BỘ GIÁO DỤC VÀ ĐÀO TẠO
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KHOA ĐÀO TẠO CHẤT LƯỢNG CAO

HCMUTE

Artificial Intelligence
ARIN337629E

AI final project

EMOTION, GENDER, AGE RECOGNITION BASE ON HUMAN FACE USING CONVOLUTIONAL NEURAL NETWORK AND BOUNDING BOX REGRESSION.

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Hồ Chí Minh, ngày 23 tháng 6, 2022

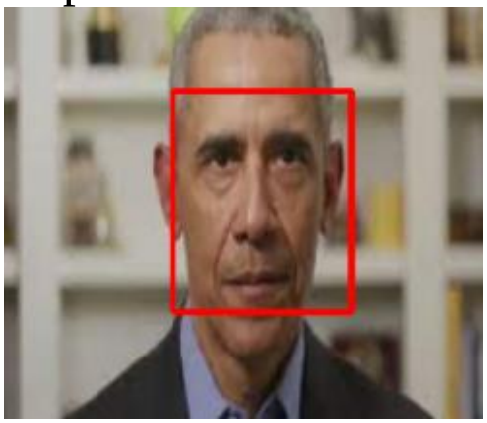
LINK YOUTUBE: https://youtu.be/TH-r1eoEoZQ

Bounding Box regression training

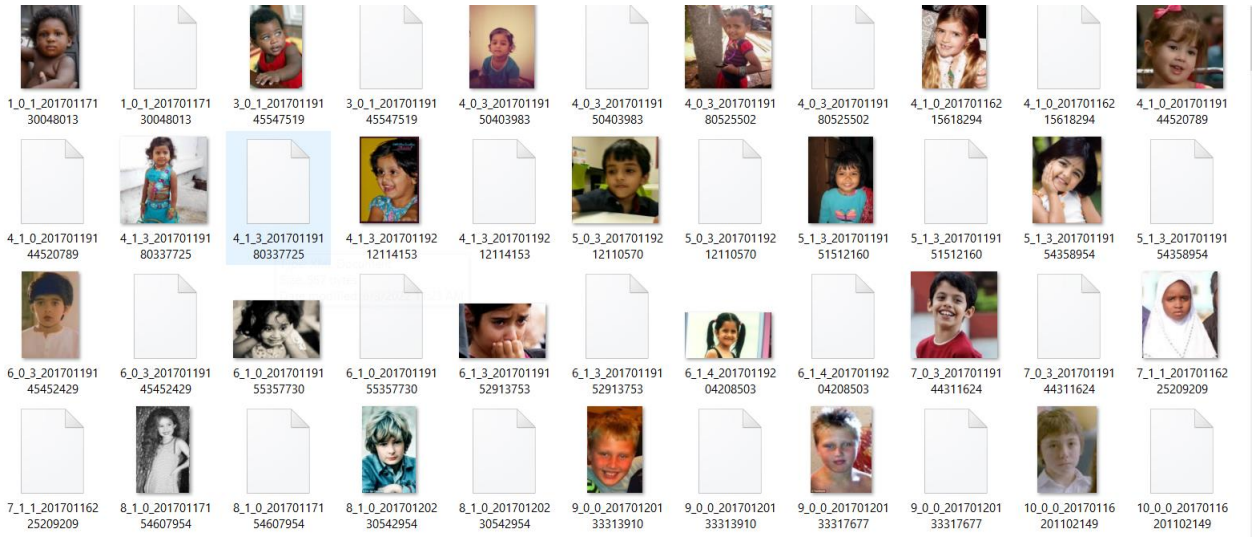
Goal of model:

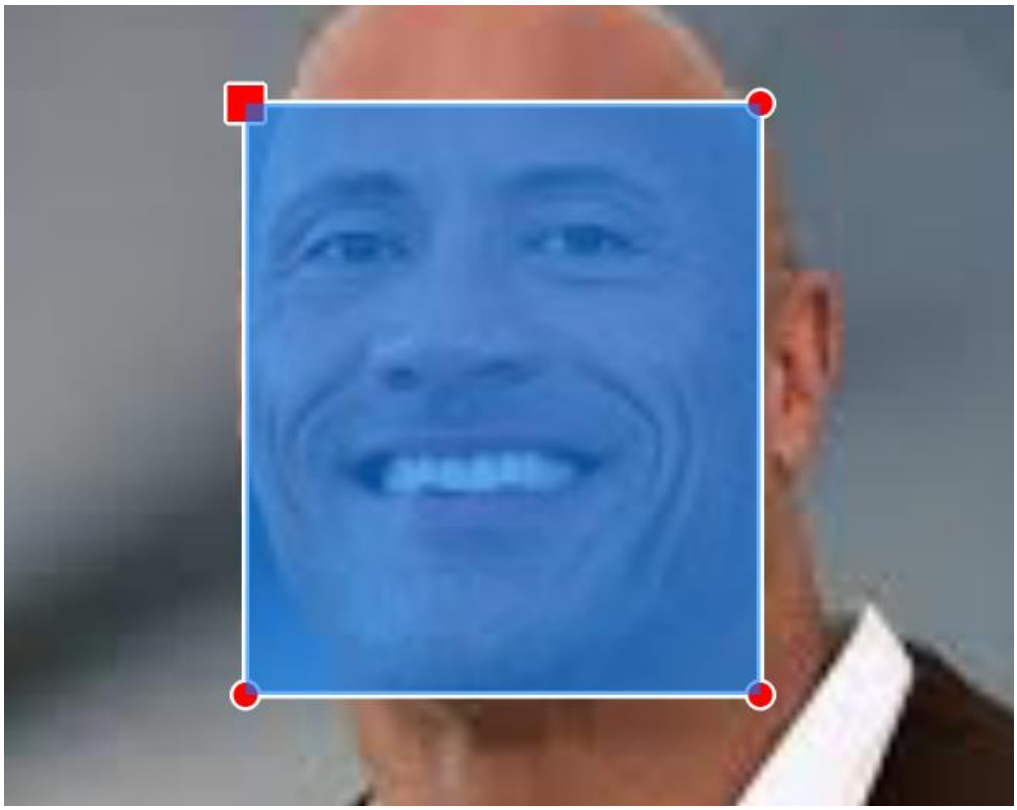
Original:

Expected result:



Dataset preparation:





Import library

Tensorflow for deep learning
Xml lib for xml file processing
OpenCV for image processing

```
import tensorflow as tf
import pandas as pd
import os
import numpy as np
from xml.dom import minidom
import cv2
import matplotlib.pyplot as plt
import glob
from sklearn.model_selection import train_test_split
from skimage import io
```

