In [1]:
```
import tensorflow as tf
import cv2
import os
import matplotlib.pyplot as plt
import numpy as np
```

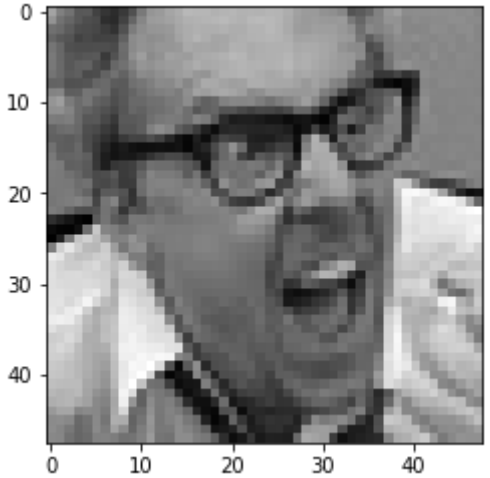
In [2]:
```
img_array = cv2.imread("Training/0/Training_3908.jpg")
```

In [3]:
```
img_array.shape
```

Out[3]:
```
(48, 48, 3)
```

In [4]:
```
plt.imshow(img_array)
```

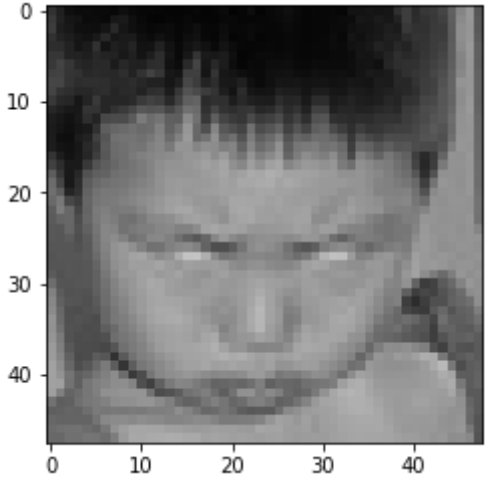
Out[4]:
```
<matplotlib.image.AxesImage at 0x229b8fa0748>
```



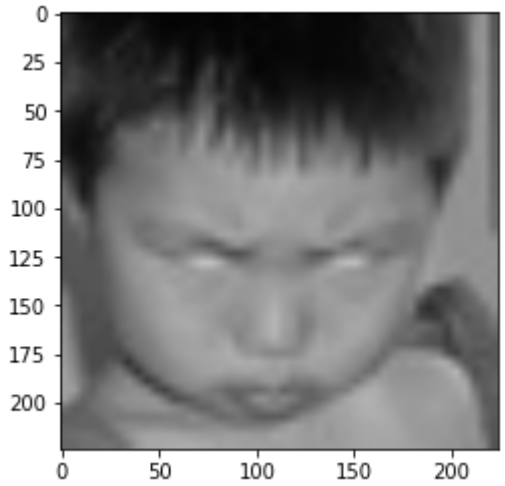
In [5]:
```
Datadirectory = "Training/"
```

In [6]:
```
Classes = ["0","1","2","3","4","5","6"] ##name of folders
```

In [7]:
```
for category in Classes:
    path = os.path.join(Datadirectory, category)
    for img in os.listdir(path):
        img_array = cv2.imread(os.path.join(path,img))
        plt.imshow(cv2.cvtColor(img_array, cv2.COLOR_BGR2RGB))
        plt.show()
        break
    break
```



In [8]:
```
img_size = 224 ##Imagenet dataset images size is 224*224
new_array = cv2.resize(img_array,(img_size,img_size))
plt.imshow(cv2.cvtColor(new_array, cv2.COLOR_BGR2RGB))
plt.show()
```



In [9]:
```
new_array.shape
```

Out[9]: (224, 224, 3)

Reading all the Images and convert them to array

In [10]:
```
training_Data = []
def create_training_Data():
    for category in Classes:
        path = os.path.join(Datadirectory, category)
        class_num = Classes.index(category)
        for img in os.listdir(path):
            try:
                img_array = cv2.imread(os.path.join(path,img))
                new_array = cv2.resize(img_array,(img_size,img_size))
                training_Data.append([new_array,class_num])
            except Exception as e:
                pass
```

In [11]:
```
create_training_Data()
```

In [12]:
```
print(len(training_Data))
```

```
3052
```

In [13]:
```
import random
random.shuffle(training_Data)
```

In [14]:
```
X = [] ## data/feature
y = [] ##label
for features,label in training_Data:
    X.append(features)
    y.append(label)

X = np.array(X).reshape(-1,img_size,img_size,3) ##converting to 4dimensions
```

In [15]:
```
X.shape
```

Out[15]:
```
(3052, 224, 224, 3)
```

In [16]:
```
print(img_array)
```

```
[[[ 50  50  50]
  [ 32  32  32]
  [ 15  15  15]
  ...
  [133 133 133]
  [151 151 151]
  [ 86  86  86]]

 [[ 57  57  57]
  [ 34  34  34]
  [ 22  22  22]
  ...
  [138 138 138]
  [151 151 151]
  [ 89  89  89]]

 [[ 61  61  61]
  [ 30  30  30]
  [ 24  24  24]
```

```
 ...
 [142 142 142]
 [149 149 149]
 [ 89  89  89]]

...

[[103 103 103]
 [100 100 100]
 [100 100 100]
 ...
 [149 149 149]
 [104 104 104]
 [ 85  85  85]]

[[107 107 107]
 [111 111 111]
 [113 113 113]
 ...
 [151 151 151]
 [120 120 120]
 [ 86  86  86]]

[[104 104 104]
 [104 104 104]
 [112 112 112]
 ...
 [143 143 143]
 [136 136 136]
 [ 83  83  83]]]
```

In [17]:
```
X=X/255.0
```

In [18]:
```
X[0]
```

Out[18]:
```
array([[[0.99607843, 0.99607843, 0.99607843],
        [0.99607843, 0.99607843, 0.99607843],
        [0.99607843, 0.99607843, 0.99607843],
        ...,
        [0.99607843, 0.99607843, 0.99607843],
        [0.99607843, 0.99607843, 0.99607843],
        [0.99607843, 0.99607843, 0.99607843]],

       [[0.99607843, 0.99607843, 0.99607843],
```

```
        [0.99607843, 0.99607843, 0.99607843],
        [0.99607843, 0.99607843, 0.99607843],
        ...,
        [0.99607843, 0.99607843, 0.99607843],
        [0.99607843, 0.99607843, 0.99607843],
        [0.99607843, 0.99607843, 0.99607843]],

       [[0.97647059, 0.97647059, 0.97647059],
        [0.97647059, 0.97647059, 0.97647059],
        [0.97647059, 0.97647059, 0.97647059],
        ...,
        [0.98039216, 0.98039216, 0.98039216],
        [0.98039216, 0.98039216, 0.98039216],
        [0.98039216, 0.98039216, 0.98039216]],

       ...,

       [[0.21960784, 0.21960784, 0.21960784],
        [0.21960784, 0.21960784, 0.21960784],
        [0.21960784, 0.21960784, 0.21960784],
        ...,
        [0.34117647, 0.34117647, 0.34117647],
        [0.34117647, 0.34117647, 0.34117647],
        [0.34117647, 0.34117647, 0.34117647]],

       [[0.21960784, 0.21960784, 0.21960784],
        [0.21960784, 0.21960784, 0.21960784],
        [0.21960784, 0.21960784, 0.21960784],
        ...,
        [0.34117647, 0.34117647, 0.34117647],
        [0.34117647, 0.34117647, 0.34117647],
        [0.34117647, 0.34117647, 0.34117647]],

       [[0.21960784, 0.21960784, 0.21960784],
        [0.21960784, 0.21960784, 0.21960784],
        [0.21960784, 0.21960784, 0.21960784],
        ...,
        [0.34117647, 0.34117647, 0.34117647],
        [0.34117647, 0.34117647, 0.34117647],
        [0.34117647, 0.34117647, 0.34117647]]])
```

