Proposal: Machine Learning Based Face Mask Recognition

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Summary of the Proposal

As the COVID-19 has brought great disaster to human beings, personal protection has become particularly important. For the purpose of controlling the spread of the epidemic, every one of us has the obligation and responsibility to wear masks. The objective of our project is to proposed a system that can monitor people's mask wearing status (Correct, Incorrect and No mask). In practical, one basic machine learning model, SVM will be implemented to finish the objective. Besides, several commonly used classification models (e.g. CNN) will also be used as the control group for the experiment.

Background

Until October 24, there have been 24,408,845 confirmed cases of COVID-19 worldwide and droplet transmission is the main cause of transmission. Therefore, to further prevent the spreading of COVID-19, it is very imperative to monitor people's mask wearing status in public places. However, due to the intensive flow of people, the current human-based supervision system will cause a great waste of human resources.

Thanks to advances in computer science and artificial intelligence in recent years, we can use image-based machine learning techniques to solve this problem. That is, collecting facial images through cameras and performing masking wearing recognition with specific machine learning frameworks. In this way, labor and time costs can be saved, and the efficiency of COVID-19 control work can be improved.

Goal and Objectives

The main objective of this project is to design a machine learning framework to classify a set of face mask images. Through the machine learning framework proposed in this project, we will finally classify this data set into "*Correct*", "*Incorrect*" and "*No Mask*", which correspond to 3 different situations below:

- **Correct:** The person in the picture is wearing a mask correctly.
- **Incorrect:** The person in the picture is not wearing the mask properly, for example by exposing his nose and mouth to the outside.
- **No Mask:** The person in the picture is not wearing a mask at all

Our system will eventually achieve recognition accuracy of more than 85% and show high robustness to different disturbances (e.g. light factors, human skin color, face orientation). Besides, we will further compare our proposed model with a variety of common machine learning or deep learning models, critically analyze the advantages and disadvantages. And the result will be summarized in the final submitted demo video and project report.

Methodologies

This project mainly implement one conventional machine learning model, Support Vector Machine (SVM) to do the classification. In order to verify the advantages and disadvantages of this method, we introduce convolutional neural network (CNN) as a comparison

Support Vector Machine: For the reason that the SVM is a binary classifier and we have three types of face mask. Our mask recognition mission needs two main process:

- Train a SVM to identify if the person in the picture is wearing a mask.
- Train another SVM to identify if the person in the picture is wearing a mask correctly. The second SVM will only be used when the first SVM identify the person in the picture is wearing a mask.

SVM is a relatively simple model without much ability of nonlinear fitting when dealing with the complex image. So we need to conduct image preprocessing before we feed them to the SVM, below are the procedures and the algorithms details.

- **Feature Extraction:** Dense local descriptors (HOG or local binary pattern); Encoding (local coordinate coding or Gaussian model super-vector coding).
- **Dimensional Reduction:** Pooling (weighted pooling or max-pooling with spatial pyramid matching); principal component analysis; linear discriminant analysis; canonical correlation analysis; non-negative matrix factorization.

Convolutional Neural Network: Compared to SVM, the CNN is more powerful to deal with images. The preprocessing of images listed above can be used but not necessary for CNN model. In order to make comparison with SVM, we will use lightweight CNN with a few layers to keep the amount of parameters of SVM and CNN in the same level. A CNN model is very easy to be conducted using some machine learning libraries like Pytorch, Tensorflow and Sklearn. And it can directly output the possibility of the 3 kinds of mask wearing.