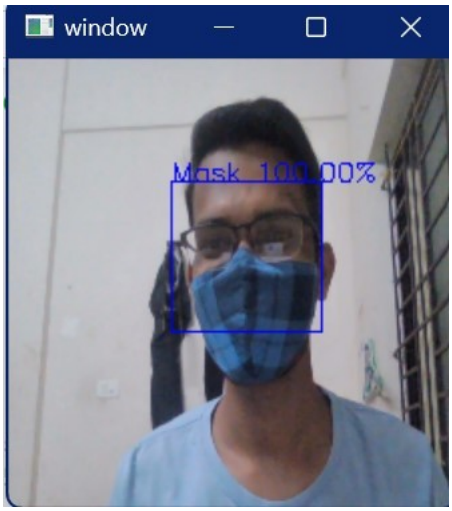
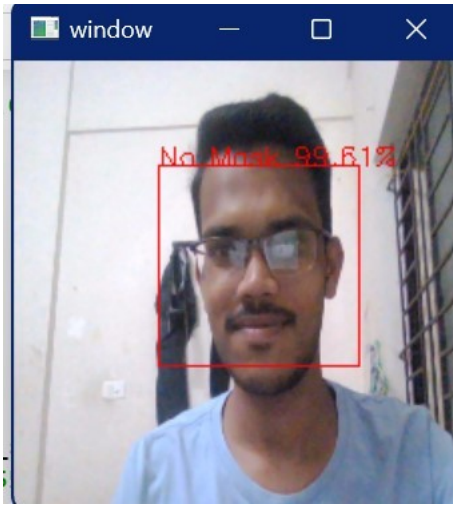
Covid-19 Face Mask Detector

With Mask



Without Mask



Concept diagram

DATASET IMAGE

Import required libraries

```
import os

from keras.preprocessing import image

import cv2
```

Define the categories of images

```
categories = ['with_mask','without_mask']
```

Initialize an empty list for the data

Loop over the categories and their corresponding directories to read and preprocess the images

```
# Initialize an empty list for the data
data = []
```

```
# Loop over the categories and their corresponding directories to read
and preprocess the images
for category in categories:
    # Define the path to the directory
    path = os.path.join('train', category)

    # Assign a label to each category (0 for 'with_mask', 1 for
'without_mask')
    label = categories.index(category)

    # Loop over the files in the directory and read the images
    for file in os.listdir(path):
        # Define the path to the image file
        img_path = os.path.join(path, file)

        # Read the image using OpenCV
        img = cv2.imread(img_path)

        # Resize the image to (224, 224)
        img = cv2.resize(img, (224, 224))

        # Append the image and its label to the data list
        data.append([img, label])
```

```
len(data)
```

```
1508
```

```
import random
```

shuffling the data to avoid biasness in fitting

```
# Shuffle the data randomly

random.shuffle(data)

# Initialize empty lists for the features (X) and labels (y)

X = []
y = []

# Separate the features and labels into different lists

for features,label in data:
    X.append(features)
    y.append(label)

len(X)
```

```
1508
```

```
len(y)
```

```
1508
```

```
import numpy as np

# Convert X and y into NumPy arrays

X = np.array(X)
y = np.array(y)
```

```
X.shape
```

```
(1508, 224, 224, 3)
```

```
y.shape
```

```
(1508,)
```

converting the color image to gray-scale

```
# Normalize the pixel values in X to be between 0 and 1

X = X/255
```

```
X[0]
```

```
array([[[1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        ...,
        [0.99607843, 1.        , 0.98431373],
        [0.99607843, 1.        , 0.98431373],
        [0.99215686, 0.99607843, 0.98039216]],

       [[1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        ...,
        [0.99607843, 1.        , 0.98431373],
        [0.99607843, 1.        , 0.98431373],
        [0.99215686, 0.99607843, 0.98039216]],

       [[1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        ...,
        [0.99607843, 1.        , 0.98431373],
        [0.99607843, 1.        , 0.98431373],
        [0.99215686, 0.99607843, 0.98039216]],

       ...,

       [[1.        , 1.        , 1.        ],
```

```
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        ...,
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ]],

       [[1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        ...,
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ]],

       [[1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        ...,
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ],
        [1.        , 1.        , 1.        ]]])
```

```
# Split the data into training and testing sets using the
train_test_split function from scikit-learn

from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size= 0.2)

X_train.shape
```

```
(1206, 224, 224, 3)
```

```
X_test.shape
```

```
(302, 224, 224, 3)
```

```
# Import the VGG16 pre-trained model from Keras

from keras.applications.vgg16 import VGG16
```

1. from keras.applications.vgg16 import VGG16: This line imports the VGG16 model from Keras, which is a pre-trained convolutional neural network (CNN) that was originally trained on the ImageNet dataset.