In [19]:
```
y[1000]
```

Out[19]: 3

In [20]:
```
Y = np.array(y)
```

In [21]:
```
Y.shape
```

Out[21]:
```
(3052,)
```

Our model for Training

In [22]:
```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
```

In [23]:
```
model = tf.keras.applications.MobileNetV2() ##Pre-trained model
```

In [24]:
```
model.summary()
```

```
Model: "mobilenetv2_1.00_224"
__________________________________________________________________________________________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================================
 input_1 (InputLayer)           [(None, 224, 224, 3  0           []
                                )]

 Conv1 (Conv2D)                 (None, 112, 112, 32  864         ['input_1[0][0]']
                                )

 bn_Conv1 (BatchNormalization)  (None, 112, 112, 32  128         ['Conv1[0][0]']
                                )

 Conv1_relu (ReLU)              (None, 112, 112, 32  0           ['bn_Conv1[0][0]']
                                )

 expanded_conv_depthwise (Depth  (None, 112, 112, 32  288        ['Conv1_relu[0][0]']
 wiseConv2D)                    )

 expanded_conv_depthwise_BN (Ba  (None, 112, 112, 32  128        ['expanded_conv_depthwise[0][0]']
 tchNormalization)              )
```

```
expanded_conv_depthwise_relu (  (None, 112, 112, 32  0          ['expanded_conv_depthwise_BN[0][0
ReLU)                           )                                ]']

expanded_conv_project (Conv2D)  (None, 112, 112, 16  512        ['expanded_conv_depthwise_relu[0]
                                )                                [0]']

expanded_conv_project_BN (Batc  (None, 112, 112, 16  64         ['expanded_conv_project[0][0]']
hNormalization)                 )

block_1_expand (Conv2D)         (None, 112, 112, 96  1536        ['expanded_conv_project_BN[0][0]'
                                )                                ]

block_1_expand_BN (BatchNormal  (None, 112, 112, 96  384        ['block_1_expand[0][0]']
ization)                        )

block_1_expand_relu (ReLU)      (None, 112, 112, 96  0          ['block_1_expand_BN[0][0]']
                                )

block_1_pad (ZeroPadding2D)     (None, 113, 113, 96  0          ['block_1_expand_relu[0][0]']
                                )

block_1_depthwise (DepthwiseCo  (None, 56, 56, 96)  864         ['block_1_pad[0][0]']
nv2D)

block_1_depthwise_BN (BatchNor  (None, 56, 56, 96)  384         ['block_1_depthwise[0][0]']
malization)

block_1_depthwise_relu (ReLU)  (None, 56, 56, 96)   0          ['block_1_depthwise_BN[0][0]']

block_1_project (Conv2D)       (None, 56, 56, 24)   2304        ['block_1_depthwise_relu[0][0]']

block_1_project_BN (BatchNorma  (None, 56, 56, 24)  96          ['block_1_project[0][0]']
lization)

block_2_expand (Conv2D)         (None, 56, 56, 144)  3456        ['block_1_project_BN[0][0]']

block_2_expand_BN (BatchNormal  (None, 56, 56, 144)  576        ['block_2_expand[0][0]']
ization)

block_2_expand_relu (ReLU)      (None, 56, 56, 144)  0          ['block_2_expand_BN[0][0]']

block_2_depthwise (DepthwiseCo  (None, 56, 56, 144)  1296       ['block_2_expand_relu[0][0]']
nv2D)

block_2_depthwise_BN (BatchNor  (None, 56, 56, 144)  576        ['block_2_depthwise[0][0]']
malization)
```

```
block_2_depthwise_relu (ReLU)  (None, 56, 56, 144)  0           ['block_2_depthwise_BN[0][0]']

block_2_project (Conv2D)       (None, 56, 56, 24)   3456        ['block_2_depthwise_relu[0][0]']

block_2_project_BN (BatchNorma  (None, 56, 56, 24)  96          ['block_2_project[0][0]']
lization)

block_2_add (Add)              (None, 56, 56, 24)   0           ['block_1_project_BN[0][0]',
                                                                 'block_2_project_BN[0][0]']

block_3_expand (Conv2D)        (None, 56, 56, 144)  3456        ['block_2_add[0][0]']

block_3_expand_BN (BatchNormal  (None, 56, 56, 144)  576        ['block_3_expand[0][0]']
ization)

block_3_expand_relu (ReLU)     (None, 56, 56, 144)  0           ['block_3_expand_BN[0][0]']

block_3_pad (ZeroPadding2D)    (None, 57, 57, 144)  0           ['block_3_expand_relu[0][0]']

block_3_depthwise (DepthwiseCo  (None, 28, 28, 144)  1296       ['block_3_pad[0][0]']
nv2D)

block_3_depthwise_BN (BatchNor  (None, 28, 28, 144)  576        ['block_3_depthwise[0][0]']
malization)

block_3_depthwise_relu (ReLU)  (None, 28, 28, 144)  0           ['block_3_depthwise_BN[0][0]']

block_3_project (Conv2D)       (None, 28, 28, 32)   4608        ['block_3_depthwise_relu[0][0]']

block_3_project_BN (BatchNorma  (None, 28, 28, 32)  128         ['block_3_project[0][0]']
lization)

block_4_expand (Conv2D)        (None, 28, 28, 192)  6144        ['block_3_project_BN[0][0]']

block_4_expand_BN (BatchNormal  (None, 28, 28, 192)  768        ['block_4_expand[0][0]']
ization)

block_4_expand_relu (ReLU)     (None, 28, 28, 192)  0           ['block_4_expand_BN[0][0]']

block_4_depthwise (DepthwiseCo  (None, 28, 28, 192)  1728       ['block_4_expand_relu[0][0]']
nv2D)

block_4_depthwise_BN (BatchNor  (None, 28, 28, 192)  768        ['block_4_depthwise[0][0]']
malization)

block_4_depthwise_relu (ReLU)  (None, 28, 28, 192)  0           ['block_4_depthwise_BN[0][0]']
```

```
block_4_project (Conv2D)       (None, 28, 28, 32)   6144        ['block_4_depthwise_relu[0][0]']

block_4_project_BN (BatchNorma  (None, 28, 28, 32)  128         ['block_4_project[0][0]']
lization)

block_4_add (Add)              (None, 28, 28, 32)   0           ['block_3_project_BN[0][0]',
                                                                 'block_4_project_BN[0][0]']

block_5_expand (Conv2D)        (None, 28, 28, 192)  6144        ['block_4_add[0][0]']

block_5_expand_BN (BatchNormal  (None, 28, 28, 192)  768        ['block_5_expand[0][0]']
ization)

block_5_expand_relu (ReLU)     (None, 28, 28, 192)  0           ['block_5_expand_BN[0][0]']

