar task on data.

In the initial phase of the project we implement the code consisting of facial recognition techniques, i.e,. human face recognition and face mask detection. To implement face recognition we make use of Computer Vision and Image processing techniques. We use the modules OpenCV, Haar Cascade Classifier and Support Vector Classifier for the object detection and recognition. As mentioned, in this phase, a set of stages are implemented to determine whether the person is wearing a face mask or not.

As previously mentioned, we first imported all the necessary libraries, after that using the function known as harcascade classifier, we trained the data using a harcascade xml file. This 'XML' file contains a pre-trained model that was created using the Adaboost algorithm. We developed a user-defined function called 'filtered loop' to display a rectangle over the recognized face in the provided video frame and resize every frame to the industry-standard 50*50 size. Presently, we train the data without wearing a mask and record all of the picture data in a npy file called nomask.npy. We then repeat these steps while wearing a mask and store the results in mask.npy. The data in the files will be converted to 2D images using the reshape function before we portray the image and load it from the files. Using the trained data, a greyscale image is displayed using the matplotlib image show function.

```
&lt;matplotlib.image.AxesImage at 0x7f9ea8047c70&gt;
```

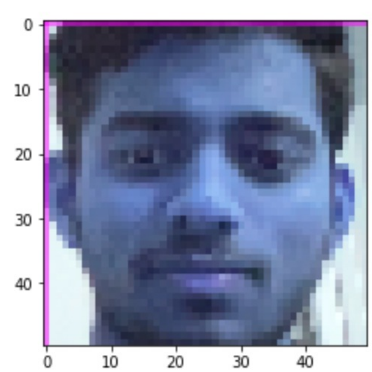

Figure 1: Grey Scale image with no mask.

<matplotlib.image.AxesImage at 0x7fc540311520>

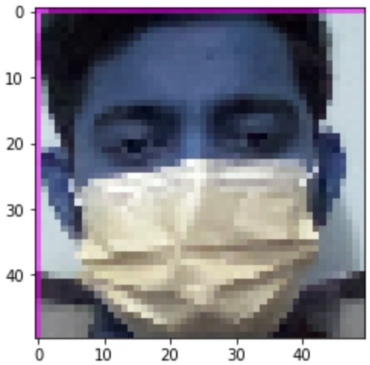

Figure 2: Grey Scale image with mask.

After completing the conversion of the data from the user-defined function, we will concatenate the converted data using the “numpy.r_” function. Therefore, we utilize a machine learning technique called support vector machine, and within the module svm, a module called support vector classifier, to assess whether or not the individual in the photos or in the video is wearing a mask. Using a predetermined function, the data is divided into training and testing sets before being loaded into the linear support vector classifier from Sklearn. We used a test size of 0.25 to avoid overfitting. Principal component analysis is used to decrease the linear dimensionsity. Finally, we develop a user-defined function called ”adjustframe” to resize the frames in the video to the conventional 50*50 size. To obtain the accuracy, we utilize the built-in function “accuracy_score”, which is a built-in function in sklearn.metrics. Then, we developed a module to determine whether or not the person in front of the camera is wearing a mask.

In the second phase of implementation, we implement the code that identifies the person wearing masks and compares the image with the existing images that are captured during the training. We use these existing images to train the system that identifies the features, which maps and compares them with live webcam photos to verify the person.

For this phase, we initially created a user-defined function for loading the designated images from the respective directory and then the loaded images were resized using the ”adjustframe” user-defined function. After resizing the image to standard size, it is encoded using the ”face_recognition” function. Inorder to store the encoded values which are obtained through a user-defined function ”encode”. In the encode function we will compare the face encodings and store the results in a list.

Later, to verify the person’s identity in the live video capturing, we initialize the variables to store the masked data and person’s name. Then, the captured live frames are encoded and given as input to the ”encode” function. Then, to display the desired result in the output screen we make use of a user-defined function called ”result”, where a rectangle is prompted on the person’s face and the expected output is shown.

Results

Verifying Person’s Identity in Different Situations

Person Identification with mask The results below indicate that the person’s identity is verified when they are wearing a mask.

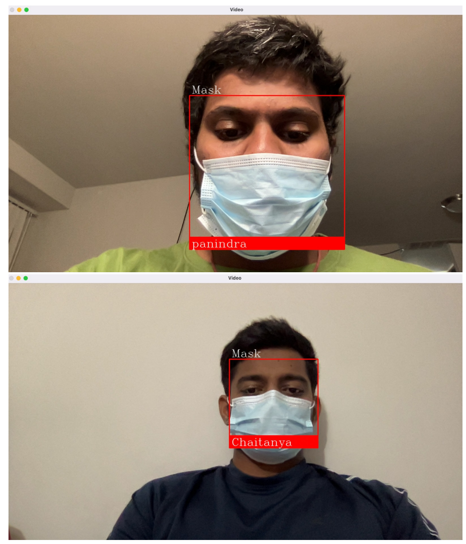

Figure 3: Person Identification with the mask.

Person Identification with no mask The results below indicate that the person’s identity is verified when they are not wearing a mask.

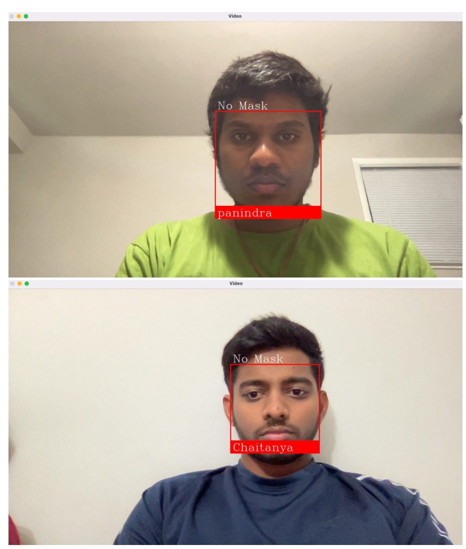

Figure 4: Person Identification with no mask.

Unknown Person Identification with & without mask
The results below shows that the unknown person's identity is verified when they are with & without a mask.

Figure 5: Unknown Person Identification with no mask.

Figure 6: Unknown Person Identification with mask.

Conclusion

In this project, we designed a software program that should be able to recognize a person in the scenario of wearing a mask. We applied a Face Encoding technique, which records certain significant facial measurements. In order to categorize the photos and determine the average of the squares of the errors we applied Mean Squared Error, we employed the Minimal Squared Error Classification (MSEC), a widely used technique to classify images. We used pictures of our teammates for the dataset. In the first phase of the training, we will train the program without any mask in the bright light, in the second phase we will train the software by wearing a mask-on under bright light focussing the face of the person, and it will output the results (name of the person and whether the person is masked or unmasked) accurately regardless of the different colours and patterns of the mask you are wearing.
While executing the software without wearing the mask, our program's accuracy is 94%, but when it is executed with mask a on it reduced to 79%. The person must be in a bright light, though, which is the only restriction or requirement for using the suggested model. The model can be further enhanced to recognize the individual even in low light and to categorize the kind of mask he is donning.

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