2. The VGG16 model consists of 16 layers, including 13 convolutional layers and 3 fully connected layers.

3. The convolutional layers use small filters (3x3) with a stride of 1 and padding, and are followed by a max pooling layer. This architecture helps the model learn hierarchical features in the input images.

4. The fully connected layers at the end of the model use the learned features to classify the input images into one of the 1000 categories in the ImageNet dataset.

5. In this code, we are using the pre-trained VGG16 model as a feature extractor by removing the last fully connected layer and adding a new output layer with a single neuron to classify images as either with or without masks.

```
# Instantiate the VGG16 model

vgg = VGG16()

vgg.summary()
```

```
Model: "vgg16"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 224, 224, 3)]     0

 block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0

 block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)       (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)  (None, 28, 28, 256)       0
```

```
 block4_conv1 (Conv2D)       (None, 28, 28, 512)       1180160

 block4_conv2 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_conv3 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_pool (MaxPooling2D)  (None, 14, 14, 512)       0

 block5_conv1 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv2 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv3 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_pool (MaxPooling2D)  (None, 7, 7, 512)         0

 flatten (Flatten)           (None, 25088)             0

 fc1 (Dense)                 (None, 4096)              102764544

 fc2 (Dense)                 (None, 4096)              16781312

 predictions (Dense)         (None, 1000)              4097000

=================================================================
Total params: 138,357,544
Trainable params: 138,357,544
Non-trainable params: 0
_________________________________________________________________
```

```
# Create a new sequential model
from keras import Sequential

model = Sequential()

# Add all layers from the VGG16 model to the new model except for the
last layer
for layer in vgg.layers[:-1]:
    model.add(layer)

model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0
```

```
 block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)       (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)  (None, 28, 28, 256)       0

 block4_conv1 (Conv2D)       (None, 28, 28, 512)       1180160

 block4_conv2 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_conv3 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_pool (MaxPooling2D)  (None, 14, 14, 512)       0

 block5_conv1 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv2 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv3 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_pool (MaxPooling2D)  (None, 7, 7, 512)         0

 flatten (Flatten)           (None, 25088)             0

 fc1 (Dense)                 (None, 4096)              102764544

 fc2 (Dense)                 (None, 4096)              16781312

=================================================================
Total params: 134,260,544
Trainable params: 134,260,544
Non-trainable params: 0
_________________________________________________________________
```

```
# Freeze the weights of all layers in the new model
for layer in model.layers:
    layer.trainable = False

model.summary()
```

```
Model: "sequential"
_________________________________________________________________
```

```
 Layer (type)                Output Shape              Param #
=================================================================
 block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0

 block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)       (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)  (None, 28, 28, 256)       0

 block4_conv1 (Conv2D)       (None, 28, 28, 512)       1180160

 block4_conv2 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_conv3 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_pool (MaxPooling2D)  (None, 14, 14, 512)       0

 block5_conv1 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv2 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv3 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_pool (MaxPooling2D)  (None, 7, 7, 512)         0

 flatten (Flatten)           (None, 25088)             0

 fc1 (Dense)                 (None, 4096)              102764544

 fc2 (Dense)                 (None, 4096)              16781312

=================================================================
Total params: 134,260,544
Trainable params: 0
Non-trainable params: 134,260,544
_________________________________________________________________
```

```
# Add a new dense output layer with sigmoid activation
from keras.layers import Dense

model.add(Dense(1,activation='sigmoid'))

model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 block1_conv1 (Conv2D)        (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)        (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)   (None, 112, 112, 64)      0

 block2_conv1 (Conv2D)        (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)        (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)   (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)        (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)        (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)        (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)   (None, 28, 28, 256)       0

 block4_conv1 (Conv2D)        (None, 28, 28, 512)       1180160

 block4_conv2 (Conv2D)        (None, 28, 28, 512)       2359808

 block4_conv3 (Conv2D)        (None, 28, 28, 512)       2359808

 block4_pool (MaxPooling2D)   (None, 14, 14, 512)       0

 block5_conv1 (Conv2D)        (None, 14, 14, 512)       2359808

 block5_conv2 (Conv2D)        (None, 14, 14, 512)       2359808

 block5_conv3 (Conv2D)        (None, 14, 14, 512)       2359808

 block5_pool (MaxPooling2D)   (None, 7, 7, 512)         0

 flatten (Flatten)            (None, 25088)             0

 fc1 (Dense)                  (None, 4096)              102764544
```

```
 fc2 (Dense)                 (None, 4096)              16781312

 dense (Dense)               (None, 1)                 4097

=================================================================
Total params: 134,264,641
Trainable params: 4,097
Non-trainable params: 134,260,544
_________________________________________________________________
```

```
# Compile the model with binary cross-entropy loss and accuracy as the
evaluation metric
model.compile(optimizer='Adam',loss='binary_crossentropy',metrics=['ac
curacy'])

# Train the model on the training set for 5 epochs and validate on the
testing set
history =
model.fit(X_train,y_train,epochs=5,validation_data=(X_test,y_test))
```

```
Epoch 1/5
38/38 [==============================] - 176s 5s/step - loss: 0.1615 -
accuracy: 0.9569 - val_loss: 0.1685 - val_accuracy: 0.9669
Epoch 2/5
38/38 [==============================] - 175s 5s/step - loss: 0.1467 -
accuracy: 0.9577 - val_loss: 0.1748 - val_accuracy: 0.9536
Epoch 3/5
38/38 [==============================] - 190s 5s/step - loss: 0.1382 -
accuracy: 0.9635 - val_loss: 0.1477 - val_accuracy: 0.9536
Epoch 4/5
38/38 [==============================] - 192s 5s/step - loss: 0.1243 -
accuracy: 0.9685 - val_loss: 0.1393 - val_accuracy: 0.9636
Epoch 5/5
38/38 [==============================] - 219s 6s/step - loss: 0.1159 -
accuracy: 0.9710 - val_loss: 0.1554 - val_accuracy: 0.9503
```

```
print("[INFO] saving mask detector model...")
model.save("mask_detector.model", save_format="h5")
```

```
[INFO] saving mask detector model...
```

```
# Initialize the video capture object
cap = cv2.VideoCapture(0)
# from tensorflow.keras.models import load_model
# model = load_model("mask_detector.model")

# Define a function to detect if a face in an image is wearing a mask
or not
def detect_face_mask(img):
    # Make a prediction on the input image using the trained model
    y_pred = model.predict(img.reshape(1,224,224,3))
    return y_pred
```

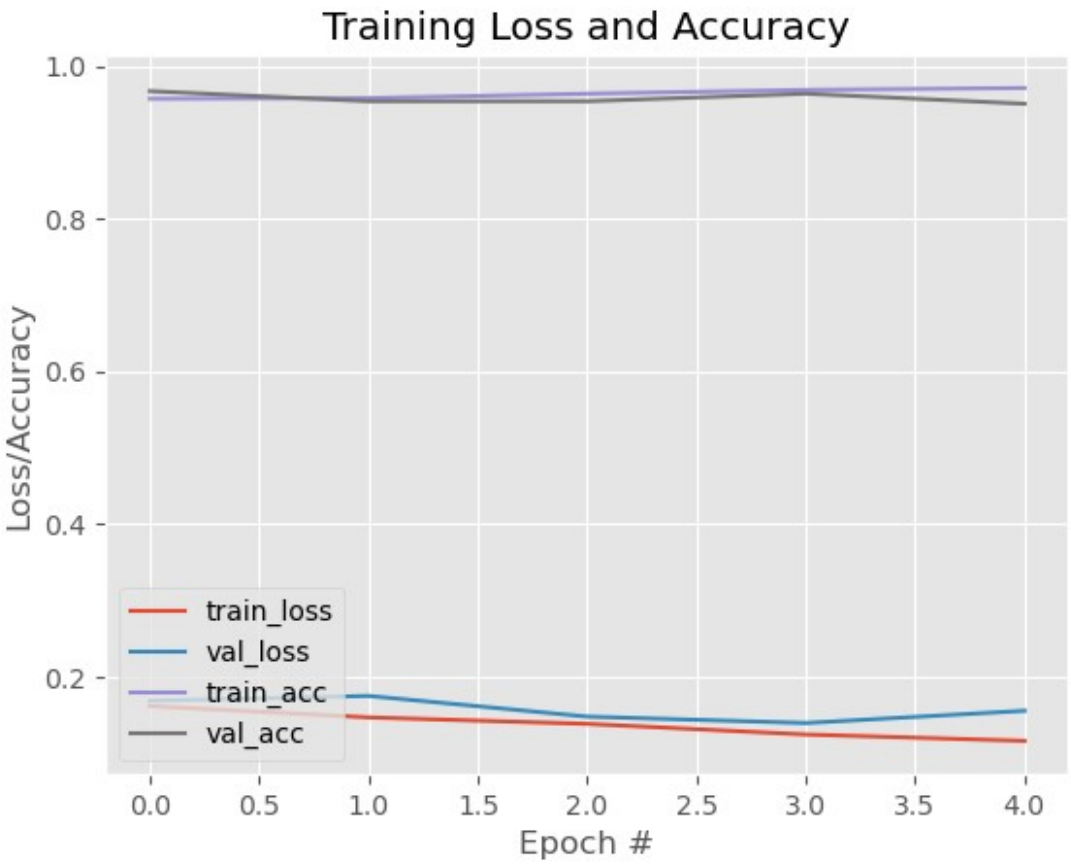
```
def detect_face(img):
    coods = haar.detectMultiScale(img)
    return coods

# Read in an example image for testing the face mask detection
function
sample1 = cv2.imread('samples/3.jpg')
sample1 = cv2.resize(sample1,(224,224))

# Test the face mask detection function on the example image
detect_face_mask(sample1)
```

```
1/1 [==============================] - 1s 818ms/step

array([[2.4732947e-06]], dtype=float32)
```

```
# this is used to show a rectangle accross the face in camera frame
def draw_label(img,text,pos,bg_color):

    text_size =
cv2.getTextSize(text,cv2.FONT_HERSHEY_COMPLEX,1,cv2.FILLED)

    end_x = pos[0]+text_size[0][0]+2
    end_y = pos[1]+text_size[0][1]+2

    cv2.rectangle(img,pos,(end_x,end_y),bg_color,cv2.FILLED)
    cv2.putText(img,text,pos,cv2.FONT_HERSHEY_COMPLEX,1,
(0,0,0),1,cv2.LINE_AA)


# This line of code initializes the Haar Cascade classifier using the
# pre-trained XML file 'haarcascade_frontalface_default.xml' located
in the current directory.
haar = cv2.CascadeClassifier('./haarcascade_frontalface_default.xml')
```

```
import matplotlib.pyplot as plt
plt.style.use("ggplot")
plt.figure()
plt.plot(history.history["loss"], label="train_loss")
plt.plot(history.history["val_loss"], label="val_loss")
plt.plot(history.history["accuracy"], label="train_acc")
plt.plot(history.history["val_accuracy"], label="val_acc")
plt.title("Training Loss and Accuracy")
plt.xlabel("Epoch #")
plt.ylabel("Loss/Accuracy")
plt.legend(loc="lower left")
```

```
<matplotlib.legend.Legend at 0x1ee9033b730>
```




```
while True:
    # capture frames from the camera
    ret,frame = cap.read()

    # resize the frame to fit the model's input shape
    frame = cv2.resize(frame,(224,224))

    # detect faces in the frame using the detect_face() method
    coods = detect_face(cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY))

    # draw rectangles around the detected faces
    for x,y,w,h in coods:
        cv2.rectangle(frame,(x,y),(x+w,y+h),(255,0,0),1)

    # make predictions using the detect_face_mask() method
    y_pred = detect_face_mask(frame)
    print(y_pred)

    # calculate the probabilities of having or not having a mask
    no_mask = y_pred[0][0]*100
    mask = 100 - (y_pred[0][0]*100)

    # display the label and percentage probability of each detected
```

```
face
    if mask>no_mask and mask>95:
        # if the model predicts that the face is wearing a mask, label
it as "Mask" and display the percentage probability
        for x,y,w,h in coods:
            label_str = "{:.2f}".format(mask)
            cv2.putText(frame,"Mask" + " " + label_str+"%" , (x,
y),cv2.FONT_HERSHEY_SIMPLEX, 0.45, (255,0,0), 1)
            cv2.rectangle(frame,(x,y),(x+w,y+h),(255,0,0),1)

    else:
        # if the model predicts that the face is not wearing a mask,
label it as "No Mask" and display the percentage probability
        for x,y,w,h in coods:
            label_str = "{:.2f}".format(no_mask)
            cv2.putText(frame,"No Mask" + " " + label_str+"%" , (x,
y),cv2.FONT_HERSHEY_SIMPLEX, 0.45, (0,255,0), 1)
            cv2.rectangle(frame,(x,y),(x+w,y+h),(0,255,0),1)

    # display the resulting frame
    cv2.imshow('window',frame)

    # exit the program if the 'x' key is pressed
    if cv2.waitKey(1) & 0xFF == ord('x'):
        break

# release the camera and close all windows
cv2.destroyAllWindows()
```

```
1/1 [==============================] - 0s 234ms/step
[[0.99079484]]
1/1 [==============================] - 0s 217ms/step
[[0.943617]]
1/1 [==============================] - 0s 165ms/step
[[0.92066]]
1/1 [==============================] - 0s 169ms/step
[[0.96179074]]
1/1 [==============================] - 0s 189ms/step
[[0.90673524]]
1/1 [==============================] - 0s 234ms/step
[[0.9043212]]
1/1 [==============================] - 0s 223ms/step
[[0.84232175]]
1/1 [==============================] - 0s 269ms/step
[[0.933592]]
1/1 [==============================] - 0s 216ms/step
[[0.90307117]]
1/1 [==============================] - 0s 230ms/step
[[0.9256817]]
1/1 [==============================] - 0s 212ms/step
```

```
[[0.91146386]]
1/1 [==============================] - 0s 230ms/step
[[0.8321544]]
```