block_5_depthwise (DepthwiseCo  (None, 28, 28, 192)  1728       ['block_5_expand_relu[0][0]']
nv2D)

block_5_depthwise_BN (BatchNor  (None, 28, 28, 192)  768        ['block_5_depthwise[0][0]']
malization)

block_5_depthwise_relu (ReLU)  (None, 28, 28, 192)  0           ['block_5_depthwise_BN[0][0]']

block_5_project (Conv2D)       (None, 28, 28, 32)   6144        ['block_5_depthwise_relu[0][0]']

block_5_project_BN (BatchNorma  (None, 28, 28, 32)  128         ['block_5_project[0][0]']
lization)

block_5_add (Add)              (None, 28, 28, 32)   0           ['block_4_add[0][0]',
                                                                 'block_5_project_BN[0][0]']

block_6_expand (Conv2D)        (None, 28, 28, 192)  6144        ['block_5_add[0][0]']

block_6_expand_BN (BatchNormal  (None, 28, 28, 192)  768        ['block_6_expand[0][0]']
ization)

block_6_expand_relu (ReLU)     (None, 28, 28, 192)  0           ['block_6_expand_BN[0][0]']

block_6_pad (ZeroPadding2D)    (None, 29, 29, 192)  0           ['block_6_expand_relu[0][0]']

block_6_depthwise (DepthwiseCo  (None, 14, 14, 192)  1728       ['block_6_pad[0][0]']
nv2D)

block_6_depthwise_BN (BatchNor  (None, 14, 14, 192)  768        ['block_6_depthwise[0][0]']
malization)

block_6_depthwise_relu (ReLU)  (None, 14, 14, 192)  0           ['block_6_depthwise_BN[0][0]']
```

```
block_6_project (Conv2D)       (None, 14, 14, 64)   12288       ['block_6_depthwise_relu[0][0]']

block_6_project_BN (BatchNorma  (None, 14, 14, 64)  256         ['block_6_project[0][0]']
lization)

block_7_expand (Conv2D)        (None, 14, 14, 384)  24576       ['block_6_project_BN[0][0]']

block_7_expand_BN (BatchNormal  (None, 14, 14, 384)  1536        ['block_7_expand[0][0]']
ization)

block_7_expand_relu (ReLU)     (None, 14, 14, 384)  0           ['block_7_expand_BN[0][0]']

block_7_depthwise (DepthwiseCo  (None, 14, 14, 384)  3456        ['block_7_expand_relu[0][0]']
nv2D)

block_7_depthwise_BN (BatchNor  (None, 14, 14, 384)  1536        ['block_7_depthwise[0][0]']
malization)

block_7_depthwise_relu (ReLU)  (None, 14, 14, 384)  0           ['block_7_depthwise_BN[0][0]']

block_7_project (Conv2D)       (None, 14, 14, 64)   24576       ['block_7_depthwise_relu[0][0]']

block_7_project_BN (BatchNorma  (None, 14, 14, 64)  256         ['block_7_project[0][0]']
lization)

block_7_add (Add)              (None, 14, 14, 64)   0           ['block_6_project_BN[0][0]',
                                                                 'block_7_project_BN[0][0]']

block_8_expand (Conv2D)        (None, 14, 14, 384)  24576       ['block_7_add[0][0]']

block_8_expand_BN (BatchNormal  (None, 14, 14, 384)  1536        ['block_8_expand[0][0]']
ization)

block_8_expand_relu (ReLU)     (None, 14, 14, 384)  0           ['block_8_expand_BN[0][0]']

block_8_depthwise (DepthwiseCo  (None, 14, 14, 384)  3456        ['block_8_expand_relu[0][0]']
nv2D)

block_8_depthwise_BN (BatchNor  (None, 14, 14, 384)  1536        ['block_8_depthwise[0][0]']
malization)

block_8_depthwise_relu (ReLU)  (None, 14, 14, 384)  0           ['block_8_depthwise_BN[0][0]']

block_8_project (Conv2D)       (None, 14, 14, 64)   24576       ['block_8_depthwise_relu[0][0]']

block_8_project_BN (BatchNorma  (None, 14, 14, 64)  256         ['block_8_project[0][0]']
```

```
lization)

block_8_add (Add)              (None, 14, 14, 64)   0           ['block_7_add[0][0]',
                                                                 'block_8_project_BN[0][0]']

block_9_expand (Conv2D)        (None, 14, 14, 384)  24576       ['block_8_add[0][0]']

block_9_expand_BN (BatchNormal  (None, 14, 14, 384)  1536       ['block_9_expand[0][0]']
ization)

block_9_expand_relu (ReLU)     (None, 14, 14, 384)  0           ['block_9_expand_BN[0][0]']

block_9_depthwise (DepthwiseCo  (None, 14, 14, 384)  3456       ['block_9_expand_relu[0][0]']
nv2D)

block_9_depthwise_BN (BatchNor  (None, 14, 14, 384)  1536       ['block_9_depthwise[0][0]']
malization)

block_9_depthwise_relu (ReLU)  (None, 14, 14, 384)  0           ['block_9_depthwise_BN[0][0]']

block_9_project (Conv2D)       (None, 14, 14, 64)   24576       ['block_9_depthwise_relu[0][0]']

block_9_project_BN (BatchNorma  (None, 14, 14, 64)  256         ['block_9_project[0][0]']
lization)

block_9_add (Add)              (None, 14, 14, 64)   0           ['block_8_add[0][0]',
                                                                 'block_9_project_BN[0][0]']

block_10_expand (Conv2D)       (None, 14, 14, 384)  24576       ['block_9_add[0][0]']

block_10_expand_BN (BatchNorma  (None, 14, 14, 384)  1536       ['block_10_expand[0][0]']
lization)

block_10_expand_relu (ReLU)    (None, 14, 14, 384)  0           ['block_10_expand_BN[0][0]']

block_10_depthwise (DepthwiseC  (None, 14, 14, 384)  3456       ['block_10_expand_relu[0][0]']
onv2D)

block_10_depthwise_BN (BatchNo  (None, 14, 14, 384)  1536       ['block_10_depthwise[0][0]']
rmalization)

block_10_depthwise_relu (ReLU)  (None, 14, 14, 384)  0         ['block_10_depthwise_BN[0][0]']

block_10_project (Conv2D)      (None, 14, 14, 96)   36864       ['block_10_depthwise_relu[0][0]']

block_10_project_BN (BatchNorm  (None, 14, 14, 96)  384         ['block_10_project[0][0]']
alization)
```

```
block_11_expand (Conv2D)       (None, 14, 14, 576)  55296       ['block_10_project_BN[0][0]']

block_11_expand_BN (BatchNorma  (None, 14, 14, 576)  2304       ['block_11_expand[0][0]']
lization)

block_11_expand_relu (ReLU)    (None, 14, 14, 576)  0          ['block_11_expand_BN[0][0]']

block_11_depthwise (DepthwiseC  (None, 14, 14, 576)  5184       ['block_11_expand_relu[0][0]']
onv2D)

block_11_depthwise_BN (BatchNo  (None, 14, 14, 576)  2304       ['block_11_depthwise[0][0]']
rmalization)

block_11_depthwise_relu (ReLU)  (None, 14, 14, 576)  0          ['block_11_depthwise_BN[0][0]']