Make a data and annotation loading function

```python
def load_img(path) :
    X = []
    for i in sorted(glob.glob(path)) :
        img = cv2.imread(i,cv2.COLOR_BGR2RGB)
        img = cv2.cvtColor(img,cv2.COLOR_BGR2RGB)
        img = cv2.resize(img,(225,225))
        X.append(img)
    return np.asarray(X)
```

```python
def load_xml(path) :
    y = []
    for i in sorted(glob.glob(path)) :

        obj = minidom.parse(i)
        folder = obj.getElementsByTagName('folder')[0].firstChild.nodeValue
        width = get_value(obj,'width')
        height = get_value(obj,'height')
        xmin = get_value(obj,'xmin')/width
        ymin = get_value(obj,'ymin')/height
        xmax = get_value(obj,'xmax')/width
        ymax = get_value(obj,'ymax')/height


        y.append([xmin,ymin,xmax,ymax])
    return np.asarray(y)
```

Load data and label

```
X = load_img('gdrive/MyDrive/facetest/*.jpg')
X.shape
```

```
(304, 225, 225, 3)
```

```
Y = load_xml('gdrive/MyDrive/facetest/*.xml')
Y.shape
```

```
(304, 4)
```

Build Model CNN + Regression
Input is the RGB image with tensor shape (225,225,3)
The output is 4 equivalent to 4 corner of bounding box: xmin, ymin, xmax, ymax

```
model = Sequential()
model.add(Conv2D(32,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same',input
model.add(Conv2D(32,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Conv2D(64,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(64,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Conv2D(128,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(128,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Conv2D(256,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(256,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(Conv2D(512,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(512,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
#model.add(Conv2D(512,(1,1),activation='relu',kernel_initializer='he_uniform',padding='same'))
#model.add(Conv2D(512,(1,1),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
#model.add(Conv2D(512,(1,1),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(BatchNormalization())
model.add(Flatten())
model.add(Dropout(0.2))
#model.add(Dense(512,activation='relu'))
model.add(Dense(252,activation='relu'))
model.add(Dense(128,activation='relu'))
model.add(Dense(64,activation='relu'))

#model.compile(loss='mse',optimizer=keras.optimizers.Adam(),metrics=['mae'])
model.add(Dense(4))
```

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_108 (Conv2D)          (None, 225, 225, 32)      896

conv2d_109 (Conv2D)          (None, 225, 225, 32)      9248

max_pooling2d_59 (MaxPoolin  (None, 112, 112, 32)      0
g2D)

batch_normalization_39 (Bat  (None, 112, 112, 32)      128
chNormalization)

conv2d_110 (Conv2D)          (None, 112, 112, 64)      18496

conv2d_111 (Conv2D)          (None, 112, 112, 64)      36928

max_pooling2d_60 (MaxPoolin  (None, 56, 56, 64)        0
g2D)

batch_normalization_40 (Bat  (None, 56, 56, 64)        256
chNormalization)

conv2d_112 (Conv2D)          (None, 56, 56, 128)       73856
...
Total params: 11,078,496
Trainable params: 11,077,024
Non-trainable params: 1,472
```

Compile CNN model with optimizer is Adam, loss function is ‘Huber’

$$L_\delta(a) = \begin{cases} \frac{1}{2}a^2 & \text{for } |a| \le \delta, \\ \delta \cdot \left(|a| - \frac{1}{2}\delta\right), & \text{otherwise.} \end{cases}$$

```
model.compile(optimizer='adam',loss='huber')
```

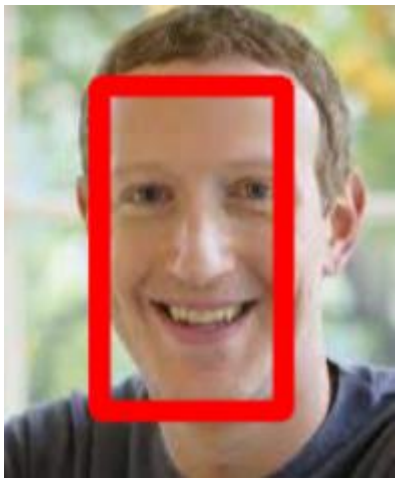
Loss result of model

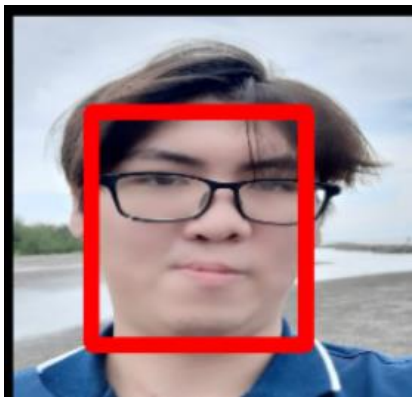
```
Epoch 199/200
10/10 [==============================] - 2s 161ms/step - loss: 4.9854e-04
Epoch 200/200
10/10 [==============================] - 2s 161ms/step - loss: 4.3969e-04

<keras.callbacks.History at 0x7fb728525150>
```

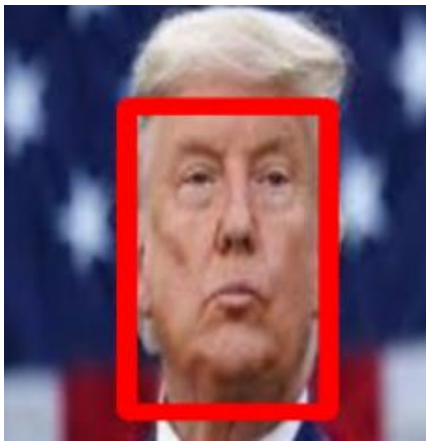
Save model

