Background pattern

Description automatically generatedShape

Description automatically generated



**Mask detection**

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# **project's domain background**

the project is in deep learning field and computer vision domain, and image preprocessing.

Computer vision is one of the most used field these days specially with the improvement in deep learning. I choose this project for two reasons:

* Improve my CNN and image preprocessing and intuition and having more experience in this field.
* For fun, I am enjoying of learning and doing new things.

One of the similar projects in real life is a social distance detection in amazon warehouse, where it is detect if two workers were near to each other.

# **problem statement**

the problem is how to detect the people are not wearing mask and localizing the person in the image by putting a box around his face. The detected faces should be labeled to three categories wear mask, not wear mask, wear mask incorrectly. This is a research paper for face recognition and localizing it should be useful for this project, link [HERE](https://ieeexplore.ieee.org/abstract/document/6626244).

# **datasets**

the dataset used is a face mask detection data from Kaggle website. The data set is created by [Ashish Jangra](https://www.kaggle.com/ashishjangra27).

[The dataset page here.](https://www.kaggle.com/ashishjangra27/face-mask-12k-images-dataset)

Data set info:

|  |  |
| --- | --- |
| Training examples | 12k |
| Number of labels (classes) | 2 |
| labels | * With mask * Without mask |
| bounding boxes | In PASCAL VOC format using mediapipe library |

Data set features:

* Generalization
* People in the images has different background
* More than one face in a one image

Why this data set?

It has more than person in one image, different image size, collected from different distribution and labeled correctly.

# **solution statement**

the suggested solution is using deep learning to solve the problem by the following techniques Convolutional neural network and VVG19 CNN architecture. With help of keras and tensor flow packages and OpenCV API this problem can be solved easily and fast because of GPU acceleration.

# **benchmark model**

There is a lot of projects done on the same data set and with great result, for example [HERE](https://www.kaggle.com/feyzazkefe/mask-and-social-distancing-detection-using-vgg19) a project that use VVG19 and reach 98 % accuracy, this project will the reference project of this project.

# **evaluation metrics**

the dataset is unbalanced so the preferred evaluation metrics here is F1-score and accuracy.

# **project design**

the project design will be in two phases training and testing. In training phase, the data will be loaded and processed if needed then the train the VVG19 model. In the testing phase the model will be evaluated according to the chosen metric which is F1-score.

The deploy pipeline

# Project implementation and deploying

In the project there are two main tasks:

* Load and preprocess data
* Training
* Testing

After the tasks above completed the project will be ready for *deployment*.

## Load and preprocess data

All project files are in Faris-ML git hub repository, data set cloned from git hub in three groups (Train , Validation, Test).

|  |  |
| --- | --- |
|  | Number of examples |
| Train | 10000 |
| Test | 992 |
| Validation | 800 |

Process the data by applying data augmentation methods, methods used:

* Scaling.
* Brightness.
* Zoom.
* Shear.
* Horizontal flip.

## Training

The used algorithm for mask detection is CNN (convolutional neural network) and the architecture is VVG19 with adding a few layers, all neural network architecture specification will be written in details in table 2.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Type | Filter size | Filter channel | stride | Zero padding | Output size |
| Input | - | - | - | - | 128 x 128 x 3 |
| Conv 2d | 3 x 3 | 64 | 1 | 1 x 1 | 127 x 127 x 64 |
| Conv 2d | 3 x 3 | 64 | 1 | 1 x 1 | 126 x 126 x 64 |
| Max pooling | 2 x 2 | - | 2 | - | 63 x 63 x 64 |
| Conv 2d | 3 x 3 | 128 | 1 | 1 x 1 | 62 x 62 x 128 |
| Conv 2d | 3 x 3 | 128 | 1 | 1 x 1 | 61 x 61 x 128 |
| Max pooling | 2 x 2 | - | 2 | - | 31 x 31 x 128 |
| Conv 2d | 3 x 3 | 256 | 1 | 1 x 1 | 30 x 30 x 256 |
| Conv 2d | 3 x 3 | 256 | 1 | 1 x 1 | 29 x 29 x 256 |
| Conv 2d | 3 x 3 | 256 | 1 | 1 x 1 | 28 x 28 x 256 |
| Conv 2d | 3 x 3 | 256 | 1 | 1 x 1 | 27 x 27 x 256 |
| Max pooling | 2 x 2 | - | 2 | - | 14 x 14 x 256 |
| Conv 2d | 3 x 3 | 512 | 1 | 1 x 1 | 13 x 13 x 512 |
| Conv 2d | 3 x 3 | 512 | 1 | 1 x 1 | 12 x 12 x 512 |
| Conv 2d | 3 x 3 | 512 | 1 | 1 x 1 | 11 x 11 x 512 |
| Conv 2d | 3 x 3 | 512 | 1 | 1 x 1 | 10 x 10 x 512 |
| Max pooling | 2 x 2 | - | 2 | - | 5 x 5 x 512 |
| Conv 2d | 3 x 3 | 512 | 1 | 1 x 1 | 4 x 4 x 512 |
| Conv 2d | 3 x 3 | 512 | 1 | 1 x 1 | 3 x 3 x 512 |
| Conv 2d | 3 x 3 | 512 | 1 | 1 x 1 | 2 x 2 x 512 |
| Conv 2d | 3 x 3 | 512 | 1 | 1 x 1 | 1 x 1 x 512 |
| Max pooling | 1 x 1 | - | 1 | - | 1 x 1 x 512 |
| Flatten | - | - | - | - | 512 |
| Dense | 4096 | - | - | - | - |
| Dense | 4096 | - | - | - | - |
| Dense | 1000 | - | - | - | - |
| Dense | 128 | - | - | - | - |
| Dense | 64 | - | - | - | - |
| Dense | 32 | - | - | - | - |
| Dense | 16 | - | - | - | - |
| Dense | 8 | - | - | - | - |
| Dense | 4 | - | - | - | - |
| Dense | 2 | - | - | - | - |

All layers has Relu activation function and the output layer has softmax activation function.

The model trained by transfer learning on image-net weights for 20 epochs.

## Testing

The goal is to reach 98 % accuracy and with help with confusion matrix all performance measures can be calculated.

Confusion matrix:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | actual | |
|  |  | 1 | 0 |
| predicted | 1 | 476 | 7 |
| 0 | 4 | 505 |

Performance measures:

|  |  |
| --- | --- |
| Performance measure | The score |
| Accuracy | 0.989 |
| Misclassification rate | 0.011 |
| True positive rate | 0.992 |
| False positive rate | 0.014 |
| True negative rate | 0.986 |
| precision | 0.986 |
| prevalence | 0.516 |
| Balanced accuracy | 0.989 |
| F1 score | 0.989 |

The model is accurate with 0.989 score.

Heat map:

Chart, treemap chart

Description automatically generated

# Used tools

For accomplished this task some needed tools used.

APIs:

* Sklearn.

For performance measures.

* Tensorflow:

For training and building the neural network.

* Matplotlib:

For plotting and visualization.

* Open CV

For camera capture and image reading.

* Keras
* Numpy

Linear algebra operations.

* Mediapipe

For face detection.

IDEs:

Google colab: because the limitations in computational power.

Pycharm: using the personal device camera for maskdetecting.

# Sample output

Images: Graphical user interface, application

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A picture containing graphical user interface

Description automatically generated

My own video capturing:

A person wearing a hat and glasses

Description automatically generated with low confidence

A person wearing a mask

Description automatically generated with medium confidence

# Submitted files:

All submitted files with any necessary hints for using the file content.

mrain.py: python file for training task.

mrain.ipynb: notebook file for training task.

model\_testing.py: python file for testing task.

model\_testing.ipynb: notebook file for testing task.

mask\_detection.py: python file for deployment and pipeline inference.

masknet.h5: saved model in h5 format.

The rest files are data set and reports.