block_11_project (Conv2D)      (None, 14, 14, 96)   55296       ['block_11_depthwise_relu[0][0]']

block_11_project_BN (BatchNorm  (None, 14, 14, 96)  384        ['block_11_project[0][0]']
alization)

block_11_add (Add)             (None, 14, 14, 96)   0          ['block_10_project_BN[0][0]',
                                                                'block_11_project_BN[0][0]']

block_12_expand (Conv2D)       (None, 14, 14, 576)  55296       ['block_11_add[0][0]']

block_12_expand_BN (BatchNorma  (None, 14, 14, 576)  2304       ['block_12_expand[0][0]']
lization)

block_12_expand_relu (ReLU)    (None, 14, 14, 576)  0          ['block_12_expand_BN[0][0]']

block_12_depthwise (DepthwiseC  (None, 14, 14, 576)  5184       ['block_12_expand_relu[0][0]']
onv2D)

block_12_depthwise_BN (BatchNo  (None, 14, 14, 576)  2304       ['block_12_depthwise[0][0]']
rmalization)

block_12_depthwise_relu (ReLU)  (None, 14, 14, 576)  0          ['block_12_depthwise_BN[0][0]']

block_12_project (Conv2D)      (None, 14, 14, 96)   55296       ['block_12_depthwise_relu[0][0]']

block_12_project_BN (BatchNorm  (None, 14, 14, 96)  384        ['block_12_project[0][0]']
alization)

block_12_add (Add)             (None, 14, 14, 96)   0          ['block_11_add[0][0]',
                                                                'block_12_project_BN[0][0]']
```

```
block_13_expand (Conv2D)       (None, 14, 14, 576)  55296       ['block_12_add[0][0]']

block_13_expand_BN (BatchNorma  (None, 14, 14, 576)  2304       ['block_13_expand[0][0]']
lization)

block_13_expand_relu (ReLU)    (None, 14, 14, 576)  0          ['block_13_expand_BN[0][0]']

block_13_pad (ZeroPadding2D)   (None, 15, 15, 576)  0          ['block_13_expand_relu[0][0]']

block_13_depthwise (DepthwiseC  (None, 7, 7, 576)   5184       ['block_13_pad[0][0]']
onv2D)

block_13_depthwise_BN (BatchNo  (None, 7, 7, 576)   2304       ['block_13_depthwise[0][0]']
rmalization)

block_13_depthwise_relu (ReLU)  (None, 7, 7, 576)   0          ['block_13_depthwise_BN[0][0]']

block_13_project (Conv2D)      (None, 7, 7, 160)    92160      ['block_13_depthwise_relu[0][0]']

block_13_project_BN (BatchNorm  (None, 7, 7, 160)   640        ['block_13_project[0][0]']
alization)

block_14_expand (Conv2D)       (None, 7, 7, 960)    153600     ['block_13_project_BN[0][0]']

block_14_expand_BN (BatchNorma  (None, 7, 7, 960)   3840       ['block_14_expand[0][0]']
lization)

block_14_expand_relu (ReLU)    (None, 7, 7, 960)    0          ['block_14_expand_BN[0][0]']

block_14_depthwise (DepthwiseC  (None, 7, 7, 960)   8640       ['block_14_expand_relu[0][0]']
onv2D)

block_14_depthwise_BN (BatchNo  (None, 7, 7, 960)   3840       ['block_14_depthwise[0][0]']
rmalization)

block_14_depthwise_relu (ReLU)  (None, 7, 7, 960)   0          ['block_14_depthwise_BN[0][0]']

block_14_project (Conv2D)      (None, 7, 7, 160)    153600     ['block_14_depthwise_relu[0][0]']

block_14_project_BN (BatchNorm  (None, 7, 7, 160)   640        ['block_14_project[0][0]']
alization)

block_14_add (Add)             (None, 7, 7, 160)    0          ['block_13_project_BN[0][0]',
                                                               'block_14_project_BN[0][0]']

block_15_expand (Conv2D)       (None, 7, 7, 960)    153600     ['block_14_add[0][0]']
```

```
block_15_expand_BN (BatchNorma  (None, 7, 7, 960)   3840        ['block_15_expand[0][0]']
lization)

block_15_expand_relu (ReLU)    (None, 7, 7, 960)    0           ['block_15_expand_BN[0][0]']

block_15_depthwise (DepthwiseC  (None, 7, 7, 960)   8640        ['block_15_expand_relu[0][0]']
onv2D)

block_15_depthwise_BN (BatchNo  (None, 7, 7, 960)   3840        ['block_15_depthwise[0][0]']
rmalization)

block_15_depthwise_relu (ReLU)  (None, 7, 7, 960)   0           ['block_15_depthwise_BN[0][0]']

block_15_project (Conv2D)      (None, 7, 7, 160)    153600      ['block_15_depthwise_relu[0][0]']

block_15_project_BN (BatchNorm  (None, 7, 7, 160)   640         ['block_15_project[0][0]']
alization)

block_15_add (Add)             (None, 7, 7, 160)    0           ['block_14_add[0][0]',
                                                                 'block_15_project_BN[0][0]']

block_16_expand (Conv2D)       (None, 7, 7, 960)    153600      ['block_15_add[0][0]']

block_16_expand_BN (BatchNorma  (None, 7, 7, 960)   3840        ['block_16_expand[0][0]']
lization)

block_16_expand_relu (ReLU)    (None, 7, 7, 960)    0           ['block_16_expand_BN[0][0]']

block_16_depthwise (DepthwiseC  (None, 7, 7, 960)   8640        ['block_16_expand_relu[0][0]']
onv2D)

block_16_depthwise_BN (BatchNo  (None, 7, 7, 960)   3840        ['block_16_depthwise[0][0]']
rmalization)

block_16_depthwise_relu (ReLU)  (None, 7, 7, 960)   0           ['block_16_depthwise_BN[0][0]']

block_16_project (Conv2D)      (None, 7, 7, 320)    307200      ['block_16_depthwise_relu[0][0]']

block_16_project_BN (BatchNorm  (None, 7, 7, 320)   1280        ['block_16_project[0][0]']
alization)

Conv_1 (Conv2D)                (None, 7, 7, 1280)   409600      ['block_16_project_BN[0][0]']

Conv_1_bn (BatchNormalization)  (None, 7, 7, 1280)  5120        ['Conv_1[0][0]']

out_relu (ReLU)                (None, 7, 7, 1280)   0           ['Conv_1_bn[0][0]']
```

```
global_average_pooling2d (Glob  (None, 1280)        0           ['out_relu[0][0]']
alAveragePooling2D)

predictions (Dense)            (None, 1000)         1281000     ['global_average_pooling2d[0][0]'
                                                                ]

==================================================================================================
Total params: 3,538,984
Trainable params: 3,504,872
Non-trainable params: 34,112
__________________________________________________________________________________________________
```

Transfer Learning - Tuning , weights will start from last checkpoint

In [25]:
```
base_input = model.layers[0].input
```

In [26]:
```
base_output = model.layers[-2].output
```

In [27]:
```
base_output
```

Out[27]:
```
<KerasTensor: shape=(None, 1280) dtype=float32 (created by layer 'global_average_pooling2d')>
```

In [28]:
```
final_output = layers.Dense(128)(base_output) ##adding new layer
final_output = layers.Activation('relu')(final_output)
final_output = layers.Dense(64)(final_output)
final_output = layers.Activation('relu')(final_output)
final_output = layers.Dense(7,activation='softmax')(final_output)
```

In [29]:
```
final_output
```

Out[29]:
```
<KerasTensor: shape=(None, 7) dtype=float32 (created by layer 'dense_2')>
```

In [30]:
```
new_model = keras.Model(inputs=base_input,outputs=final_output)
```

In [31]:

```
new_model.summary()
```

```
Model: "model"
__________________________________________________________________________________________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================================
 input_1 (InputLayer)           [(None, 224, 224, 3  0           []
                                )]

 Conv1 (Conv2D)                 (None, 112, 112, 32  864         ['input_1[0][0]']
                                )

 bn_Conv1 (BatchNormalization)  (None, 112, 112, 32  128         ['Conv1[0][0]']
                                )

 Conv1_relu (ReLU)              (None, 112, 112, 32  0           ['bn_Conv1[0][0]']
                                )

 expanded_conv_depthwise (Depth  (None, 112, 112, 32  288        ['Conv1_relu[0][0]']
 wiseConv2D)                    )

 expanded_conv_depthwise_BN (Ba  (None, 112, 112, 32  128        ['expanded_conv_depthwise[0][0]']
 tchNormalization)              )

 expanded_conv_depthwise_relu (  (None, 112, 112, 32  0          ['expanded_conv_depthwise_BN[0][0
 ReLU)                          )                                 ]']

 expanded_conv_project (Conv2D)  (None, 112, 112, 16  512        ['expanded_conv_depthwise_relu[0]
                                )                                 [0]']

 expanded_conv_project_BN (Batc  (None, 112, 112, 16  64         ['expanded_conv_project[0][0]']
 hNormalization)                )

 block_1_expand (Conv2D)        (None, 112, 112, 96  1536        ['expanded_conv_project_BN[0][0]'
                                )                                 ]

 block_1_expand_BN (BatchNormal  (None, 112, 112, 96  384        ['block_1_expand[0][0]']
 ization)                       )

 block_1_expand_relu (ReLU)     (None, 112, 112, 96  0           ['block_1_expand_BN[0][0]']
                                )

 block_1_pad (ZeroPadding2D)    (None, 113, 113, 96  0           ['block_1_expand_relu[0][0]']
                                )

 block_1_depthwise (DepthwiseCo  (None, 56, 56, 96)  864         ['block_1_pad[0][0]']
 nv2D)
```

```
block_1_depthwise_BN (BatchNor  (None, 56, 56, 96)  384         ['block_1_depthwise[0][0]']
malization)

block_1_depthwise_relu (ReLU)  (None, 56, 56, 96)   0           ['block_1_depthwise_BN[0][0]']

block_1_project (Conv2D)       (None, 56, 56, 24)   2304        ['block_1_depthwise_relu[0][0]']

block_1_project_BN (BatchNorma  (None, 56, 56, 24)  96          ['block_1_project[0][0]']
lization)

block_2_expand (Conv2D)        (None, 56, 56, 144)  3456        ['block_1_project_BN[0][0]']

block_2_expand_BN (BatchNormal  (None, 56, 56, 144)  576        ['block_2_expand[0][0]']
ization)

block_2_expand_relu (ReLU)     (None, 56, 56, 144)  0           ['block_2_expand_BN[0][0]']

block_2_depthwise (DepthwiseCo  (None, 56, 56, 144)  1296       ['block_2_expand_relu[0][0]']
nv2D)

block_2_depthwise_BN (BatchNor  (None, 56, 56, 144)  576        ['block_2_depthwise[0][0]']
malization)

block_2_depthwise_relu (ReLU)  (None, 56, 56, 144)  0           ['block_2_depthwise_BN[0][0]']

block_2_project (Conv2D)       (None, 56, 56, 24)   3456        ['block_2_depthwise_relu[0][0]']

block_2_project_BN (BatchNorma  (None, 56, 56, 24)  96          ['block_2_project[0][0]']
lization)

block_2_add (Add)              (None, 56, 56, 24)   0           ['block_1_project_BN[0][0]',
                                                                 'block_2_project_BN[0][0]']

block_3_expand (Conv2D)        (None, 56, 56, 144)  3456        ['block_2_add[0][0]']

block_3_expand_BN (BatchNormal  (None, 56, 56, 144)  576        ['block_3_expand[0][0]']
ization)

block_3_expand_relu (ReLU)     (None, 56, 56, 144)  0           ['block_3_expand_BN[0][0]']

block_3_pad (ZeroPadding2D)    (None, 57, 57, 144)  0           ['block_3_expand_relu[0][0]']

block_3_depthwise (DepthwiseCo  (None, 28, 28, 144)  1296       ['block_3_pad[0][0]']
nv2D)

block_3_depthwise_BN (BatchNor  (None, 28, 28, 144)  576        ['block_3_depthwise[0][0]']
```

```
malization)

block_3_depthwise_relu (ReLU)  (None, 28, 28, 144)  0           ['block_3_depthwise_BN[0][0]']

block_3_project (Conv2D)       (None, 28, 28, 32)   4608        ['block_3_depthwise_relu[0][0]']

block_3_project_BN (BatchNorma  (None, 28, 28, 32)  128         ['block_3_project[0][0]']
lization)

block_4_expand (Conv2D)        (None, 28, 28, 192)  6144        ['block_3_project_BN[0][0]']

block_4_expand_BN (BatchNormal  (None, 28, 28, 192)  768        ['block_4_expand[0][0]']
ization)

block_4_expand_relu (ReLU)     (None, 28, 28, 192)  0           ['block_4_expand_BN[0][0]']

block_4_depthwise (DepthwiseCo  (None, 28, 28, 192)  1728       ['block_4_expand_relu[0][0]']
nv2D)

block_4_depthwise_BN (BatchNor  (None, 28, 28, 192)  768        ['block_4_depthwise[0][0]']
malization)

block_4_depthwise_relu (ReLU)  (None, 28, 28, 192)  0           ['block_4_depthwise_BN[0][0]']

block_4_project (Conv2D)       (None, 28, 28, 32)   6144        ['block_4_depthwise_relu[0][0]']

block_4_project_BN (BatchNorma  (None, 28, 28, 32)  128         ['block_4_project[0][0]']
lization)

block_4_add (Add)              (None, 28, 28, 32)   0           ['block_3_project_BN[0][0]',
                                                                 'block_4_project_BN[0][0]']