```
model.save('face.h5')
```

Result:







Human Age regression training

A person's age cannot be precisely determined by facial appearance, instead, we estimate a person's age in a certain age range by using regression with CNN for image feature extraction, the loss function is mse

Build model

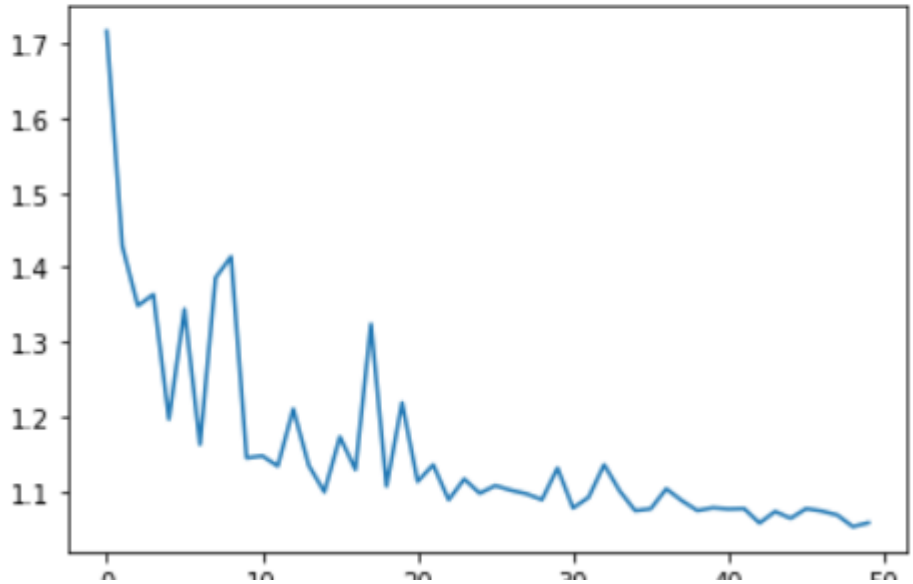
```
model = Sequential()
model.add(Conv2D(32,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same',input_shape=(100,100,3)))
model.add(Conv2D(32,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Conv2D(64,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(64,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Conv2D(128,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(128,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Conv2D(256,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(256,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(Conv2D(512,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(512,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Flatten())
model.add(Dropout(0.2))
model.add(Dense(252,activation='relu'))
model.add(Dense(128,activation='relu'))
model.add(Dense(1,activation='linear'))
model.compile(loss='mse',optimizer=keras.optimizers.Adam(),metrics=['mae'])
model.summary()
```

Loss result of model:

```
Epoch 46/50
646/646 [==============================] - 77s 119ms/step - loss: 0.1639 - mae: 0.2837 - val_loss: 2.4702 - val_mae: 1.0763
Epoch 47/50
646/646 [==============================] - 77s 119ms/step - loss: 0.1600 - mae: 0.2780 - val_loss: 2.5382 - val_mae: 1.0730
Epoch 48/50
646/646 [==============================] - 77s 119ms/step - loss: 0.1591 - mae: 0.2784 - val_loss: 2.4481 - val_mae: 1.0677
Epoch 49/50
646/646 [==============================] - 77s 119ms/step - loss: 0.1550 - mae: 0.2736 - val_loss: 2.3827 - val_mae: 1.0521
Epoch 50/50
646/646 [==============================] - 77s 119ms/step - loss: 0.1418 - mae: 0.2614 - val_loss: 2.4635 - val_mae: 1.0573
```

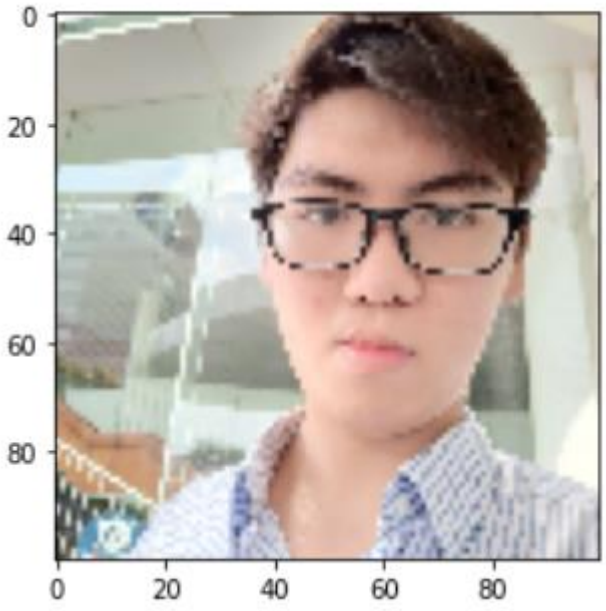
```
[ ]  plt.plot(hist.history['val_mae'])
```

