Face Mask Detection System

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Abstract - The COVID-19 pandemic is taking a toll on the lives of people. The World Health Organization (WHO) has proposed wearing a face mask in public areas as an effective protection method. This deadly pandemic has forced governments from across the world to impose a lockdown to prevent virus transmissions. Reports indicate that wearing facemasks while at work evidently reduces the risk of transmission. After this pandemic has flared up, many preventive measures made use of Deep Learning to develop our face detector model. The architecture used for the object detection purpose is Single Shot Detector (SSD) because of its good performance accuracy and high speed. Together, we have used basic concepts of Transfer Learning in neural networks to finally output the presence or absence of a face mask in an image or a video stream. Experimental results show that our model performs well on the test data with 100% and 99% precision and recall, respectively.

I . INTRODUCTION

Motivation - Covid-19 is a World-Wide pandemic. Various guidelines have been adopted for protection against the spread of coronavirus. In the current situation, there are no efficient face mask detection applications that are now in high demand for transportation means, densely populated areas, residential districts, large-scale manufacturers, and other enterprises to ensure safety.

Scope - Covering our faces with a mask has become a new normal amidst the pandemic, as face masks are effective in preventing the virus outbreak. Many developed and underdeveloped nations worldwide have made it compulsory for people to wear masks if leaving home or visiting public places. Other precautionary measures are also advocated by the government to maintain safety and hygiene, apart from shielding faces. On the other hand, it will be challenging to recognize faces with masks on any monitoring systems, while maintaining touch-less access control in buildings. Covering faces with masks has posed a challenge for face detection algorithms and performance.

Objective - This report aims to help the developer understand each building block thoroughly with the description of each component as well as code documentation. The rest of the report is organized as follows. In Section 2, we will go through the literature review and related work. In Section 3, the methodology of our proposed solution is discussed in detail. In Section 4, the model is evaluated and results are discussed. Section 5 discuss limitations and future work and finally, with Section 6, the report is concluded.

Project Introduction - The year 2020 has shown mankind some mind-boggling series of events amongst which the COVID19 pandemic is the most life-changing event which the very basic hygiene standards to the treatments in the hospitals, people are doing all they can for their own and society's safety; face masks are one of the personal protective equipment. People wear face masks once they step out of their homes and authorities strictly ensure that people are wearing face masks while they are in groups and public places. To monitor that people are following this basic safety principle, a strategy should be developed. A face mask detector system can be implemented to check this. Face mask detection means identifying whether a person is wearing a mask or not. The first step to recognize the presence of a mask on the face is to detect the face, which makes the strategy divided into two parts: to detect faces and to detect masks on those faces.

Face detection is one of the applications of object detection and can be used in many areas like security, biometrics, law enforcement, and more. There are many detector systems developed around the world and being implemented. However, all this science needs optimization; a better, more precise detector, because the world cannot afford any more increase in corona cases. 1 In this project, we will be developing a face mask detector that is able to distinguish between faces with masks and faces with no masks. In this report, we have proposed a detector that employs SSD for face detection and a neural network to detect the presence of a face mask. The implementation of the algorithm is on images, videos, and live video streams.

Face recognition is a simple way to identify faces, including facial features through technology, especially hardware, like video cameras. The face recognition app or software uses biometrics to map the facial features from any image or video, by comparing it with a database of known faces. Government initiatives and increasing demand for surveillance systems to enhance security will increase facial recognition software adoption. So, this is about facial recognition without masks!. Amid the global crisis, new demand has emerged in the market, and that is of face mask detection. It is one such technology capable of detecting a face with a mask and verifying that person's identity. It incorporates a deep learning-based recognition system that uses biometric data of individuals. It extracts facial features and classifies them into different categories. Besides, it can also identify people without masks by generating an alarm or notification to notify security or officials. They can see who has not covered faces with masks through software, mobile app, device, or a website.

Deep Learning - Deep learning methods aim at learning feature hierarchies with features from higher levels of the hierarchy formed by the composition of lower-level features. Automatically learning features at multiple levels of abstraction allow the system to learn complex functions mapping the input to the output directly from data, without depending completely on human crafted features. Deep learning algorithms seek to exploit the unknown structure in the input distribution in order to discover good representations, often at multiple levels, with higher-level learned features defined in terms of lower-level features and forms.

Ⅱ. LITERATURE REVIEW

Object detection is one of the trending topics in the field of image processing and computer vision. Ranging from small-scale personal applications to large-scale industrial applications, object detection, and recognition are employed in a wide range of industries. Some examples include image retrieval, security and intelligence, OCR, medical imaging, and agricultural monitoring. In object detection, an image is read and one or more objects in that image are categorized. The location of those objects is also specified by a boundary called the bounding box. Traditionally, researchers used pattern recognition to predict faces based on prior face models. A breakthrough face detection technology then was developed named as Viola-Jones detector that was an optimized technique of using Haar [1], digital image features used in object recognition. However, it failed because it did not perform well on faces in dark areas and non-frontal faces. Since then, researchers are eager to develop new algorithms based on deep learning to improve the models. Deep learning allows us to learn features in an end-to-end manner and removing the need to use prior knowledge for forming feature extractors. There are various methods of object detection based on deep learning which are divided into two categories: one-stage and two-stage object detectors. 12 Figure 2.1: Bounding boxes in an image. Two-stage detectors use two neural networks to detect objects, for instance, region-based convolutional neural networks (R-CNN) and Faster R-CNN. The first neural network is used to generate region proposals and the second one refines these region proposals; performing a coarse-to-fine detection. This strategy results in high detection performance compromising on speed. R-CNN uses selective search to propose some candidate regions which may contain objects. After that, the proposals are fed into a CNN model to extract features, and a support vector machine (SVM) is used to recognize classes of objects. However, the second stage of R-CNN is computationally expensive since the network has to detect proposals in a one-by-one manner and uses a separate SVM for final classification. Fast R-CNN solves this problem by introducing a region of interest (ROI) pooling layer to input all proposal regions at once. Faster RCNN is the evolution of R-CNN and Fast R-CNN, and as the name implies its training and testing speed is greater than those of its predecessors.

Methodology - We strive and designed a programmed slick structure for eliminating the persons who are not wearing a face mask. This is an improved version of a normal mask detector. Under the bright center, capital, and town almost all public places are supervised by IP/CCTV cameras. These existing IP cameras including CCTV cameras are used to catch images from public places/areas and accommodations; then these pictures are feed into a system that recognizes if any person without a face mask appears in the image if so if anyone without a face mask is detected then this information/data is sent to the designated authority to take necessary actions. The block diagram of the developed structure is illustrated in Fig. 4.1 All the blocks of the developed system are described as follows.

A) Face recognize and photograph preprocessing -

Face recognization functions as the primary phase of our structure. A new RGB photo is transferred as the data in this phase. The face detector/recognizer extracts and harvests all the faces recognized in the image/photo with their bounding box coordinates. Bounding boxes from stage 1 are integrated together with stage 2 in which the image is with the entire head of the person which classifies that the present person is masked up or not. An initial step is to expand the bounded box parameters by 20% which covered the required Region of Interest (ROI) with minimal overlap to other faces. Then for the second stage, the extracted ROI is resized and establish. To set up a highly reliable face detector requires a lot of assigned data and because of this, we select a pre-trained model raised on a large dataset for easy and hustle free detection. A CNN-based classifier based on three different image/photo analysis patterns: MobileNetV2, DenseNet121, NASNet all are based on lightweight architecture. Tested output replicates the person's face is masked or unmasked.

B) Deep learning architecture -

Deep learning architecture/structure gives an objective of getting featured hierarchies among features of higher levels of the hierarchy determined by the theme of lower-level features assists/train us to learns various important features from the given data. Later, this trained structure is used to predict earlier unseen data. To train our deep learning architecture/structure, we accumulate images from the dataset. The structure of this learning method highly depends on CNN. The involved features of deep learning architecture are described below.

Ⅰ. Assembled Dataset -

Data are assembled for preparation and examining the model. We managed a total of 3835 images of people in which masked faces are 1916 and the rest 1919 images are the unmasked face. We split our dataset into three parts: training dataset, test dataset, and validation dataset. The purpose of doing so is to avoid overfitting which notices minor details/noise which is not necessary and only optimizes the training dataset accuracy. The training set which is an actual subset of the data set is what we use to train the model. Once the model performs well on the validation dataset then we stop learning from the training dataset. Data is split as per a split ratio which is highly dependent on the type of model we are building and the dataset itself. If our dataset and model are such that a lot of training is required, then we use a large piece of the data just for training.

Ⅱ. Architecture/Structure evolution -

In designed architecture, Fig. 1 represents our proposed system architecture here learning model is based on CNN which is for images pattern recognition. The features extracted by CNN are used by multiple dense neural networks for classification purposes. The first stage of our architecture includes a Face Detector, which confines various faces in images/photos of different sizes and detects faces also in an overlapping situation. The detected faces regions of interest(ROI) derived from this stage are grouped and passed to CNN-based Face Mask Classifier which is the second stage of our architecture. As a result, the final output is retained after decoding the result of the second stage here all faces in the image are correctly detected by present architecture and provide a distinguished output of masked unmasked faces.

Ⅲ. Conclusion and notifying designated authority -

Our goal is to make a robust system to minimize the spread of coronavirus by eliminating persons who are not following guidelines of using a face mask to maintain hygiene. This
face mask detector can be deployed in many areas like shopping malls, airports, and other huge traffic places to avoid the spread of the virus. The learning architecture recognizes
whether any input image or photo of persons is with or without a face mask. If such a person is detected, then this data is transferred to the designated authority to do all needful
with necessary actions. This will help to minimize the spread of coronavirus (Covid-19). Proper masking gives us an

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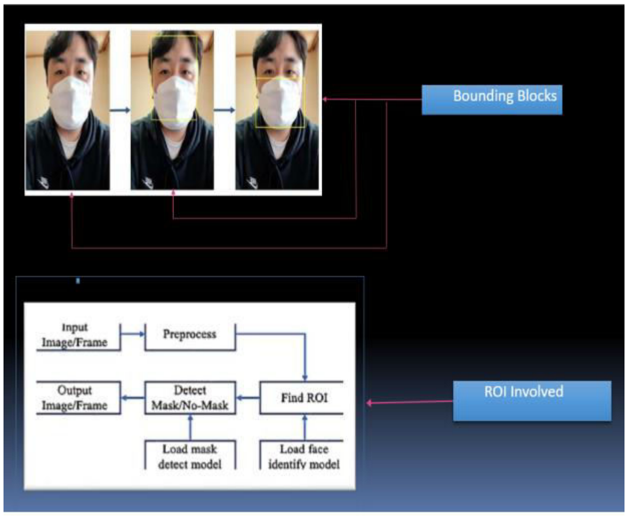
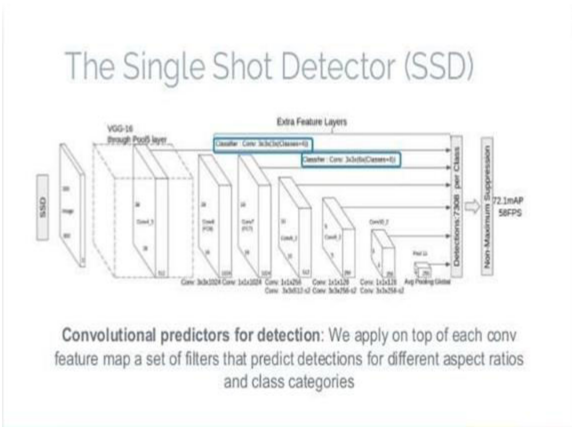
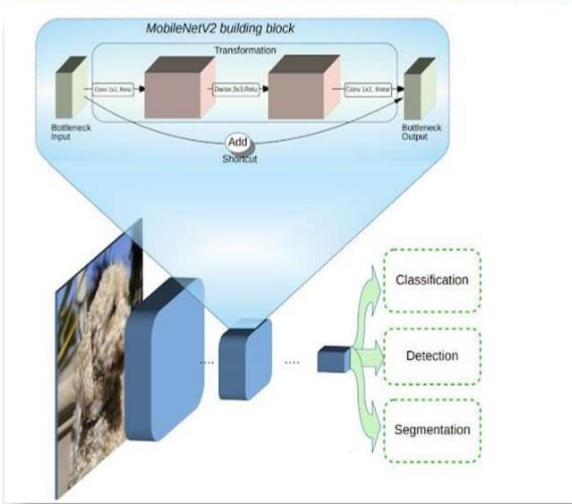
upper hand to fight against the pandemic.







Ⅳ. HELPFUL HINTS

There are several systems and software that use the concept of machine learning which helped us a lot in making this project adaptable and deployable.

Nowadays Machine learning is widely used in several projects and companies because of its tremendous benefits, some of them are Google Cloud, Amazon Web services, IBM, etc.

Machine learning helps in a lot of ways to enhance the growth of a company or a project in several ways such as continuous improvement, automation for almost everything, and its use in a variety of applications. The best part of using machine learning is that it helps to increase its performance on its own.

→ **Amazon Web Services**: It is a company that uses machine learning and provides several most demanded and widely used services such as Infrastructure as a service(IaaS), Platform as a service(PaaS). With the help of machine learning, AWS is able to make its platform open for all, also it allows broad framework support that helps to make any type of model that is selected.

ML makes the platform so much secure with many policies that authenticate the permission to use their platform

Ⅴ.CONCLUSION

In order to reduce the spread of the Covid-19 pandemic, there are several ways that are necessary to be taken. So we have taken a revolutionized step and designed a face mask detector with the help of a Solid-state drive architecture and building a neural network by transmitting all the learning methods. By keeping every significant procedure like its training, authentication, and testing of the model in consideration, we have created a database that consists of 1916 different images of faces that are masked and similarly 1919 different images of faces that are not masked. Several places like a shopping mall, airports, and other heavy crowded places can take benefit from this face mask detector that will help to analyze the crowd and will prevent the circulation of disease by observing who is obeying the rules and who is not. In this dangerous Covid-19 pandemic when everyone wants to live a normal life and restart their work, this face mask detection system can easily be adopted and will automatically check whether someone has put the mask on their face or not, and hence it will make them as well as the environment safe.