In [1]:
```
import pandas as pd                          # import the required libraries
import matplotlib.pyplot as plt
import numpy as np
import tensorflow as tf
from tensorflow import keras
from keras import layers,Sequential,Model
from keras.layers import Dense, Dropout,Flatten,Conv2D,MaxPooling2D,BatchNormalization,Lambda,Input
import os
import cv2 as cv
```

In [2]:
```
path=r"C:\Users\Hrishikesh\Desktop\DL PROJECTS\DL\Cityscape Dataset"    #path of dataset
```

In [3]:
```
dis=os.listdir(path)                                                    # shows the list of folders in direct
dis
```

Out[3]:
```
['Bridge',
 'Commercial',
 'Industrial',
 'Intersection',
 'Landmark',
 'Park',
 'Parking',
 'Playground',
 'Residential',
 'Stadium']
```

In [7]:
```
data=[]                                  # connects the path with files in directories
for i in dis:
    A=os.path.join(path,i)
    for j in os.listdir(A):
        B=os.path.join(A,j)
        img=cv.imread(B)                # convert raw image into pixel intensity
        C=cv.resize(img,(150,150))      # resize the image
        T=dis.index(i)                  # save target variable in T
        data.append([C,T])              # Append the target in features in data
```

In [8]:
```
data
```

Out[8]:
```
[[array([[[37, 39, 27],
          [37, 39, 27],
          [37, 39, 27],
          ...,
          [60, 73, 75],
          [57, 72, 74],
          [54, 68, 71]],

         [[37, 39, 27],
          [37, 39, 27],
          [37, 39, 27],
          ...,
          [50, 63, 65],
          [49, 64, 66],
          [59, 74, 76]],

         [[37, 39, 27],
          [37, 39, 27],
          [37, 39, 27],
```

In [9]:
```
import random                # randomly shuffle the data
random.shuffle(data)
```

In [10]:
```
F=[]                         # append the features and target seoerately
T=[]
for i,j in data:
    F.append(i)
    T.append(j)
```

In [11]:
```
F1=np.array(F)             # covert feature and target into array for faster cakculations
T1=np.array(T)
```

In [12]:
```
F=F1/255                    # min max scaling
F
```

Out[12]:
```
array([[[[0.42352941, 0.48235294, 0.49411765],
         [0.42352941, 0.47058824, 0.49019608],
         [0.17647059, 0.21960784, 0.23529412],
         ...,
         [0.28235294, 0.28627451, 0.12941176],
         [0.28235294, 0.28627451, 0.12941176],
         [0.28235294, 0.28627451, 0.12941176]],

        [[0.41176471, 0.45882353, 0.4745098 ],
         [0.41176471, 0.45490196, 0.47058824],
         [0.15686275, 0.19607843, 0.21176471],
         ...,
         [0.27843137, 0.28235294, 0.1254902 ],
         [0.27843137, 0.28235294, 0.1254902 ],
         [0.27843137, 0.28235294, 0.1254902 ]],

        [[0.25490196, 0.30196078, 0.31764706],
         [0.24705882, 0.28235294, 0.29803922],
         [0.09411765, 0.11764706, 0.1372549 ],
```

In [13]:
```
T=pd.get_dummies(T1,dtype="int")    # dummies for target as no order matters
T
```

Out[13]:

	0	1	2	3	4	5	6	7	8	9
0	0	1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	0	0
2	1	0	0	0	0	0	0	0	0	0
3	0	1	0	0	0	0	0	0	0	0
4	0	1	0	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...	...
7995	0	0	0	0	0	0	1	0	0	0
7996	0	0	0	0	0	0	1	0	0	0
7997	0	0	1	0	0	0	0	0	0	0
7998	0	0	0	0	0	0	0	0	0	1
7999	0	0	0	0	0	0	0	0	0	1

8000 rows × 10 columns

TRANSFER LEARNING MODELS:-

VGG16:-

In [14]:
```
from keras.applications.vgg16 import VGG16,preprocess_input    # import transfer learning model VGG16
```

In [15]:
```
vgg=VGG16(input_shape=[150,150,3],                              # set parameters
          weights='imagenet',
          include_top=False)
```