```
[<matplotlib.lines.Line2D at 0x7fc24eee0c50>]
```

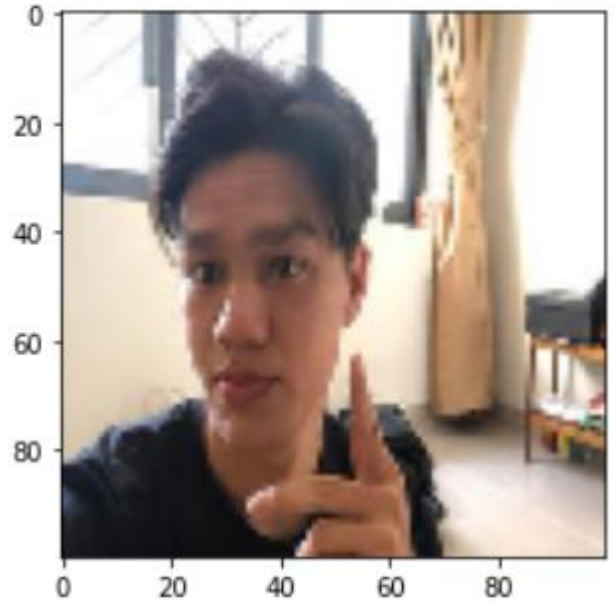


Testing result

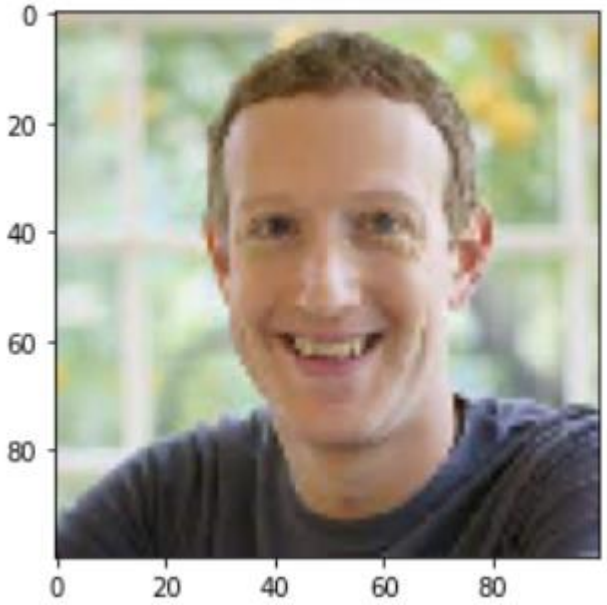
```
expectation 21-25 tuoi
```



expectation 21-25 tuoi



expectation 36-40 tuoi



Sex classification training

There ‘re only 2 biological genders: male and female

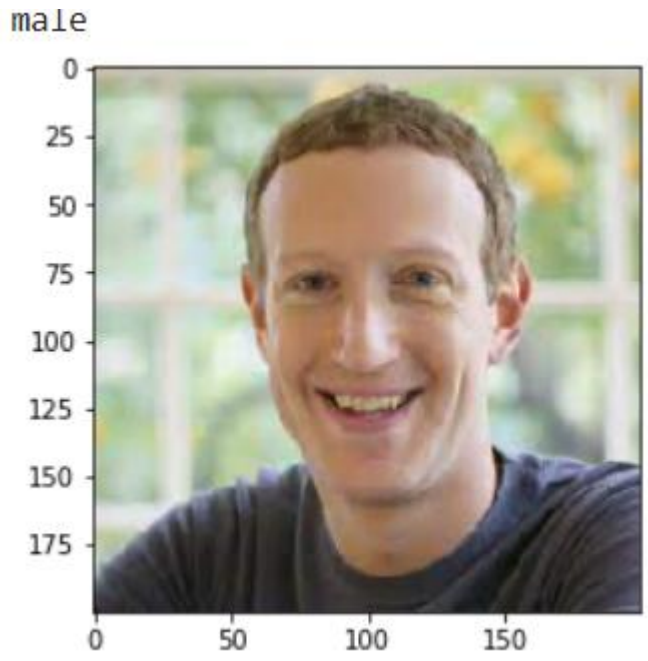
The label of genders data is binary data which mean only 0 and 1

The output of model for sex classification is 1 with the activation function sigmoid

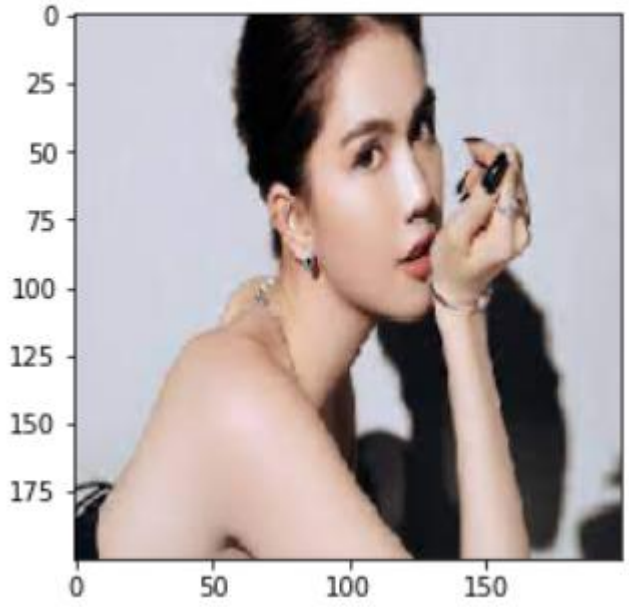
Which mean we are gonna use logistic classication with CNN model

```
model = Sequential()
model.add(Conv2D(32,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same',input_shape=(200,200,3)))
model.add(Conv2D(32,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Conv2D(64,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(64,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Conv2D(128,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(128,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Conv2D(256,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(256,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(Conv2D(512,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(Conv2D(512,(3,3),activation='relu',kernel_initializer='he_uniform',padding='same'))
model.add(MaxPooling2D((2,2)))
model.add(BatchNormalization())
model.add(Flatten())
model.add(Dropout(0.2))
model.add(Dense(252,activation='relu'))
model.add(Dense(128,activation='relu'))
model.add(Dense(1,activation='sigmoid'))
model.compile(loss='binary_crossentropy',optimizer=keras.optimizers.Adam(),metrics=['accuracy'])
model.summary()
```

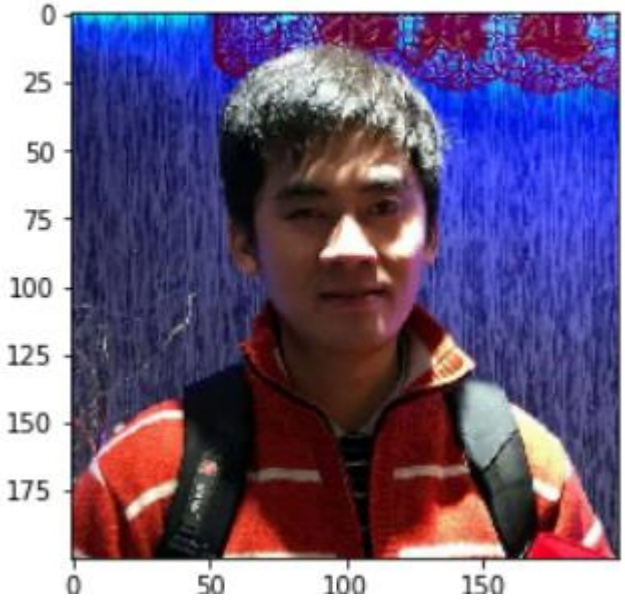
Testing result:



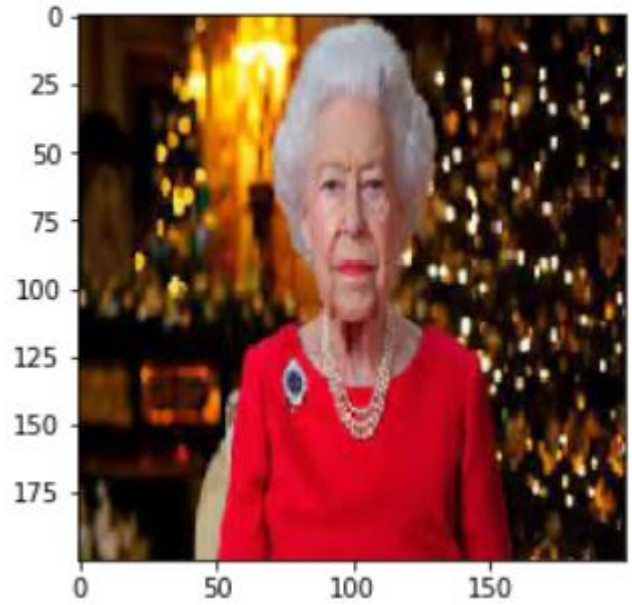
```
female
[[0.9980172]]
```




