Detecting Face Masks Through Embedded Machine Learning Algorithms: A Transfer Learning Approach for Affordable Microcontrollers

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The goal

Problem

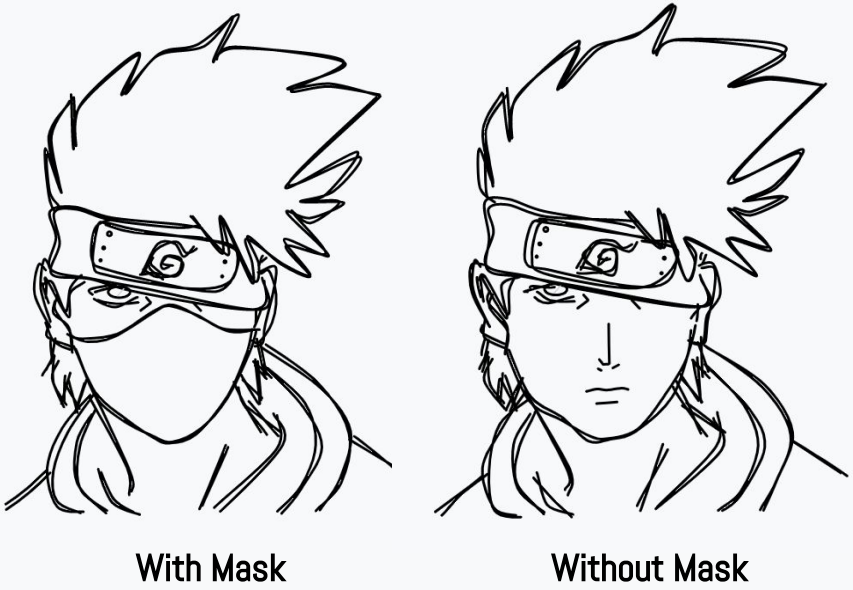
Airborne diseases

Verify if the person is wearing or not a mask

Solution

Image classifier

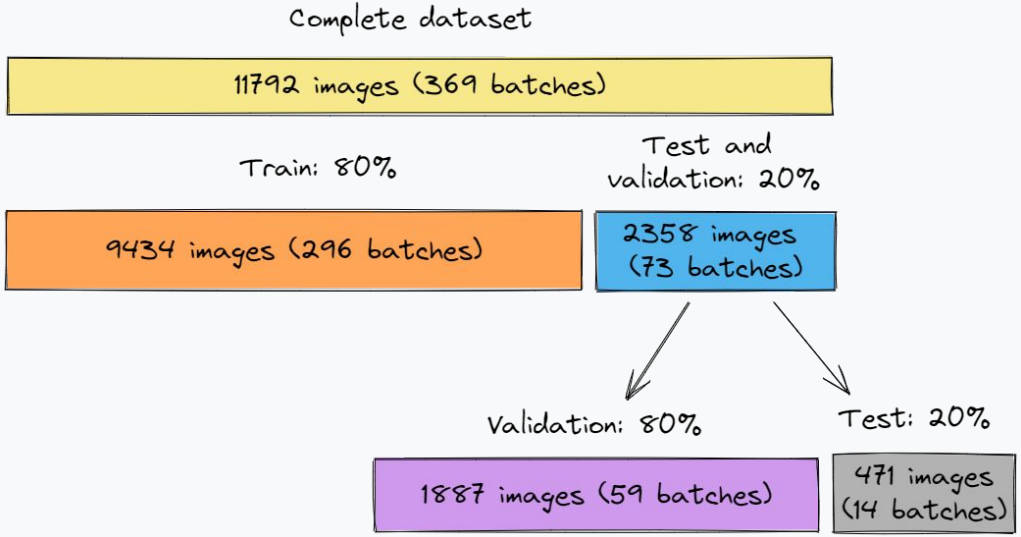
Neural network with transfer learning to verify with images if a person is wearing or not a mask



Data acquisition

Without mask

With mask



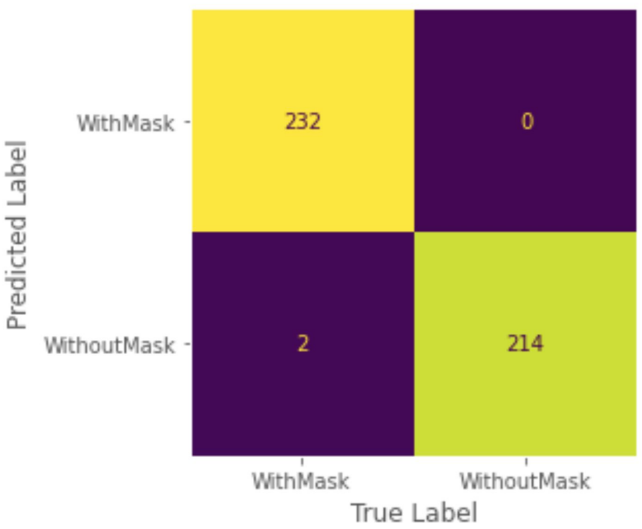
Initial Models

```
class FCHeadNet:
        @staticmethod
        def build(baseModel, classes, neurons):
                # initialize the head model that will be placed on top of
                # the base, then add a FC layer
                headModel = baseModel.output
                headModel = Flatten(name="flatten")(headModel)
                headModel = Dense(neurons, activation="relu")(headModel)
                headModel = Dropout(0.5)(headModel)

                # add a softmax layer
                headModel = Dense(classes, activation="softmax")(headModel)

                # return the model
                return headModel
```

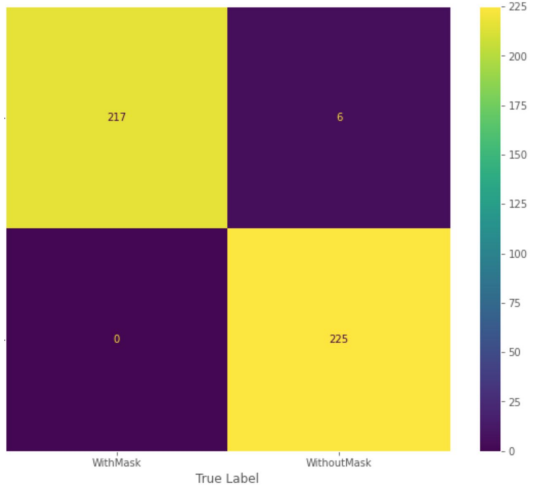
```
opt = RMSprop(learning_rate=0.0001)
model.compile(loss="categorical_crossentropy", optimizer=opt,
              metrics=["accuracy"])
```

Initial Models

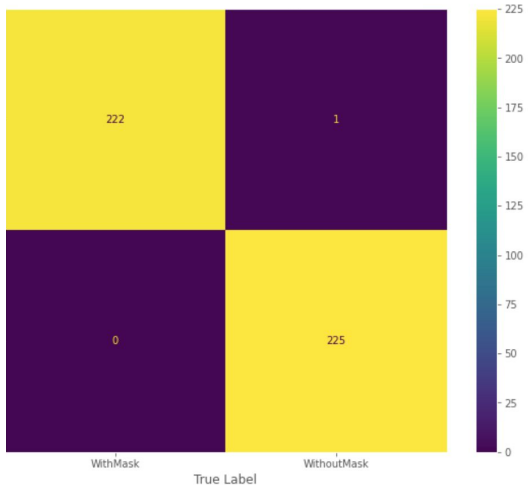
VGG-16



Densenet



Mobilenet



Run Summary

VGG-16

Acc	0.99554
CO2_Emissions	0.00439
Count_Params	21137986
Energy_CPU	0.00265
Energy_Consumed	0.00696
Energy_GPU	0.00401
Energy_RAM	0.0003
F1	0.99554
Precision	0.99558
Recall	0.99554

Densenet

Acc	0.98661
CO2_Emissions	0.00099
Count_Params	42407234
Energy_CPU	0.00275
Energy_Consumed	0.00717
Energy_GPU	0.0041
Energy_RAM	0.00031
F1	0.98661
Precision	0.98697
Recall	0.98661

Mobilenet

Acc	0.99777
CO2_Emissions	0.01145
Count_Params	16074690
Energy_CPU	0.00769
Energy_Consumed	0.01814
Energy_GPU	0.00959
Energy_RAM	0.00086
F1	0.99777
Precision	0.99778
Recall	0.99777

Arduino Nano BLE Sense 33

Model architecture

MobileNetV1

64 neurons

Dropout (0.1)

Output layer (2 classes)

RGB-mobilenetv1

Accuracy: 96%

Latency: exceeds target by 891ms

300ms

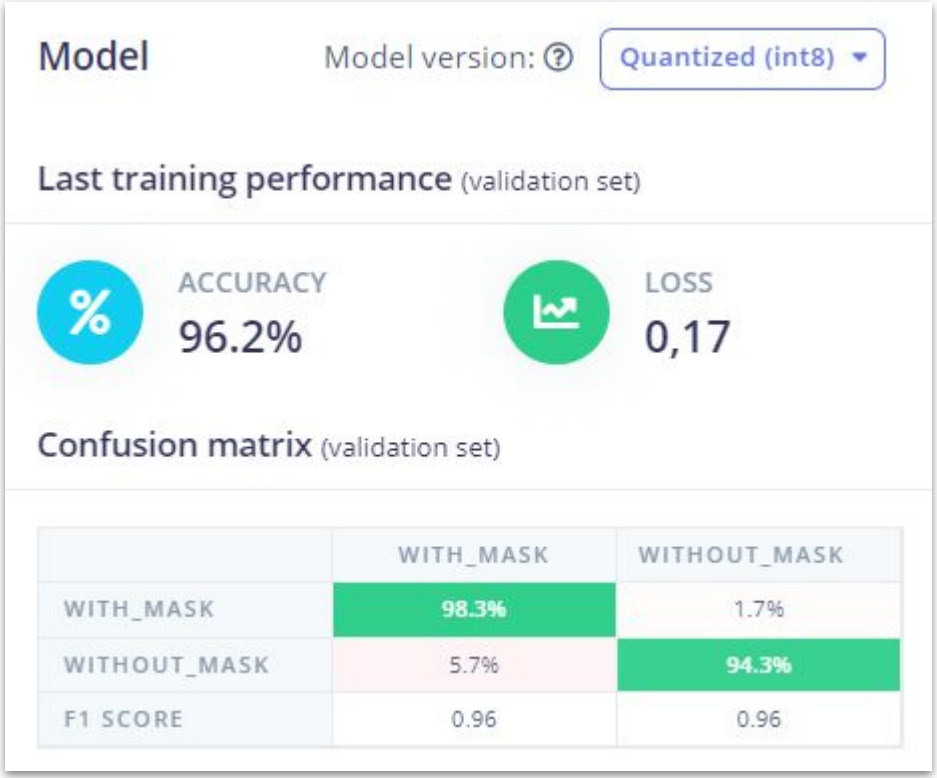
RAM

256kB

ROM

1024kB

Evaluation


Model
Model version:
Quantized (int8)
Last training performance (validation set)
ACCURACY
96.2%
LOSS
0,17
Confusion matrix (validation set)
WITH_MASK
WITHOUT_MASK
WITH_MASK
98.3%
1.7%
WITHOUT_MASK
5.7%
94.3%
F1 SCORE
0.96
0.96