In [16]:
```
for i in vgg.layers:                                    # avoid parameter updation
    i.trainable=False
```

In [17]:
```
x=Flatten()(vgg.output)                                 # flatten the output of model
```

In [18]:
```
y=Dense(60,activation="relu")(x)                        # add dense hidden layer
```

In [19]:
```
Z=Dense(80,activation="relu")(y)                        # add dense hidden layer
```

In [20]:
```
v=Dense(10,activation="softmax")(Z)                     # add output layer
```

In [21]:
```
model=Model(vgg.input,v)                                # model is made
```

In [22]:
```
model.compile(optimizer="adam",loss="categorical_crossentropy",metrics=(["accuracy"]))
                                                        # model is compiled and parameters are set
```

In [23]:
```
model.fit(F,T,epochs=2,validation_split=.15,batch_size=10)   # model is fit and trained
```

```
Epoch 1/2
680/680 ━━━━━━━━━━━━━━━━━━━━ 382s 558ms/step - accuracy: 0.5215 - loss: 1.3685 - val_accuracy: 0.6708 - val_
loss: 0.9659
Epoch 2/2
680/680 ━━━━━━━━━━━━━━━━━━━━ 377s 554ms/step - accuracy: 0.8087 - loss: 0.5687 - val_accuracy: 0.7767 - val_
loss: 0.6609
```

Out[23]:
```
<keras.src.callbacks.history.History at 0x24ee4ddf810>
```

THE TRAINING ACCURACY FOR VGG16 MODEL IS 80.87 AND VALIDATION ACCURACY IS 77.67.

In [ ]:
```
```

VGG19:-

In [24]:
```
from keras.applications.vgg19 import VGG19,preprocess_input                # import transfer learning model VGG
```

In [25]:
```
vgg=VGG19(input_shape=(150,150,3),weights="imagenet",include_top=False)  # set parameters
```

In [26]:
```
for i in vgg.layers:                                                       # avoid parameter updation
    i.trainable=False
```

In [27]:
```
x=Flatten()(vgg.output)                                                    # flatten the output of model
```

In [28]:
```
y=Dense(60,activation="relu")(x)                                           # add dense hidden layer
```

In [29]:
```
v=Dense(80,activation="relu")(y)                                           # add dense hidden layer
```

In [30]:
```
z=Dense(10,activation="softmax")(v)                                        # add output layer
```

In [31]:
```
model1=Model(vgg.input,z)                                                  # intiailize the model
```

In [36]:
```
model1.compile(optimizer="adam",loss="categorical_crossentropy",metrics=(["accuracy"]))
                                                                           # model is compiled and parameters a
```

In [37]:
```
model1.fit(F,T,epochs=2,validation_split=.15,batch_size=10)                # model is fit and trained
```

```
Epoch 1/2
680/680 ━━━━━━━━━━━━━━━━━━━━ 508s 742ms/step - accuracy: 0.5439 - loss: 1.3335 - val_accuracy: 0.6958 - val_
loss: 0.9416
Epoch 2/2
680/680 ━━━━━━━━━━━━━━━━━━━━ 500s 735ms/step - accuracy: 0.7946 - loss: 0.6001 - val_accuracy: 0.6967 - val_
loss: 0.9117
```

Out[37]:
```
<keras.src.callbacks.history.History at 0x24ecaa17dd0>
```

THE TRAINING ACCURACY FOR VGG19 MODEL IS 79,46 AND VALIDATION ACCURACY IS 69.67

In [ ]:

GOOGLENET:-

In [49]:
```
from keras.applications import InceptionV3                                  # import transfer learning model Goo
```

In [50]:
```
inc=InceptionV3(weights="imagenet",input_shape=(150,150,3),include_top=False) # set parameters
```

In [51]:
```
for i in inc.layers:                                                        # avoid parameter updation
    i.trainable=False
```

In [52]:
```
x=Flatten()(inc.output)                                                     # flatten the output of model
```

In [53]:
```
y=Dense(60,activation="relu")(x)                                            # add dense hidden layer
```

In [54]:
```
v=Dense(80,activation="relu")(y)                                            # add dense hidden layer
```

In [55]:
```
z=Dense(10,activation="softmax")(v)                                         # add output layer
```

