Face Mask Detection

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Abstract: At the current scenario, due to outbreak of pandemic (COVID-19), face masks has become the necessary weapon of everyone to avoid spread of disease to some extent. There has been a great demand for the development of software which can easily recognize person who is wearing a mask.

Therefore we are going to develop a system which will fulfill the need using Deep Learning. Here we will use a set of images (dataset) of two categories - the one which contains persons wearing face masks and the other without face masks. We will train the program with this dataset to learn to decide whether a person is wearing a face mask or not by simply providing the image or by using camera of the system to detect. Reports indicate that wearing facemasks while at work clearly reduces the risk of transmission. An efficient and economic approach of using AI to create a safe environment in a manufacturing setup, a hybrid model using deep and classical machine learning for face mask detection will be presented. We are going to use OpenCV to do real-time face detection from a live stream via our webcam. We will use the dataset to build a COVID-19 face mask detector with computer vision using Python, OpenCV, TensorFlow and Keras.

After the successful deployment of the product, we will be able to design a software which can be installed at various places such as at the entry gates of colleges, railway stations, airports, temples, hotels, shops etc. This will easily detect the persons who are entering without face masks by using cameras of the systems. Hence this product is the need of the hour for us to develop so as to work for the safety of humans.

Keywords: Face Mask, OpenCV, TensorFlow, COVID-19, Deep Learning, Face Detection

Introduction

The trend of wearing face masks in public is rising due to the COVID-19 corona virus pandemic all over the world. Before COVID-19, People were wearing masks to protect their health from air pollution. While other people are self-conscious about their physique, they hide their sentiments from the public by hiding their faces. Scientists proved that wearing face masks works on controlling COVID-19 transmission to some extent. COVID-19 is the latest pandemic virus that hits the human health in the last century. In 2020, the rapid spreading of COVID-19 has forced the WHO to declare it as a global pandemic. More than five million cases had been infected by COVID-19 in less than 6 months across 188 countries. This virus spreads through close contact and in crowded and dense areas. The corona virus pandemic has given rise to an extraordinary ability of worldwide scientific cooperation. AI based on Machine learning and Deep Learning can help to fight COVID-19 in many ways. Machine learning allows researchers and clinicians to manipulate enormous amount of data to forecast the distribution of COVID-19 to serve as an early warning mechanism for potential epidemics, and to classify vulnerable populated areas. The provision of healthcare demands funding for emerging technology such as AI, IoT, big data and machine learning to tackle and predict new type of diseases. In order to better understand infection rates and to trace and smoothly detect infections, the AI’s power has been exploited to address the COVID-19 pandemic. People have been forced by laws and orders to wear face masks in public in most of the countries. These rules and laws had been developed as an action to the exponential growth in cases and deaths in several areas. However, the process of monitoring large number of people has becoming more tedious. The monitoring process involves the detection of person who is not wearing a mask on his face.

Here we are going to introduce a mask face detection system which is based on neural networks and deep learning. The proposed model can be integrated with surveillance cameras to control the COVID-19 transmission by allowing the detection of people who are wearing masks not wearing face masks. The model is basically an integration between deep learning and machine learning methods with OpenCV, Keras and TensorFlow.

Problem Formulation

The main idea behind this research paper is to present a report on Face Mask Detector where we took advantage of those available technological advancements to develop classification models for Detection of masked and unmasked faces. The Problem Statement in this is we have to develop a classification model for given dataset of with mask and without mask.

Related work

“It’s something we don’t know yet because it has not been deployed in that environment” Moore says. His engineers are testing their technology on masked faces and are hurriedly gathering images of masked faces to tune their machine-learning algorithms during epidemic times.
Face recognition has become more widespread and accurate in past years, as an AI technology called deep learning has made computers much better at interpreting images. Govts. and professional companies use face recognition to identify people at workplaces, schools, and airports, among other places, though some algorithms perform less good on women and people with darker skin tones. Now the facial-recognition industry has been trying to adapt to a world where many people keep their faces shielded to avoid transmitting disease.

Face-recognition experts say that algorithms are generally less accurate when a face is uncertain, whether by an obstacle, a camera angle, or a mask, because there is fewer information available to compare. “When you have fewer than 1,00,000 people in the database, you will not feel the difference,” says Alexander Khanin, CEO and co-founder of VisionLabs, a startup based in Amsterdam. With 1 million people, he says, accuracy will be noticeably lowered and the system may need coping, depending on how it is being utilized. Some vendors and users of face recognition say that the technology works good enough on faces having masks. “We can identify a person wearing a balaclava, or a medical mask and a hat covering the forehead,” says Artem Kuharenko, founder of NtechLab, a Russian company whose technology is deployed on 1,50,000 cameras in Moscow. He says that the company has some experience with face masks through contracts in southeast Asia, where masks are literally worn to curb colds and flu. US Customs and Border Protection, which uses face recognition on travelers boarding international flights at US airports, says its technology can detect masked faces.

But Anil Jain, a professor at Michigan State University who works on facial recognition and biometrics, says such claims can’t be easily justified. “Companies can quote internal numbers, but we don’t have a trusted database or evaluation to check that yet” says. “There’s no third-party validation.”

The WIRED Guide to Artificial Intelligence
Supersmart algorithms would not take all the jobs, but they are learning quicker than ever, doing everything from medical diagnostics to serving up ads. An US govt. lab at the National Institute of Standards and Technology that works as the world’s arbiter on the accuracy of face-recognition algorithms hopes to provide that external validation—but is being held up by the same epidemic that prompted that project.

Patrick Grother, a computer scientist who leads NIST’s facial-recognition testing program, says his group is preparing tests to quantify how accurately algorithms identify people wearing masks. NIST has been planning to digitally add masks to its existing stockpile of images and test algorithms previously submitted to a test that involves checking whether one image matches other, similar to the job of a border security guard checking passports.

Methodology
A. Tool used for Detection - Cascade Classifier:
Cascading is a special case of ensemble learning based on the concatenation of many classifiers, using all data (informations) obtained from the output from a given classifier as additional information for the next classifier in the cascade. Unlike voting or stacking ensembles, which are multi-expert systems, cascading is a multistage one.

Cascading classifiers are trained with several "positive" sample views of a particular object and arbitrary "negative" images of the same size. After the classifier is trained it can be applied to an area of a photo and detect the object in query. To search for the object in the entire frame, the search window can be moved across the image and check every location for the classifier. This process is mostly and frequently used in image processing for object detection and tracking, primarily facial detection and recognition.
Design:
Complete Work Plan Layout

Two-phase COVID-19 Face Mask Detector

Phase #1: Train Face Mask Detector
- Load face mask dataset
- Train face mask classifier with Keras/TensorFlow
- Serialize face mask classifier to disk

Phase #2: Apply Face Mask Detector
- Load face mask classifier from disk
- Detect faces in image/video stream
- Extract each face ROI
- Apply face mask classifier to each face ROI to determine "mask" or "no mask"
- Show results

Phases and individual steps for building a COVID-19 face mask detector with computer vision and deep learning using Python, OpenCV, and TensorFlow/Keras.

In order to train a custom face mask detector, we need to break our project into two distinct phases, each with its own respective sub-steps (as shown in the Figure above):

1) **Training**: Here we will focus on loading our face mask detection dataset from disk, training a model (using Keras/TensorFlow) on this dataset, and then serializing the face mask detector to disk

2) **Deployment**: Once the face mask detector has been trained, we can then move on to loading the mask detector, performing face detection, and then classifying each face as with_mask or without_mask
Description

A. OpenCV: OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was invented to provide a common infrastructure for computer vision applications and to increase the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it comfortable for businesses to use and modify the code. The library has more than 2500 optimized algorithms, that includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and identify faces, identify objects, classify various human actions in videos, trace camera movements, track moving objects, extract 3D models of objects, procure 3Dimensional point clouds from stereo cameras, stitch photos together to produce a high resolution image of an entire scene, find same kind of images from an image database, remove brown eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. OpenCV has more than 47 thousand people of user community and estimated number of downloads more than 18 millions. The library has been used extensively in companies, research groups and by govt. bodies. Along with well-established companies like Google, Yahoo, Microsoft, Intel, IBM, Sony, Honda, Toyota that employ the library, there are many startups such as Applied Minds, Video Surf which make extensive use of OpenCV. OpenCVs deployed exceed the range from stitching street view photos together, detecting intrusions in surveillance video in Israel, monitoring mine equipment in China, aiding robots navigate and pick up objects at Willow Garage, identification of swimming pool drowning accidents in Europe, running interactive art in Spain and New York, checking runways for debris in Turkey, inspecting labels on products in factories in Japan, among many other applications.

B. TensorFlow: TensorFlow is a free and open-source software library for dataflow and differentiable programming across a range of work. It is a symbolic math library, and is also used for machine learning applications such as neural networks. It is used for both research and production at Google. TensorFlow is Google Brain’s second-generation system. While the reference implementation runs on single devices, TensorFlow can run on multiple CPUs and GPUs (with optional CUDA and SYCL extensions for general-purpose computing on graphics processing units). TensorFlow is available on 64-bit Linux, macOS, Windows, and mobile computing platforms including Android and iOS. Its flexible architecture allows for the smooth deployment of computation around a variety of platforms (CPUs & GPUs), and from desktops to group of servers to mobile and edge devices. The name TensorFlow has been derived from the operations that such neural networks perform on multidimensional data arrays, which are called as tensors. During the Google I/O Conference in June 2016, Jeff Dean stated that 1,500 repositories on GitHub mentioned TensorFlow, of which only 5 were from Google.Unlike other numerical libraries specially intended for using in Deep Learning like Theano, TensorFlow was designed for using both in research and development and in production systems, not less RankBrain in Google search and the fun DeepDream project. It can be easily executed on single CPU systems, GPUs as well as mobile devices and large scale distributed systems of hundreds of machines.

C. Keras: Keras is an API designed for human beings, not machines. Keras follows best practices for reducing cognitive load: it offers consistent & simple API’s, it lowers the number of user actions required for common use cases, and it gives clear & actionable error messages. It also has extensive documentation and developer guides. Keras contains several implementations of commonly used neural network building blocks such as layers, objectives, activation functions, optimisers, and a host of tools to make working with text data smoother to simplify the coding beneficiary for writing deep neural network code. The code is hosted on GitHub, and community support forums include the GitHub issues page, and a Slack channel. Keras is a minimalist Python library for deep learning that can run on top of Theano or TensorFlow. It was developed to make implementing deep learning models as quick and easy as possible for research and development. It runs on Python 2.7 or 3.5 and can seamlessly execute on GPUs and CPUs given the underlying frameworks. It is released under the permissive MIT license.

Limitations and Future Scope

Limitations:
1. The product is not able to detect objects from a distance greater than the 2 metres.
2. The product is unable to detect different objects in the same frame simultaneously.
3. The product is unable to detect transparent masks.
4. The product is not able to do recognitions related to light brightness frames.

Future Scope:
1. The product is in demand as per the present scenario of the pandemic COVID-19.
2. In future also this product can be very useful in case of scanning a masked face during entries at hospitals.
3. With the advancement of technology, the modified product can deal with the distant object too which will be great for the needs.
4. This product can be modified to detect various objects in a single frame simultaneously with use of some advanced algorithms.
5. The product can be very useful in making a thought of reopening schools and colleges with mandatory scanning of students and faculties and staff at the entry gates using this device.

Conclusion
Since the modern technology are blooming with emerging trends in the availability so we have real time face mask detector which can possibly contribute to public health. The architecture consists of MobileNet as the backbone it can be used for max and min computation situations. In order to extract more vigorous features, we utilize transfer learning to adopt weights from a same kind of task face detection, which is trained on a very large dataset. We had used OpenCV, TensorFlow, Keras and CNN to detect whether people were wearing face masks or not. The models were tested with images and real-time video streams. The accuracy of
the model is justified and, the optimization of the model is a continuous process and we are making a highly accurate solution by tuning the hyper parameters. This specific system could be utilized as a use case for edge analytics. Moreover, the proposed method achieves state-of-the-art results on a public face mask dataset. By the development of facial mask recognition we can identify if the person is wearing a face mask and allowing their entry would be of great aid to the society.

References
1. WikiPedia

For dataset:
https://github.com/prajnasb/observations