```
male
[[2.3027935e-06]]
```



```
female
[[0.98984843]]
```



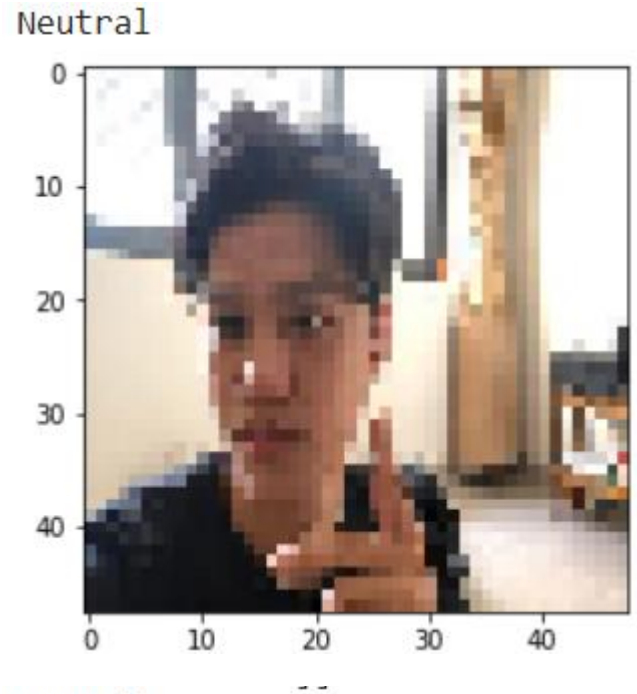
Facial emotion classification training

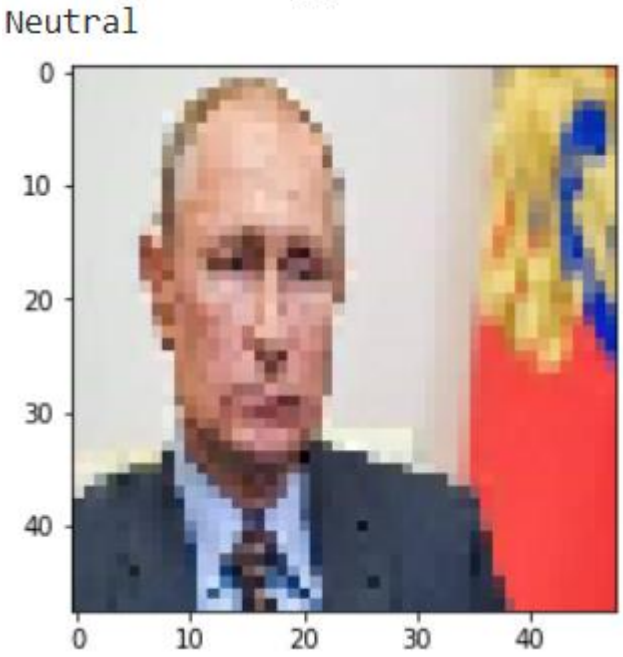
There ar 6 facial emotion of human, so we use CNN with sofmaxt function to classify them

```
# Block-4
model.add(Conv2D(256,(3,3),padding='same',kernel_initializer='he_normal'))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Conv2D(256,(3,3),padding='same',kernel_initializer='he_normal'))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Dropout(0.2))

# Block-5
model.add(Flatten())
model.add(Dense(64,kernel_initializer='he_normal'))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Dropout(0.5))

# Block-6
model.add(Dense(64,kernel_initializer='he_normal'))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Dropout(0.5))

# Block-7
model.add(Dense(6,kernel_initializer='he_normal'))
model.add(Activation('softmax'))
model.compile(loss='categorical_crossentropy',optimizer=keras.optimizers.Adam(),metrics=['accuracy'])
```

```
693/693 [==============================] - 9s 14ms/step - loss: 0.1560 - accuracy: 0.9512 - val_loss: 2.9832 - val_accuracy: 0.5556
Epoch 46/50
693/693 [==============================] - 9s 13ms/step - loss: 0.1587 - accuracy: 0.9499 - val_loss: 2.2803 - val_accuracy: 0.6552
Epoch 47/50
693/693 [==============================] - 10s 14ms/step - loss: 0.1480 - accuracy: 0.9535 - val_loss: 2.2947 - val_accuracy: 0.6470
Epoch 48/50
693/693 [==============================] - 9s 13ms/step - loss: 0.1544 - accuracy: 0.9523 - val_loss: 1.8658 - val_accuracy: 0.7015
Epoch 49/50
693/693 [==============================] - 9s 13ms/step - loss: 0.1446 - accuracy: 0.9531 - val_loss: 2.6135 - val_accuracy: 0.6060
Epoch 50/50
693/693 [==============================] - 9s 13ms/step - loss: 0.1467 - accuracy: 0.9526 - val_loss: 2.5204 - val_accuracy: 0.5983
```

Testing result:





Realtime

Load model

```
model = load_model('face.h5')
model1 = load_model('linear.h5')
model2 = load_model('gender.h5')
model3 = load_model('emotion.h5')
```

Make label

```
label = {0: '1-5 ',
         1: '6-10 ',
         2: '11-15 ',
         3: '16-20 ',
         4: '21-25 ',
         5: '26-30 ',
         6: '31-35 ',
         7: '36-40 ',
         8: '41-45 ',
         9: '46-50 ',
         10: '51-55 ',
         11: '56-60 ',
         12: '61-65 ',
         13: '65-70 ',
         14: '71 -75 ',
         15: '75-80 ',
         16: '80-85 ',
         17: '85 tro len'}
gender_labels = ['Male', 'Female']
emotion_labels=['Angry','Disgust','Happy','Neutral','sad','Surprise']
```

‘face’ is the location of facial bouding box

extract the corner xmin ymin xmax ymax from ‘face’

draw the bouding box with cv.rectangle() function

```
face = model.predict(face.reshape(1,225,225,3))
gray=cv.cvtColor(frame,cv.COLOR_BGR2GRAY)

for (x1,y1,x2,y2) in face:
    #cv.rectangle(frame,(int(x1*680),int(y1*480)),(int(x2*680),int(y2*480)),(255,0,0),2)
    cv.rectangle(frame,(int(x1*670),int(y1*680)),(int(x2*680),int(y2*680)),(255,0,0),2)
    #roi_color=frame[int(y1*480):int(y2*480),int(x1*680):int(x2*680)]
```

Predict the age of human

```
roi_color=frame[int(y1*680):int(y2*680),int(x1*680):int(x2*680)]
roi_color=cv.resize(roi_color,(100,100),interpolation=cv.INTER_AREA)
result = model1.predict(np.array(roi_color).reshape(-1,100,100,3))
labels=label[(int(result))]
label_position=(int(x1*225),int(y2*225)+10) #50 pixels below to move the label
cv.putText(frame,labels,label_position,cv.FONT_HERSHEY_SIMPLEX,1,(0,255,0),2)
```

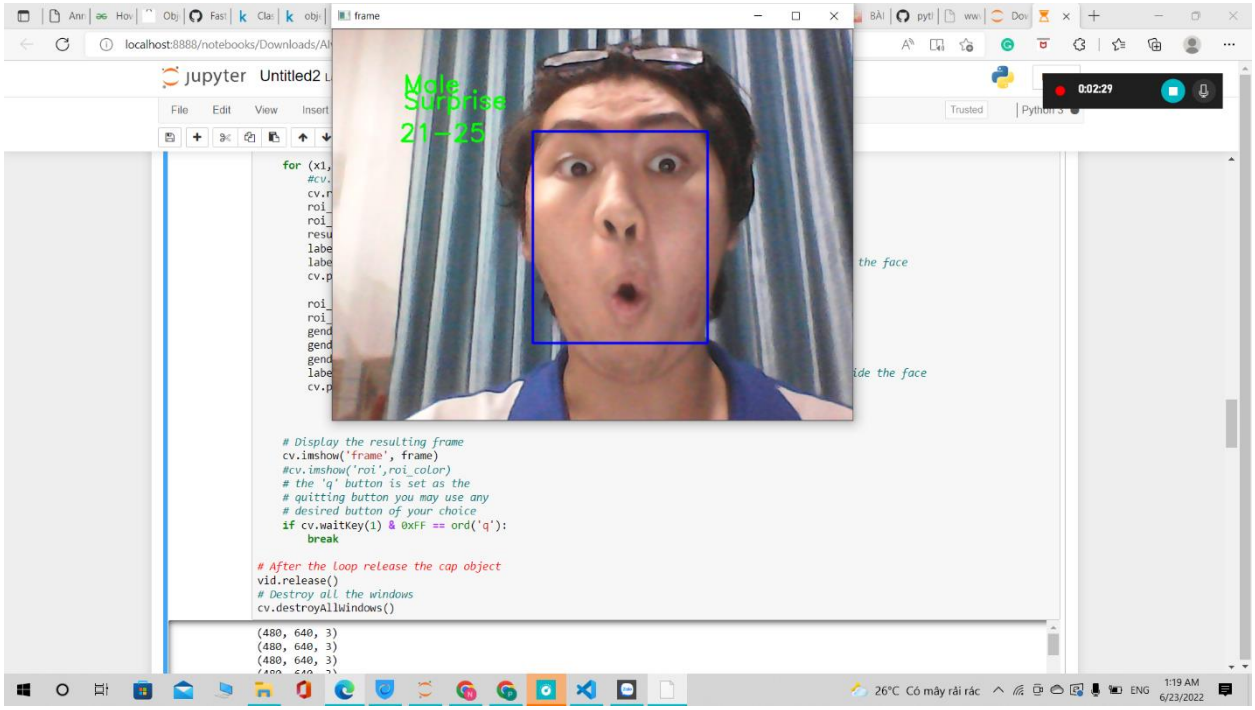
Predict the gender of human

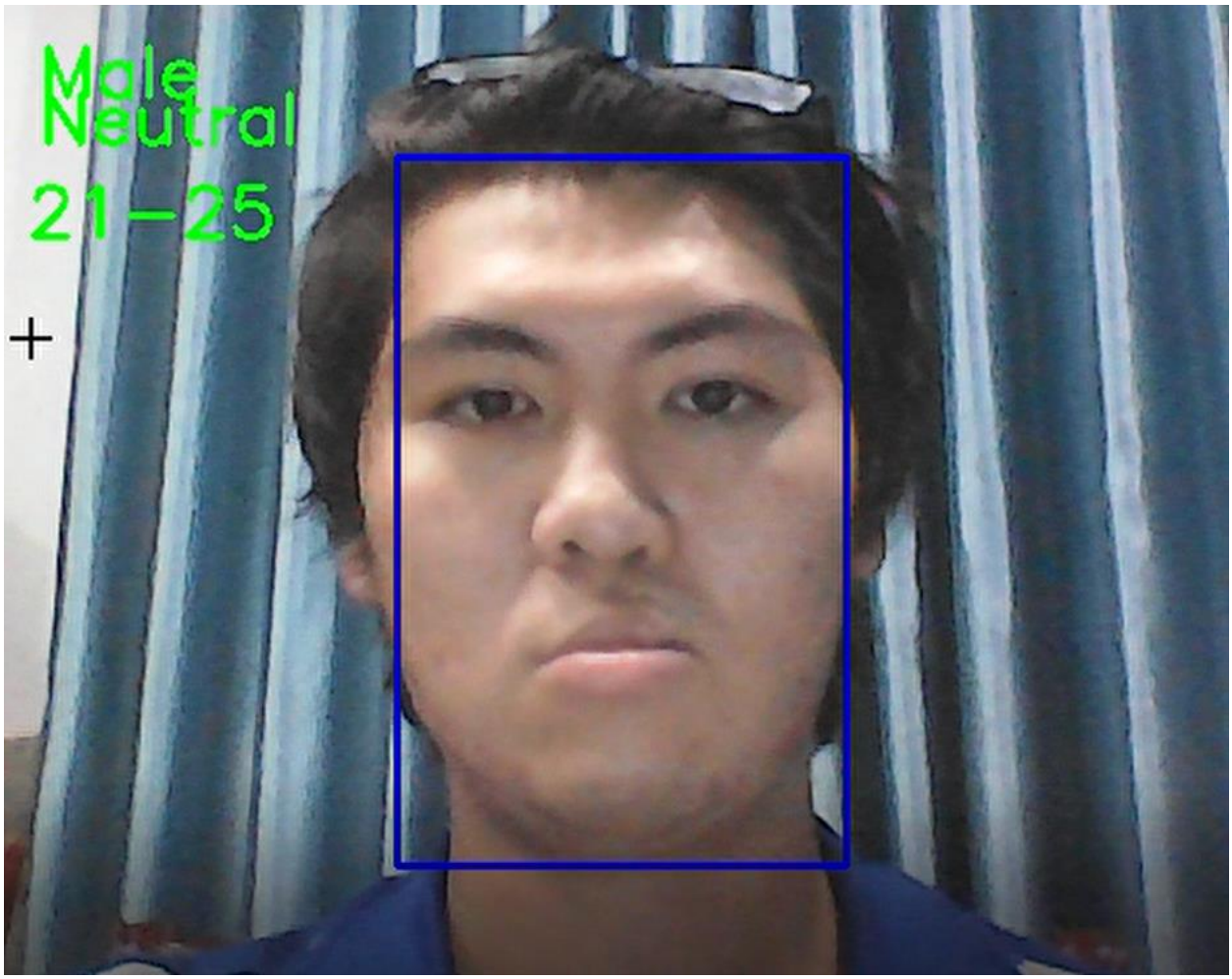
```
roi_gender=frame[int(y1*680):int(y2*680),int(x1*680):int(x2*680)]
roi_gender=cv.resize(roi_gender,(200,200),interpolation=cv.INTER_AREA)
gender = model2.predict(np.array(roi_gender).reshape(-1,200,200,3))
gender = (gender>= 0.5).astype(int)[:,0]
gender_label=gender_labels[gender[0]]
label_position1=(int(x1*225)+5,int(y2*225)-50) #50 pixels below to move the label oqut
cv.putText(frame,gender_label,label_position1,cv.FONT_HERSHEY_SIMPLEX,1,(0,255,0),2)
```

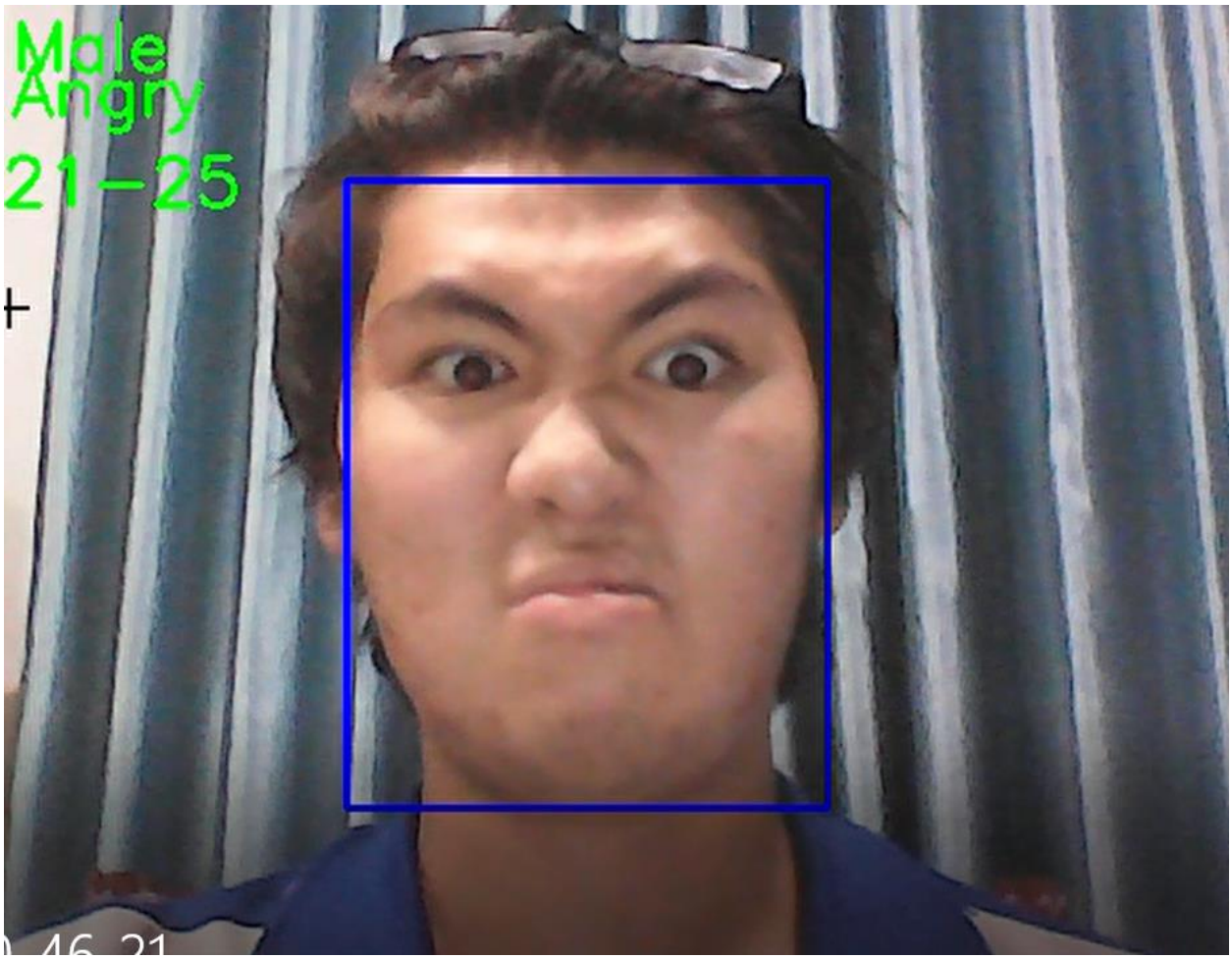
Predict the facial emotion

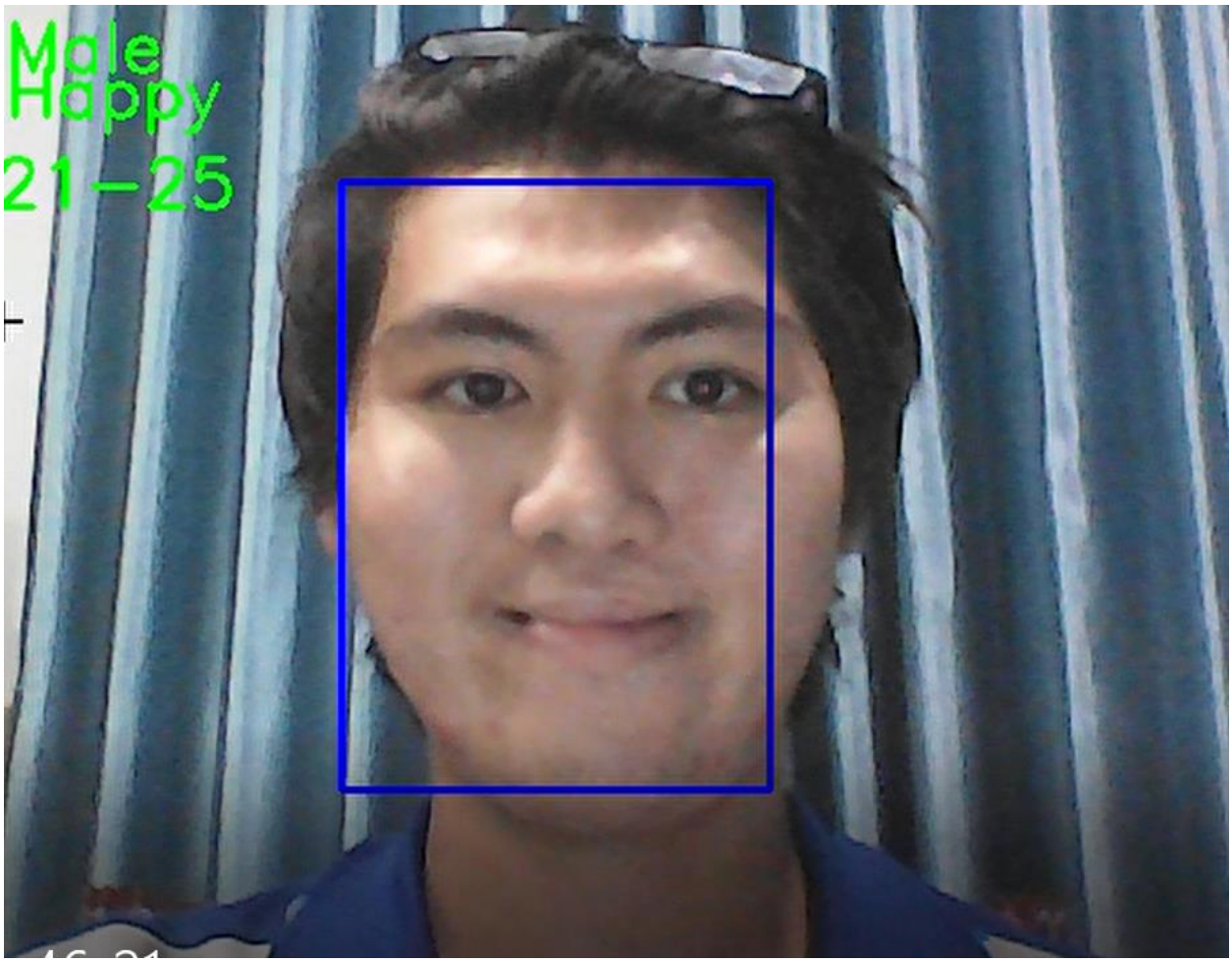
```
roi_emo=gray[int(y1*680):int(y2*680),int(x1*680):int(x2*680)]
roi_emo=cv.resize(roi_emo,(48,48),interpolation=cv.INTER_AREA)
emo = model3.predict(np.array(roi_emo).reshape(-1,48,48,1))
```

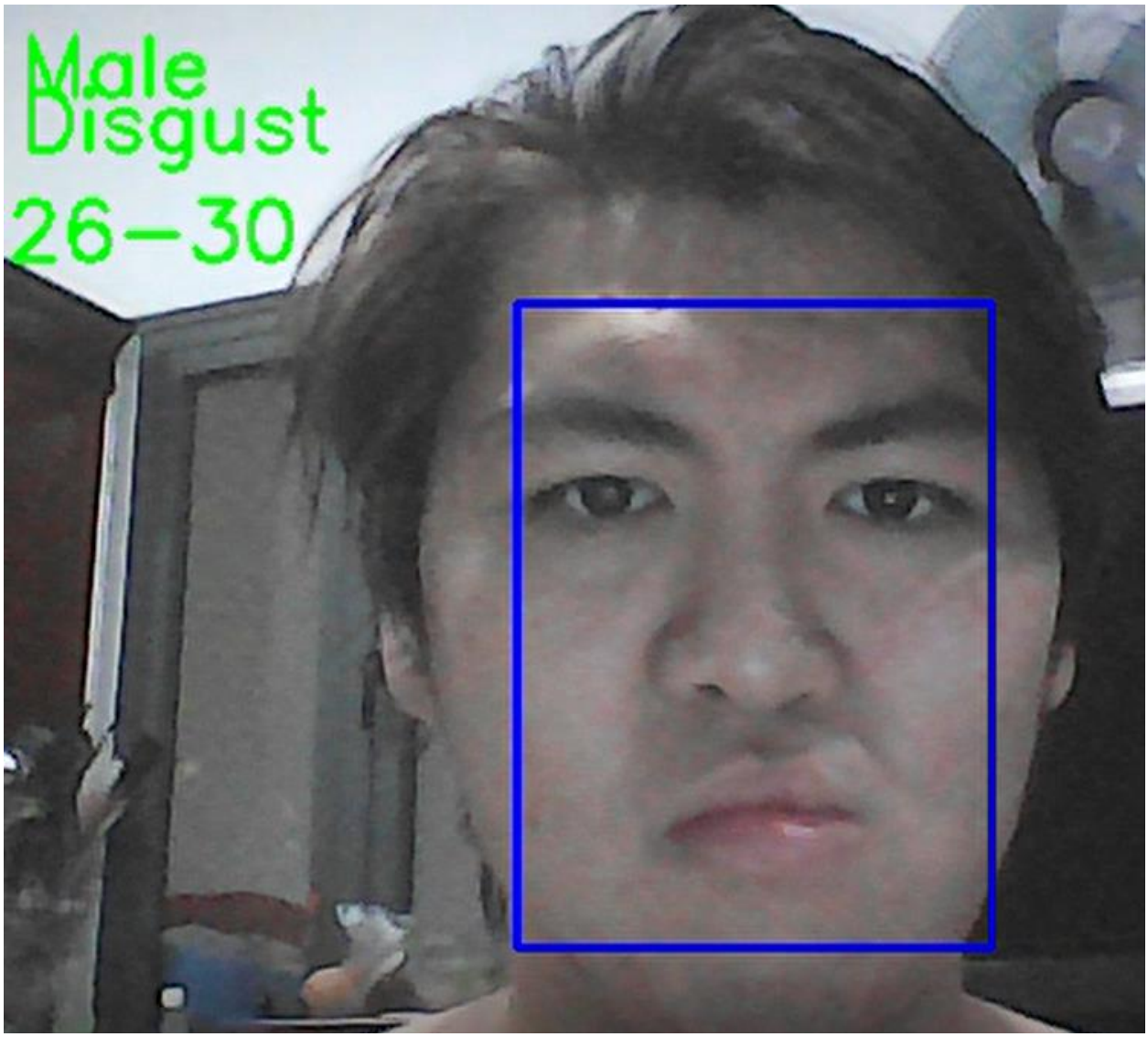
Real-time result




Male
Neutral
21-25


Male
Angry
21-25


Male
Happy
21-25


Male
Disgust
26-30