In [56]:
```
model3=Model(inc.input,z)                                                   # intiailize the model
```

In [57]:
```
model3.compile(optimizer="adam",loss="categorical_crossentropy",metrics=(["accuracy"]))
                                                                           # model is compiled and parameters ar
```

In [58]:
```
model3.fit(F,T,epochs=2,validation_split=.15,batch_size=10)            # model is fit and trained
```

```
Epoch 1/2
680/680 ━━━━━━━━━━━━━━━━━━━━ 144s 199ms/step - accuracy: 0.5404 - loss: 1.7711 - val_accuracy: 0.6767 - val_
loss: 0.9675
Epoch 2/2
680/680 ━━━━━━━━━━━━━━━━━━━━ 135s 199ms/step - accuracy: 0.7797 - loss: 0.6746 - val_accuracy: 0.7708 - val_
loss: 0.6970
```

Out[58]:
```
<keras.src.callbacks.history.History at 0x2500a8f6d90>
```

THE TRAINING ACCURACY FOR GoogleNet MODEL IS 77.97 AND VALIDATION ACCURACY IS 77.08

In [ ]:
```
```

DENSENET:- ¶

In [59]:
```
from keras.applications import DenseNet121                              # import transfer learning model Dense
```

In [60]:
```
den=DenseNet121(weights="imagenet",input_shape=(150,150,3),include_top=False) # set parameters
```

In [61]:
```
for i in den.layers:                                                    # avoid parameter updation
    i.trainable=False
```

In [62]:
```
x=Flatten()(den.output)                                                 # flatten the output of model
```

In [63]:
```
y=Dense(60,activation="relu")(x)                                        # add dense hidden layer
```

In [64]:
```
v=Dense(80,activation="relu")(y)                                        # add dense hidden layer
```

In [65]:
```
z=Dense(10,activation="softmax")(v)                                     # add output layer
```

In [66]:
```
model4=Model(den.input,z)                                    # intiailize the model
```

In [67]:
```
model4.compile(optimizer="adam",loss="categorical_crossentropy",metrics=(["accuracy"]))
                                                             # model is compiled and parameters are s
```

In [68]:
```
model4.fit(F,T,epochs=2,validation_split=.15,batch_size=10)         # model is fit and trained
```

```
Epoch 1/2
680/680 ━━━━━━━━━━━━━━━━━━━━ 314s 442ms/step - accuracy: 0.6606 - loss: 1.1384 - val_accuracy: 0.8150 - val_
loss: 0.5881
Epoch 2/2
680/680 ━━━━━━━━━━━━━━━━━━━━ 284s 418ms/step - accuracy: 0.8679 - loss: 0.4178 - val_accuracy: 0.8042 - val_
loss: 0.6860
```

Out[68]:
```
<keras.src.callbacks.history.History at 0x2501c21ed90>
```

THE TRAINING ACCURACY FOR DenseNet MODEL IS 86.79 AND VALIDATION ACCURACY IS 80.42

In [ ]:
```

```

ACCURACY CHART:-

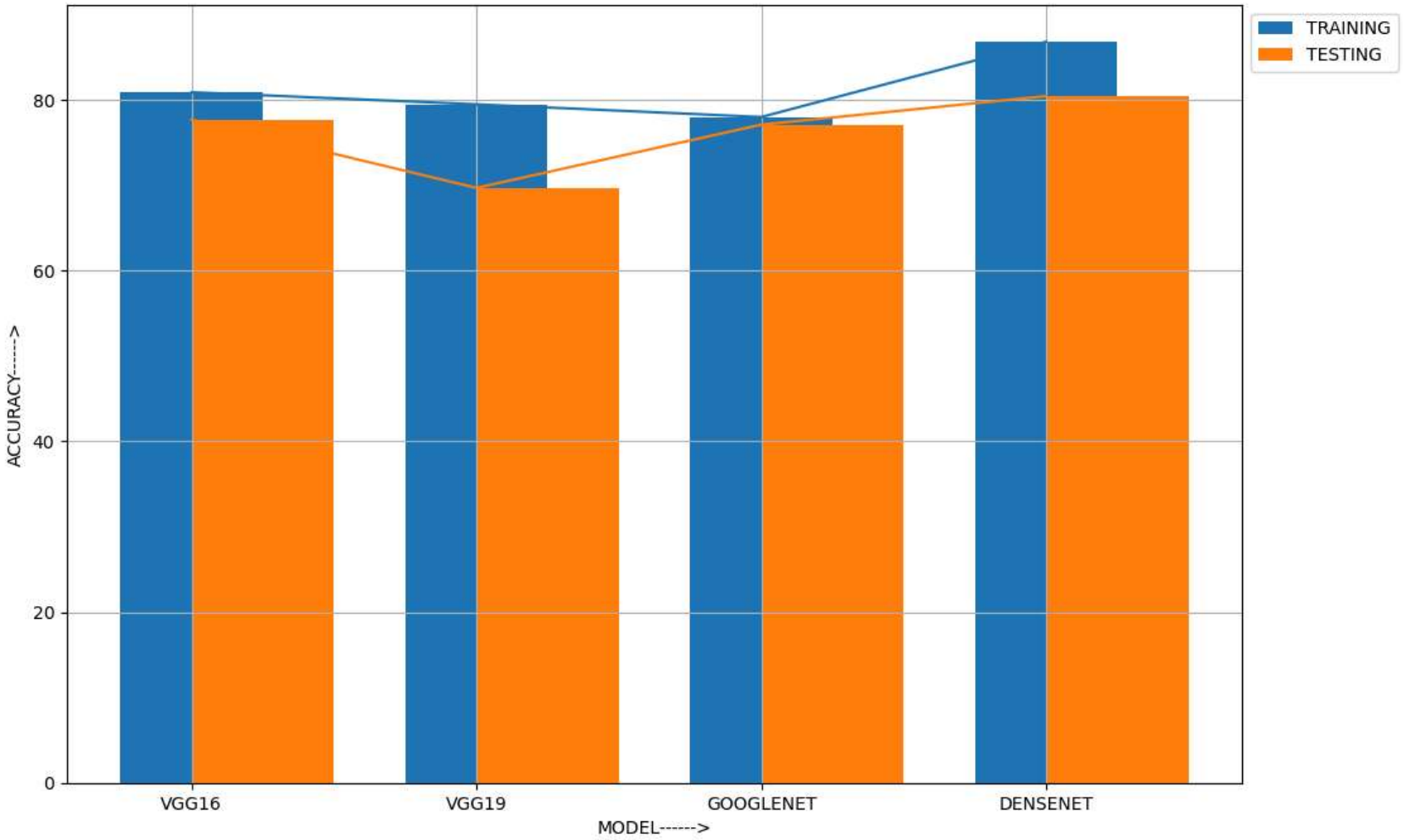
In [90]:
```
D={"MODEL":["VGG16","VGG19","GOOGLENET","DENSENET"],
   "TRAINING ACCURACY":[ 80.87,79.46,77.97,86.79 ],
   "VALIDATION ACCURACY":[77.67,69.67,77.08,80.42]}
```

In [91]:
```
b=pd.DataFrame(D)                                    # creating a dataframe
b
```

Out[91]:

	MODEL	TRAINING ACCURACY	VALIDATION ACCURACY
0	VGG16	80.87	77.67
1	VGG19	79.46	69.67
2	GOOGLENET	77.97	77.08
3	DENSENET	86.79	80.42

In [98]:
```
plt.figure(figsize=(12,8))
plt.bar(b["MODEL"],b["TRAINING ACCURACY"],width=.5,label="TRAINING")                # plotting the accuracy p
plt.bar(b["MODEL"],b["VALIDATION ACCURACY"],align="edge",width=.5,label="TESTING")
plt.plot(b["MODEL"],b["TRAINING ACCURACY"])
plt.plot(b["MODEL"],b["VALIDATION ACCURACY"])
plt.xlabel("MODEL------>")
plt.ylabel("ACCURACY------>")
plt.legend(bbox_to_anchor=[1,0,0,1])
plt.grid()
plt.show()
```



CONCLUSION:-

FROM ABOVE GRAPH IT IS CLEAR THAT GOOGLENET WILL WORK BEST FOR THIS DATASET IMAGE CLASSIFICATION.

In [ ]: