Project: Face Mask Detection

Phase 2 Report : Research + Data Collection

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Paper Reviews

Paper 1: A hybrid deep transfer learning model with machine learning methods for face mask detection in the era of COVID-19 Pandemic.s

In this paper, a hybrid model using deep and classical machine learning for face mask detection was presented. Three datasets had been experimented on, and different training and testing strategies had been adopted through this research. The plans include training on a specific dataset while testing over other datasets to prove the efficiency of the proposed model.

The authors of this paper have used three datasets:

1. RMFD:- Real World Masked face dataset
2. SMFD:- Simulated Masked Face dataset
3. LFW:- Labeled faces in the wild

From the above 3 mentioned datasets RMFD dataset has been made up of real world images of the people with and without masks and the remaining 2 datasets has been made by using a simulated process of adding masks to normal images. So we are thinking about using RMFD from this paper as it consists of real mask images.

While coming to the model that has been proposed and used in the paper, The proposed model in this paper consists of two components:

1.Feature Extraction by using Resnet50(a Convolution Neural Network of 50 layers deep also Known as deep neural network)

2. Then the Classification process, in the classification stage they have experimented the model performance with various machine learning models which are:

1: Support Vector Machines(SVM)
2: Decision Trees
3:Ensemble Algorithm

Ensemble methods are algorithms of machine learning that create a collection of classifiers. The used Ensemble methods are K-Nearest Neighbors Algorithm (k-NN), Linear Regression ,and Logistic Regression

The performance metrics used in this paper are
1:Accuracy : TP + TN/(TP + FP)(TN + FN)
2:Precision : TP /TP +FP
3:Recall: TP/ TP + FN
4: F1 Score:2* (Precision*Recall)/(Precision + Recall)

While coming to the Performance of the models on the RMFD dataset The SVM classifier in RMFD achieved 99.64% testing accuracy. In SMFD, it gained 99.49%, while in LFW, it reached 100% testing accuracy. The SVM classifier consumed less time than the decision trees classifier and ensemble algorithm. In some of the test cases the ensemble algorithm has outperformed the other two classifiers but the time complexity is very high for it when compared to the results.

Finally to conclude, Despite the good performance of the model the major drawback is the dataset/images that have been considered in this paper which consists of only the faces of the person despite considering the whole image which will be used only in the second stage of our model for feature extraction.

Citation:

Loey, M., Manogaran, G., Taha, M. H. N., & Khalifa, N. E. M. (2020). A hybrid deep transfer learning model with machine learning methods for face mask detection in the era of the COVID-19 pandemic. *Measurement*, *167*, 108288.

Paper 2: An empirical comparison of supervised learning algorithms.

Summary: This paper provides an extensive comparison of 10 various supervised Learning algorithms against various performance metrics. It performs binary classification on 11 datasets with 10 algorithms and evaluates using 8 performance metrics. And for novices like us, I think this paper is a good place to start learning these algorithms.

The authors have experimented with the following algorithms,
1. SVM
2. ANN
3. Logistic Regression (LOGREG)
4. Naive Bayes (NB)
5. KNN
6. Random Forests (RF)
7. Decision Trees (DT)
8. Bagged Trees (BAG-DT)
9. Boosted Trees (BST-DT)
10. Boosted Stumps (BST-STMP)

And the performance metrics used are,
1. Accuracy (ACC)
2. F-Score (FSC)
3. Lift (LFT)
4. ROC
5. Average Precision (APR)
6. Precision/Recall Break-Even Point (BEP)
7. Squared Error (RMS)
8. Cross-Entropy (MXE)

In essence, this paper provides us the opportunity to learn and experiment with the various supervised Learning algorithms. Though we may not use all these algorithms in our experimentation, we hope it helps us explore and get a good understanding of which of these algorithms are used for what along with a fair knowledge of performance metrics. And how we can use these algorithms and performance metrics for the extracted features of the face images.

Citation:

Caruana, R., & Niculescu-Mizil, A. (2006, June). An empirical comparison of supervised learning algorithms. In *Proceedings of the 23rd international conference on Machine learning* (pp. 161-168).

