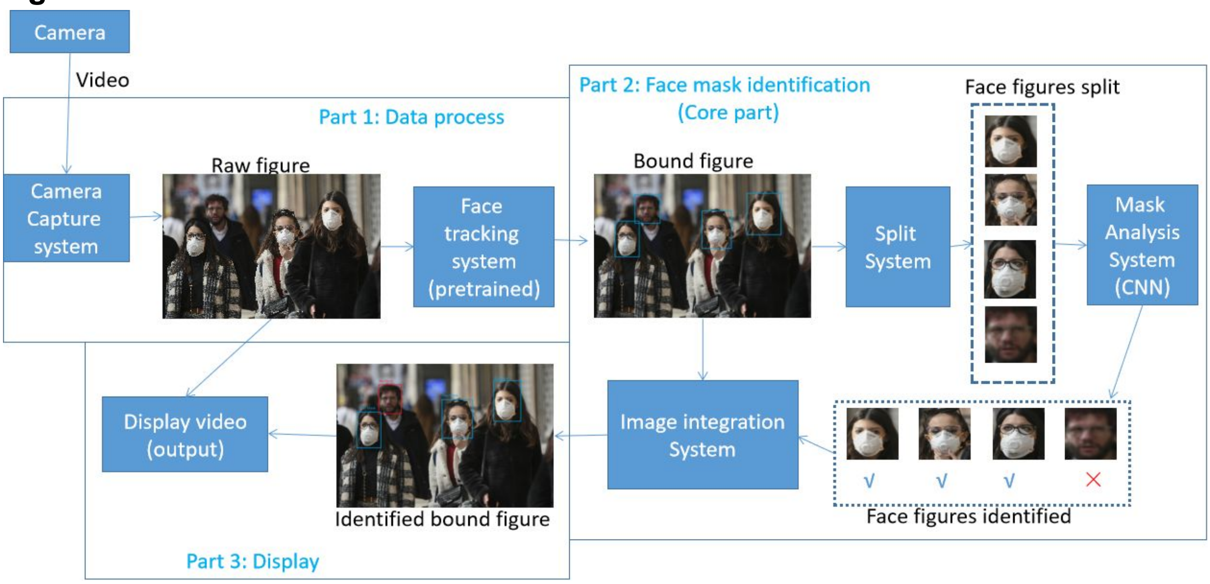
Introduction

The current global pandemic, COVID-19, has resulted in over a million deaths worldwide. To help prevent the spread of the virus, everyone has been urged to wear a face mask while in indoor public areas. Unfortunately, many people either wear their masks incorrectly (not covering their nose, creating holes in the mask, etc.) or choose not to wear one at all because they do not understand it to be a pertinent method of protection against the virus. The goal of this project is to be able to detect whether or not someone is wearing a face mask. If used, this system could alert and aid in denying entry to those who are not wearing a mask. This would ensure public safety and ultimately have the potential to save lives. Machine learning is an appropriate approach because it has the ability to handle multiple types of data and could therefore scan a large crowd of people and immediately provide an alert upon detecting a public health violation of not wearing a mask.

Figure



Todo

Background & Related Work

Existing Systems

Currently existing applications related to this project are LeewayHertz's 'Face Mask Detection System using Artificial Intelligence' [Face Mask Detection System using AI | AI Mask Detection] and Mobisoft's 'Face Mask Detection System' [Recognizing Masked Faces with Face Mask Detection System]. Both systems are intended to work with existing cameras in public spaces (airports, hospitals, offices, etc.) to detect faces without masks. They are also equipped to send alerts with a picture of the person in violation of the safety regulation so security can approach them and enforce the wearing of masks or remove them from the premises. Mibosoft's system is further able to detect attributes such as location of faces, face orientation, types of masks and more.

Related Research Papers

In light of the novel Coronavirus of 2019, many face mask detection systems have been introduced. In December 2019, Ejaz, M.S., and Islam, M.R. released their “Implementation of principal component analysis on masked and non-masked face recognition”, but the accuracy rate when a person is wearing a mask is less than 70%. More recently, Qin, B., and Li, D. have introduced a system that detects whether a face mask is being worn, not worn correctly, or not worn at all. Their proposed methodology reached the high 90% accuracy during training and 100% during testing.

Ejaz, M.S., Islam, M.R., Sifatullah, M., Sarker, A., Implementation of principal component analysis on masked and non-masked face recognition, 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT), 2019, pp. 1–5.

Qin, B., and Li, D., Identifying facemask-wearing condition using image super-resolution with classification network to prevent COVID-19 (2020), Unpublished results, doi: 10.21203/rs.3.rs-28668/v1.
https://www.mdpi.com/1424-8220/20/18/5236/pdf

Multi-Stage CNN Architecture for Face Mask Detection
Real-Time Face Mask Detection

Data Processing

Currently we found 3 dataset:

The first dataset[1] has 1842 images with masks and 6000 images without masks. All images are cropped nearly perfect to a human’s face with or without a mask so it can be used to train the mask analysis system. But these images need to be preprocessed to have the same resolution first. The images in this dataset are separated into training dataset, validation dataset and testing dataset. But we will put all images together and separate them by ourselves because there are augmented images in the dataset and we need to filter them out.

The second dataset[2] has 503 images with masks and 503 images without masks. The images in this dataset have different resolutions and some of them are not cropped perfectly. We need to preprocess these images to make sure they have the same resolution and are cropped correctly to make the human face almost stay at the center of the image. Then we can start to feed them into the augment system and use it to train the mask analysis system.