block_5_expand (Conv2D)        (None, 28, 28, 192)  6144        ['block_4_add[0][0]']

block_5_expand_BN (BatchNormal  (None, 28, 28, 192)  768        ['block_5_expand[0][0]']
ization)

block_5_expand_relu (ReLU)     (None, 28, 28, 192)  0           ['block_5_expand_BN[0][0]']

block_5_depthwise (DepthwiseCo  (None, 28, 28, 192)  1728       ['block_5_expand_relu[0][0]']
nv2D)

block_5_depthwise_BN (BatchNor  (None, 28, 28, 192)  768        ['block_5_depthwise[0][0]']
malization)

block_5_depthwise_relu (ReLU)  (None, 28, 28, 192)  0           ['block_5_depthwise_BN[0][0]']
```

```
block_5_project (Conv2D)       (None, 28, 28, 32)   6144        ['block_5_depthwise_relu[0][0]']

block_5_project_BN (BatchNorma  (None, 28, 28, 32)  128         ['block_5_project[0][0]']
lization)

block_5_add (Add)              (None, 28, 28, 32)   0           ['block_4_add[0][0]',
                                                                 'block_5_project_BN[0][0]']

block_6_expand (Conv2D)        (None, 28, 28, 192)  6144        ['block_5_add[0][0]']

block_6_expand_BN (BatchNormal  (None, 28, 28, 192)  768        ['block_6_expand[0][0]']
ization)

block_6_expand_relu (ReLU)     (None, 28, 28, 192)  0           ['block_6_expand_BN[0][0]']

block_6_pad (ZeroPadding2D)    (None, 29, 29, 192)  0           ['block_6_expand_relu[0][0]']

block_6_depthwise (DepthwiseCo  (None, 14, 14, 192)  1728       ['block_6_pad[0][0]']
nv2D)

block_6_depthwise_BN (BatchNor  (None, 14, 14, 192)  768        ['block_6_depthwise[0][0]']
malization)

block_6_depthwise_relu (ReLU)  (None, 14, 14, 192)  0           ['block_6_depthwise_BN[0][0]']

block_6_project (Conv2D)       (None, 14, 14, 64)   12288       ['block_6_depthwise_relu[0][0]']

block_6_project_BN (BatchNorma  (None, 14, 14, 64)  256         ['block_6_project[0][0]']
lization)

block_7_expand (Conv2D)        (None, 14, 14, 384)  24576       ['block_6_project_BN[0][0]']

block_7_expand_BN (BatchNormal  (None, 14, 14, 384)  1536       ['block_7_expand[0][0]']
ization)

block_7_expand_relu (ReLU)     (None, 14, 14, 384)  0           ['block_7_expand_BN[0][0]']

block_7_depthwise (DepthwiseCo  (None, 14, 14, 384)  3456       ['block_7_expand_relu[0][0]']
nv2D)

block_7_depthwise_BN (BatchNor  (None, 14, 14, 384)  1536       ['block_7_depthwise[0][0]']
malization)

block_7_depthwise_relu (ReLU)  (None, 14, 14, 384)  0           ['block_7_depthwise_BN[0][0]']

block_7_project (Conv2D)       (None, 14, 14, 64)   24576       ['block_7_depthwise_relu[0][0]']
```

```
block_7_project_BN (BatchNorma  (None, 14, 14, 64)  256         ['block_7_project[0][0]']
lization)

block_7_add (Add)               (None, 14, 14, 64)  0           ['block_6_project_BN[0][0]',
                                                                 'block_7_project_BN[0][0]']

block_8_expand (Conv2D)         (None, 14, 14, 384)  24576      ['block_7_add[0][0]']

block_8_expand_BN (BatchNormal  (None, 14, 14, 384)  1536       ['block_8_expand[0][0]']
ization)

block_8_expand_relu (ReLU)      (None, 14, 14, 384)  0          ['block_8_expand_BN[0][0]']

block_8_depthwise (DepthwiseCo  (None, 14, 14, 384)  3456       ['block_8_expand_relu[0][0]']
nv2D)

block_8_depthwise_BN (BatchNor  (None, 14, 14, 384)  1536       ['block_8_depthwise[0][0]']
malization)

block_8_depthwise_relu (ReLU)  (None, 14, 14, 384)  0          ['block_8_depthwise_BN[0][0]']

block_8_project (Conv2D)        (None, 14, 14, 64)   24576      ['block_8_depthwise_relu[0][0]']

block_8_project_BN (BatchNorma  (None, 14, 14, 64)  256         ['block_8_project[0][0]']
lization)

block_8_add (Add)               (None, 14, 14, 64)   0          ['block_7_add[0][0]',
                                                                 'block_8_project_BN[0][0]']

block_9_expand (Conv2D)         (None, 14, 14, 384)  24576      ['block_8_add[0][0]']

block_9_expand_BN (BatchNormal  (None, 14, 14, 384)  1536       ['block_9_expand[0][0]']
ization)

block_9_expand_relu (ReLU)      (None, 14, 14, 384)  0          ['block_9_expand_BN[0][0]']

block_9_depthwise (DepthwiseCo  (None, 14, 14, 384)  3456       ['block_9_expand_relu[0][0]']
nv2D)

block_9_depthwise_BN (BatchNor  (None, 14, 14, 384)  1536       ['block_9_depthwise[0][0]']
malization)

block_9_depthwise_relu (ReLU)  (None, 14, 14, 384)  0          ['block_9_depthwise_BN[0][0]']

block_9_project (Conv2D)        (None, 14, 14, 64)   24576      ['block_9_depthwise_relu[0][0]']

block_9_project_BN (BatchNorma  (None, 14, 14, 64)  256         ['block_9_project[0][0]']
```

```
lization)

block_9_add (Add)              (None, 14, 14, 64)   0           ['block_8_add[0][0]',
                                                                 'block_9_project_BN[0][0]']

block_10_expand (Conv2D)       (None, 14, 14, 384)  24576       ['block_9_add[0][0]']

block_10_expand_BN (BatchNorma  (None, 14, 14, 384)  1536       ['block_10_expand[0][0]']
lization)

block_10_expand_relu (ReLU)    (None, 14, 14, 384)  0           ['block_10_expand_BN[0][0]']

block_10_depthwise (DepthwiseC  (None, 14, 14, 384)  3456       ['block_10_expand_relu[0][0]']
onv2D)

block_10_depthwise_BN (BatchNo  (None, 14, 14, 384)  1536       ['block_10_depthwise[0][0]']
rmalization)

block_10_depthwise_relu (ReLU)  (None, 14, 14, 384)  0          ['block_10_depthwise_BN[0][0]']

block_10_project (Conv2D)      (None, 14, 14, 96)   36864       ['block_10_depthwise_relu[0][0]']

block_10_project_BN (BatchNorm  (None, 14, 14, 96)  384         ['block_10_project[0][0]']
alization)

block_11_expand (Conv2D)       (None, 14, 14, 576)  55296       ['block_10_project_BN[0][0]']

block_11_expand_BN (BatchNorma  (None, 14, 14, 576)  2304       ['block_11_expand[0][0]']
lization)

block_11_expand_relu (ReLU)    (None, 14, 14, 576)  0           ['block_11_expand_BN[0][0]']

block_11_depthwise (DepthwiseC  (None, 14, 14, 576)  5184       ['block_11_expand_relu[0][0]']
onv2D)

block_11_depthwise_BN (BatchNo  (None, 14, 14, 576)  2304       ['block_11_depthwise[0][0]']
rmalization)

block_11_depthwise_relu (ReLU)  (None, 14, 14, 576)  0          ['block_11_depthwise_BN[0][0]']