Paper 3: Masked Face Recognition Using Convolutional Neural Network

Introduction: This paper talks about how the problem of masked face detection can be solved by convolutional neural networks in three steps- detecting the facial region using Multi-Task Cascaded Convolutional Neural Network (MTCNN), facial features extraction using Google FaceNet embedding model and then classification using Support Vector Machine (SVM). The authors have performed experiments that gave remarkable results using this approach and they also did a correlative study for better understanding.
Convolutional Neural Network: It is composed of various convolutional layers, several pooling layers, non-linear layer and classification layer.

Methodology: The authors' approach can be explained into following steps-

A. Facial Image Acquisition: It involved collection of masked face images from AR, IIIT-Delhi, India face database.
B. Masked Face Detection Using MTCNN: The authors used a pre-trained MTCNN model to detect candidate masked and non- masked face portions of the given image and interpret them into high dimensional facial descriptors.
C. Image Post-processing: Crop and resizing methods were applied to input images.
D. Feature Extraction using FaceNet: The authors used the pre-trained FaceNet model as a baseline for a deep network which is supported by L2 normalization. To prepare a unique feature, max operator was applied to the features.
E. Face Verification using SVM: Verification process was consolidated to recognize candidates face by performing the classification task within a unified Support Vector Machine. The authors examined a test face to other train faces using SVM. The classification result was considered as correct if the distance among the test image and the train image of the identical person was minimum. A masked face similarity was measured upon the masked and non- masked faces by estimating an L2 normalization within the features key points collected from the net structure.

Dataset Construction: The authors acquired the dataset from two sources AR face database and IIIT- Delhi Disguise version 1 Face database and then they divided it into training(70%) and testing(30%) sets.

Experimental Results: They achieved an average accuracy of 99.78% on training data and an average accuracy of 93.72% on testing data.

Conclusion: So, overall the technique and models suggested in this paper are going to work very well on images with masked faces. The process of making and using the models is explained briefly and the results achieved by authors while experimenting are very promising. One major benefit of using this method is we can not only use images with just headshots but also full body shots and be able to recognize masked faces.

Citation: M. S. Ejaz and M. R. Islam, "Masked Face Recognition Using Convolutional Neural Network," 2019 International Conference on Sustainable Technologies for Industry 4.0 (STI), Dhaka, Bangladesh, 2019, pp. 1-6, doi: 10.1109/STI47673.2019.9068044.

Questions and Answers

Business/Customers

Applications of our software:

- Business centers
- Shopping centers
- Hospitals / medical centers
- Entrances of airports, subways, railway stations
- Sport venues
- Entertainment and hospitality industry

1. **What problem will your Computer Vision solution solve, and for whom?**

   The trend of wearing face masks in public is rising due to the COVID-19 coronavirus epidemic all over the world. Our algorithm can be used by different areas but for example is shopping malls where the entrance of the shopping mall will check if a person wears the mask or not if he wears a mask it will open the entrance door or else it will not and suggest the person to wear a mask.

2. **What value will it provide them? What are their pain points?**

   Our algorithm will help the customers or governments to check if there are any people who are not wearing masks in public places or in the shopping areas. And can make sure that all the people who enter the shop will wear a mask so that the spread Covid-19 can be reduced.

3. **How Big is the potential market?**

   As of now there is a huge market for it as governments and shopping areas are looking for precaution measures that they can take to reduce the impact of the spread of covid-19 in public places. So this will act as one of the solutions for them.

3. **Do other similar solutions exist?**

   Yeah for now there are similar solutions as a lot of people working on it. One of the similar solutions to ours is SecureOS face mask detection application.

5. **Would your business have any competitors? Who are they? How are they doing?**

As Covid-19 is a hot topic nowadays lots and lots of people are working to provide solutions that can reduce the impact the spread of the virus. The companys like ISS Intelligent Security Systems is one of the companies that has done a great job and came up with a solution that protects employees, vendors and visitors easily and effectively, using existing cameras.

6. **How are potential customers dealing with these issues now?**

Still in most of the places this software is not yet installed. But for now in some of the shopping areas they are checking manually if a person wears a mask or not if he doesn't wear a mask they are either providing him a mask or telling that person to wear a mask and enter the mall/shop.

7. **Are your customers individuals or businesses? Be sure to cite the sources you reference in your research.**

The major customers of our solution are businesses like large shopping malls for example Harris teeter and Walmart . they can plug our solution to their entrance and check if the person wears the mask or not.

8. **How much would a customer be willing to pay for your product?**

As we are not aware of the industry standards we are not sure about the pay for our product.

Academic Literature Review

1. **What academic work is relevant to your project topic?**

Research papers related to recognition of masked faces, detection of masks on faces and different machine learning models that could be used to classify the images with people wearing masks and people not wearing masks are relevant to our paper. For example- the papers that we chose to study and review for our project are:

Paper 1: A hybrid deep transfer learning model with machine learning methods for face mask detection in the era of Covid-19 pandemic.
Paper 2:An empirical comparison of supervised learning algorithms.
Paper 3: Masked Face Recognition Using Convolutional Neural Network

2. **What makes these papers important/relevant?**

These papers are relevant to our project because they give us a brief idea of how to approach the problem and the ideas are derived from multiple other researches and the results are based on real experimentation on data. There can be multiple ways to solve the problem of Face mask detection but not all will give good prediction results. These papers give us a head start.

3. **What are their results and how did they achieve these results?**

Paper 1's result is a classification model for face mask detection with an accuracy of 99.64% on testing data and it is done by building and training a model in two steps: Feature Extraction by using Resnet50 and classification(using SVM, decision trees and ensemble algorithm).

Paper 2 lays a comparison of 10 supervised learning algorithms on 10 datasets resulting in performance evaluation of the models. It is done by using various performance metrics like accuracy(ACC), F-Score(FSC), Lift, ROC, etc.

Paper 3's result is a classification model for masked face detection with an accuracy of 99.78% on training data and an average accuracy of 93.72% on testing data. This result is achieved using MTCNN, FaceNet and SVM to build the model.

4. **What's different/unique about these approaches?**

All three research papers used more than one dataset to perform the experiments and they explored different ways to get best results which makes them unique.

Open Source

1. **What open source code is available that is relevant to your topic?**

Open source codes on github and kaggle related to implementation of computer vision algorithms, image processing and deep learning are relevant to our topic.

2. **How active are the communities around these codes?**

Considering the fact that applications (like SecureOS face mask detection) and various kaggle competitions related to detection of face masks using images and videos exist, it is obvious that the communities are very active around these codes.

3. **What data is available for testing and/or training algorithms?**

   The data that we picked was available on kaggle but there were some other datasets also available which were used for experimentation by the authors of the research papers we chose.

4. **Is labeled data available? How much? How is the data licensed? Is it under copyright protection?**

   Yes, labeled data is available.
   All of 853 images in the dataset we chose were labeled.
   Yes, the data is licensed under CC0: Public Domain.
   No, because CC0 allows the public to access and rebuild.

Industry Solutions

1. **What companies are solving similar problems to yours?**

   As I mentioned earlier companies like ISS Intelligent Security Systems and Airspace as Airspace CEO mentioned about this solution in one of the press conferences.

2. **It can be tough to tell exactly how proprietary solutions work, but what can you find on the internet?**

   We have found some of the places the algorithm Is performing very good for example in In France, to guarantee that riders wear face masks, new AI software tools are integrated in the Paris Metro system's surveillance cameras by the government and making sure that all the riders wear the mask.

3. **Has anyone reverse engineered these products?**

   As I found regarding this product no company or person tried to reverse engineered these products because these products had come into the scene in recent times.

4. **If you have access to the product, what can you learn from using it?**

   If I have access to this product I will try to figure out how their algorithm is performing and try to learn those technologies that they have used in their implementation and can think about any betterments that we can make for it.

5. **Are there available talks, documentation, or other resources from their engineering teams?**

As I went through google I have found a good Documentation from ISS Intelligent Security Systems regarding this . And the CEO of Airspace also had a talk about this in one of the interviews.