The third dataset[3] has 853 images. These images contain multiple human faces with or without masks. Each image has a corresponding annotation file to annotate the human face with or without a mask. We will use the annotation file to create the image with bound. These images will be used to verify the entire system after the training on the network is done.

We will use the first and second dataset as the dataset used to train the mask analysis system. We will use the opencv and numpy method to augment the images including horizontal flips, rotation, width shift, height shift, rescale and adding noise pixel. We should have 12000 images in total after augment. Then we will use 7200 images as training dataset, 2400 images as validation dataset and 2400 images as test dataset. All the images stay the same resolution.

The third dataset will be used to verify the system so we will only change the resolution of the images in the third dataset to the same resolution. Then we will create the image with annotation on human faces by the annotation file. After that we can feed the processed figures into the entire system and compare the output with the annotation figure created by the annotation file.

Architecture
In order to detect face masks, we first need to be able to recognize and split faces. We will be using pre-trained models to accomplish both recognition and splitting. Then, the neural network model that we will be using is a Convolutional Neural Network to detect whether a face mask is being worn. We will use convolutional filters to pre-process images to help our network make better decisions such as the hand made Sobel Filter to detect lines of the face mask, and others for greyscaling and spatial awareness. The types of layers of the CNN will consist of convolutional layers, pooling layers in order to consolidate the information from the convolutions, and linear layers. However, the layers being used may be subject to change once we start testing.

Baseline Model
We will be using support vector machines as a baseline model. We will need to modify the image using processing techniques to identify types of lines, or colours, then use the pixels of the images as input. Further, with face mask detection, we are dealing with a binary classification problem. Given an image, there are two possible options: a face mask was detected or a face mask was not detected. We chose the use of SVMs as this is a shallow learning algorithm for recognition that is very accurate, and is simple to implement as there is not a large amount of hyperparameters to select. This algorithm simply plots each data item, then uses these plots to differentiate the data into two classes. We will also use simple processing techniques such as finding lines in order to detect a face mask.

Ethical Considerations

Invasion of privacy: the impact of facial recognition on privacy depends on which facial features it enters and how it uses the information. Even if people covering their faces with hats, scarves, face masks, facial recognition systems can still collect facial information. People are worried about whether facial features can be used for other purposes, whether the collected information is shared, and whether facial features such as gender, race, and emotion are collected. The limitation of our system will be the way we use facial data should be limited. Also, the facial data set may not be clear in the purpose of protecting privacy.

Discrimination: it would be detrimental to social justice if there was discrimination in facial recognition information systems or the way they are used. The limitation for our system will be the result tendency may be influenced by the data sets we use which have less accuracy with disadvantaged groups.

Project Plan

The team will use github to update the system and do version control. The team will use Goolge Colab as computation resources to run and test the system. The team decided that each team member will create their own branch on Github and develop their part in each individual branch. If a member wants to merge their branch to the master branch, they must get approval from another member.

After checking and communicating the available time slot of each team member, the team has decided the weekly meeting time on Sunday at 11am. The team will use messenger to do the group meeting and communication.

The task assignment is shown below

Tasks	Assigned person for implementation	Internal deadline
Implement camera capture system (easy)	Yuqian	**Nov. 2**
Implement face tracking system (easy)	**Jamie Anderson**	**Nov. 2**
Implement split system (easy)	**Jessica**	**Nov. 2**
Implement mask analysis system (hard)	**All group members**	**Nov 9**
Hyperparameter search for cnn in mask analysis system (hard, takes long time)	**All group members**	**Nov. 30**
Implement image integration system (medium)	**Jingxuan Su**	**Nov. 2**
Implement video output system (hard)	**All group members**	**Nov.23**

Progress Report is due on November 16
Final Project/presentation December 7

Risk Register

Risk	likelihood	Solution
The pre-trained model for the face tracking system doesn't perform well on face with mask	Low -	There are more than 3 pre-trained methods including opencv, MTCNN or VGGface2. We can choose among these method to see which one performs best
The team communication efficiency may be low because of the difference in time zone for each team member.	High	The team will communicate more often and plan time to spare to correct any miscommunication/ delay.
There is a great variety of types of face masks that may not be all covered by the dataset.	High	Most of the time people will wear two types of mask, the Medical masks or the N95 face mask. The team will make sure we have at least 1000 training images including augmented images for both of them.
The model may take longer to train than expected.	Medium - dependent on architecture	Try transfer learning with pre-learned weights. The team will evaluate the possible training time for the architecture of the model before training.
Difficulty detecting uncommon facial features (unibrows, shaved brows)	Low- These features are uncommon	The team will find and add more training data for these specific features
The model may result in unexpected behaviour presented with face coverings (e.g., for religious purposes)	Medium	The team will try not to feed the training data that contains people with religious face covering.

Link to Github or Colab Notebook

Github link:https://github.com/YuqianX/APS360-Project
Google Colab link (for internal purposes):
https://colab.research.google.com/drive/1bZ7L9x9amR2zmcMtSoZBohY-YY6aVTCI

?usp=sharing

References

[1] Face Mask ~12K Images Dataset Author: Ashish Jangra
https://www.kaggle.com/ashishjangra27/face-mask-12k-images-dataset?

[2] COVID Face Mask Detection Dataset Author: Prithwiraj Mitra
https://www.kaggle.com/prithwirajmitra/covid-face-mask-detection-dataset?

[3] Face Mask Detection Author: Larxel
https://www.kaggle.com/andrewmvd/face-mask-detection?