block_11_project (Conv2D)      (None, 14, 14, 96)   55296       ['block_11_depthwise_relu[0][0]']

block_11_project_BN (BatchNorm  (None, 14, 14, 96)  384         ['block_11_project[0][0]']
alization)

block_11_add (Add)             (None, 14, 14, 96)   0           ['block_10_project_BN[0][0]',
                                                                 'block_11_project_BN[0][0]']
```

```
block_12_expand (Conv2D)       (None, 14, 14, 576)  55296       ['block_11_add[0][0]']

block_12_expand_BN (BatchNorma  (None, 14, 14, 576)  2304       ['block_12_expand[0][0]']
lization)

block_12_expand_relu (ReLU)    (None, 14, 14, 576)  0          ['block_12_expand_BN[0][0]']

block_12_depthwise (DepthwiseC  (None, 14, 14, 576)  5184       ['block_12_expand_relu[0][0]']
onv2D)

block_12_depthwise_BN (BatchNo  (None, 14, 14, 576)  2304       ['block_12_depthwise[0][0]']
rmalization)

block_12_depthwise_relu (ReLU)  (None, 14, 14, 576)  0          ['block_12_depthwise_BN[0][0]']

block_12_project (Conv2D)      (None, 14, 14, 96)   55296       ['block_12_depthwise_relu[0][0]']

block_12_project_BN (BatchNorm  (None, 14, 14, 96)  384        ['block_12_project[0][0]']
alization)

block_12_add (Add)             (None, 14, 14, 96)   0          ['block_11_add[0][0]',
                                                                'block_12_project_BN[0][0]']

block_13_expand (Conv2D)       (None, 14, 14, 576)  55296       ['block_12_add[0][0]']

block_13_expand_BN (BatchNorma  (None, 14, 14, 576)  2304       ['block_13_expand[0][0]']
lization)

block_13_expand_relu (ReLU)    (None, 14, 14, 576)  0          ['block_13_expand_BN[0][0]']

block_13_pad (ZeroPadding2D)   (None, 15, 15, 576)  0          ['block_13_expand_relu[0][0]']

block_13_depthwise (DepthwiseC  (None, 7, 7, 576)   5184       ['block_13_pad[0][0]']
onv2D)

block_13_depthwise_BN (BatchNo  (None, 7, 7, 576)   2304       ['block_13_depthwise[0][0]']
rmalization)

block_13_depthwise_relu (ReLU)  (None, 7, 7, 576)   0          ['block_13_depthwise_BN[0][0]']

block_13_project (Conv2D)      (None, 7, 7, 160)    92160      ['block_13_depthwise_relu[0][0]']

block_13_project_BN (BatchNorm  (None, 7, 7, 160)   640        ['block_13_project[0][0]']
alization)

block_14_expand (Conv2D)       (None, 7, 7, 960)    153600     ['block_13_project_BN[0][0]']
```

```
block_14_expand_BN (BatchNorma  (None, 7, 7, 960)   3840        ['block_14_expand[0][0]']
lization)

block_14_expand_relu (ReLU)    (None, 7, 7, 960)    0           ['block_14_expand_BN[0][0]']

block_14_depthwise (DepthwiseC  (None, 7, 7, 960)   8640        ['block_14_expand_relu[0][0]']
onv2D)

block_14_depthwise_BN (BatchNo  (None, 7, 7, 960)   3840        ['block_14_depthwise[0][0]']
rmalization)

block_14_depthwise_relu (ReLU)  (None, 7, 7, 960)   0           ['block_14_depthwise_BN[0][0]']

block_14_project (Conv2D)      (None, 7, 7, 160)    153600      ['block_14_depthwise_relu[0][0]']

block_14_project_BN (BatchNorm  (None, 7, 7, 160)   640         ['block_14_project[0][0]']
alization)

block_14_add (Add)             (None, 7, 7, 160)    0           ['block_13_project_BN[0][0]',
                                                                 'block_14_project_BN[0][0]']

block_15_expand (Conv2D)       (None, 7, 7, 960)    153600      ['block_14_add[0][0]']

block_15_expand_BN (BatchNorma  (None, 7, 7, 960)   3840        ['block_15_expand[0][0]']
lization)

block_15_expand_relu (ReLU)    (None, 7, 7, 960)    0           ['block_15_expand_BN[0][0]']

block_15_depthwise (DepthwiseC  (None, 7, 7, 960)   8640        ['block_15_expand_relu[0][0]']
onv2D)

block_15_depthwise_BN (BatchNo  (None, 7, 7, 960)   3840        ['block_15_depthwise[0][0]']
rmalization)

block_15_depthwise_relu (ReLU)  (None, 7, 7, 960)   0           ['block_15_depthwise_BN[0][0]']

block_15_project (Conv2D)      (None, 7, 7, 160)    153600      ['block_15_depthwise_relu[0][0]']

block_15_project_BN (BatchNorm  (None, 7, 7, 160)   640         ['block_15_project[0][0]']
alization)

block_15_add (Add)             (None, 7, 7, 160)    0           ['block_14_add[0][0]',
                                                                 'block_15_project_BN[0][0]']

block_16_expand (Conv2D)       (None, 7, 7, 960)    153600      ['block_15_add[0][0]']
```

```
block_16_expand_BN (BatchNorma  (None, 7, 7, 960)   3840        ['block_16_expand[0][0]']
lization)

block_16_expand_relu (ReLU)     (None, 7, 7, 960)   0           ['block_16_expand_BN[0][0]']

block_16_depthwise (DepthwiseC  (None, 7, 7, 960)   8640        ['block_16_expand_relu[0][0]']
onv2D)

block_16_depthwise_BN (BatchNo  (None, 7, 7, 960)   3840        ['block_16_depthwise[0][0]']
rmalization)

block_16_depthwise_relu (ReLU)  (None, 7, 7, 960)   0           ['block_16_depthwise_BN[0][0]']

block_16_project (Conv2D)       (None, 7, 7, 320)   307200      ['block_16_depthwise_relu[0][0]']

block_16_project_BN (BatchNorm  (None, 7, 7, 320)   1280        ['block_16_project[0][0]']
alization)

Conv_1 (Conv2D)                 (None, 7, 7, 1280)  409600      ['block_16_project_BN[0][0]']

Conv_1_bn (BatchNormalization)  (None, 7, 7, 1280)  5120        ['Conv_1[0][0]']

out_relu (ReLU)                 (None, 7, 7, 1280)  0           ['Conv_1_bn[0][0]']

global_average_pooling2d (Glob  (None, 1280)        0           ['out_relu[0][0]']
alAveragePooling2D)

dense (Dense)                   (None, 128)         163968      ['global_average_pooling2d[0][0]'
                                                                ]

activation (Activation)         (None, 128)         0           ['dense[0][0]']

dense_1 (Dense)                 (None, 64)          8256        ['activation[0][0]']

activation_1 (Activation)       (None, 64)          0           ['dense_1[0][0]']

dense_2 (Dense)                 (None, 7)           455         ['activation_1[0][0]']

==================================================================================================
Total params: 2,430,663
Trainable params: 2,396,551
Non-trainable params: 34,112
__________________________________________________________________________________________________
```

In [32]:

```
new_model.compile(loss="sparse_categorical_crossentropy",optimizer="adam",metrics=["accuracy"])
```

In [33]:
```
new_model.fit(X,Y,epochs=21)
```

```
Epoch 1/21
96/96 [==============================] - 496s 5s/step - loss: 1.6188 - accuracy: 0.3781
Epoch 2/21
96/96 [==============================] - 729s 8s/step - loss: 1.3359 - accuracy: 0.4951
Epoch 3/21
96/96 [==============================] - 447s 5s/step - loss: 1.1444 - accuracy: 0.5786
Epoch 4/21
96/96 [==============================] - 446s 5s/step - loss: 1.0188 - accuracy: 0.6343
Epoch 5/21
96/96 [==============================] - 954s 10s/step - loss: 0.8830 - accuracy: 0.6782
Epoch 6/21
96/96 [==============================] - 425s 4s/step - loss: 0.8077 - accuracy: 0.7018
Epoch 7/21
96/96 [==============================] - 612s 6s/step - loss: 0.6692 - accuracy: 0.7572
Epoch 8/21
96/96 [==============================] - 368s 4s/step - loss: 0.6862 - accuracy: 0.7490
Epoch 9/21
96/96 [==============================] - 397s 4s/step - loss: 0.5856 - accuracy: 0.7955
Epoch 10/21
96/96 [==============================] - 441s 5s/step - loss: 0.4767 - accuracy: 0.8273
Epoch 11/21
96/96 [==============================] - 479s 5s/step - loss: 0.3625 - accuracy: 0.8657
Epoch 12/21
96/96 [==============================] - 487s 5s/step - loss: 0.3864 - accuracy: 0.8634
Epoch 13/21
96/96 [==============================] - 494s 5s/step - loss: 0.3152 - accuracy: 0.8932
Epoch 14/21
96/96 [==============================] - 493s 5s/step - loss: 0.3053 - accuracy: 0.8952
Epoch 15/21
96/96 [==============================] - 500s 5s/step - loss: 0.2988 - accuracy: 0.8935
Epoch 16/21
96/96 [==============================] - 495s 5s/step - loss: 0.2508 - accuracy: 0.9128
Epoch 17/21
96/96 [==============================] - 495s 5s/step - loss: 0.1925 - accuracy: 0.9400
Epoch 18/21
96/96 [==============================] - 494s 5s/step - loss: 0.2089 - accuracy: 0.9309
Epoch 19/21
96/96 [==============================] - 494s 5s/step - loss: 0.2145 - accuracy: 0.9286
Epoch 20/21
96/96 [==============================] - 430s 4s/step - loss: 0.2318 - accuracy: 0.9227
Epoch 21/21
96/96 [==============================] - 391s 4s/step - loss: 0.1473 - accuracy: 0.9502
```

Out[33]:
```
<keras.callbacks.History at 0x229de27ff08>
```

In [34]:
```
new_model.save('my_model_95p35.h5')
```

```
c:\python37\lib\site-packages\keras\engine\functional.py:1410: CustomMaskWarning: Custom mask layers require a config and must ove
rride get_config. When loading, the custom mask layer must be passed to the custom_objects argument.
  layer_config = serialize_layer_fn(layer)
```

Testing with an image from google that whether our model predicts correct expression or not

In [116…
```
frame = cv2.imread("surprised_man.jpg")
```

In [117…
```
frame.shape
```

Out[117… (1155, 1600, 3)

In [118…
```
plt.imshow(cv2.cvtColor(frame, cv2.COLOR_BGR2RGB))
```

Out[118… <matplotlib.image.AxesImage at 0x2298aefdd88>

Now we need face detection algorithm for detecting face from the image to predict expression

In [119…
```
faceCascade = cv2.CascadeClassifier(cv2.data.haarcascades+'haarcascade_frontalface_default.xml')
```

In [120…
```
gray = cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY)
```

In [121…
```
gray.shape
```

Out[121… (1155, 1600)

Below code for Detecting all the faces in the image

In [122…
```
faces = faceCascade.detectMultiScale(gray,1.1,4)
for x,y,w,h in faces:
    roi_gray=gray[y:y+h, x:x+w]
    roi_color=frame[y:y+h, x:x+w]
    cv2.rectangle(frame,(x,y),(x+w,y+h),(255,0,0),2)
    facess = faceCascade.detectMultiScale(roi_gray)
    if len(facess) == 0:
        print("Face not Detected")
    else:
        for (ex,ey,ew,eh) in facess:
            face_roi = roi_color[ey:ey+eh ,ex:ex+ew]
```

In [123…
```
plt.imshow(cv2.cvtColor(frame, cv2.COLOR_BGR2RGB))
```

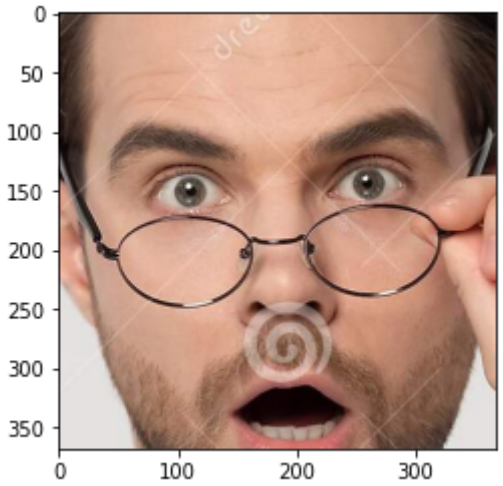
Out[123… <matplotlib.image.AxesImage at 0x2298ab94d88>

Above we can see that face is detected and surrounded with blue line

Now we will crop only the face from the image

In [124…
```
plt.imshow(cv2.cvtColor(face_roi, cv2.COLOR_BGR2RGB))
```

Out[124… <matplotlib.image.AxesImage at 0x2298a4350c8>



In [125…
```
final_image = cv2.resize(face_roi,(224,224)) ##resizing our image to appropriate size
```

```
final_image = np.expand_dims(final_image ,axis=0) ##adding fourth dimension
final_image = final_image/255.0 ##normalizing
```

In [126…

```
final_image
```

Out[126…

```
array([[[[0.27843137, 0.30588235, 0.37254902],
         [0.21568627, 0.24313725, 0.30980392],
         [0.26666667, 0.29803922, 0.36470588],
         ...,
         [0.05490196, 0.05490196, 0.0745098 ],
         [0.05490196, 0.05490196, 0.0745098 ],
         [0.04705882, 0.04705882, 0.07058824]],

        [[0.26666667, 0.29411765, 0.36078431],
         [0.21176471, 0.23921569, 0.30588235],
         [0.28235294, 0.31372549, 0.38039216],
         ...,
         [0.06666667, 0.06666667, 0.09019608],
         [0.06666667, 0.06666667, 0.09019608],
         [0.0627451 , 0.0627451 , 0.08627451]],

        [[0.25490196, 0.28235294, 0.34901961],
         [0.2627451 , 0.29019608, 0.35686275],
         [0.27058824, 0.30196078, 0.36862745],
         ...,
         [0.05490196, 0.05490196, 0.07843137],
         [0.05882353, 0.05882353, 0.08235294],
         [0.0627451 , 0.0627451 , 0.08627451]],

        ...,

        [[0.87843137, 0.88235294, 0.89803922],
         [0.87843137, 0.88235294, 0.89803922],
         [0.87843137, 0.88235294, 0.89803922],
         ...,
         [0.87843137, 0.88235294, 0.89803922],
         [0.87843137, 0.88235294, 0.89803922],
         [0.87843137, 0.88235294, 0.89803922]],

        [[0.87843137, 0.88235294, 0.89803922],
         [0.87843137, 0.88235294, 0.89803922],
         [0.87843137, 0.88235294, 0.89803922],
         ...,
         [0.87843137, 0.88235294, 0.89803922],
         [0.87843137, 0.88235294, 0.89803922],
```

```
        [0.87843137, 0.88235294, 0.89803922]],

       [[0.87843137, 0.88235294, 0.89803922],
        [0.87843137, 0.88235294, 0.89803922],
        [0.87843137, 0.88235294, 0.89803922],
        ...,
        [0.87843137, 0.88235294, 0.89803922],
        [0.87843137, 0.88235294, 0.89803922],
        [0.87843137, 0.88235294, 0.89803922]]]])
```

In [127…
```
Predictions = new_model.predict(final_image)
```

In [128…
```
Predictions[0]
```

Out[128…
```
array([1.6096264e-09, 6.0597269e-09, 6.5312663e-05, 2.3694378e-08,
       1.5606915e-07, 3.1254515e-08, 9.9993443e-01], dtype=float32)
```

In [129…
```
np.argmax(Predictions)
```

Out[129… 6

Output is 6 and our folder named 6 also contain images of surprised man.So we can say that our model is predicting correctly

In [ ]: