```
Apply ANN on fruit 365 dataset to classify with accuracy of 90%

1. create ANN based model
2. use required hyper parameters according to required task
3. add layers if required

Explain complete task accordingly
```

In [1]:

```python
## import necessary libraries

import os
import pandas as pd
import numpy as np
import cv2
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.svm import SVC
from sklearn.metrics import classification_report ,accuracy_score ,confusion_matrix
import matplotlib.pyplot as plt
from sklearn.ensemble import RandomForestClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
import joblib
import matplotlib.pyplot as plt
import cv2
```

In [2]:

```python
## listdir() will print folders in path directory
print(os.listdir("../OpenCvDataSet/fruits-360-original-size/fruits-360-original-size/Training"))
```

```
['apple_6', 'apple_braeburn_1', 'apple_crimson_snow_1', 'apple_golden_1', 'apple_golden_2', 'apple_golden_3', 'apple_granny_sm
ith_1', 'apple_hit_1', 'apple_pink_lady_1', 'apple_red_1', 'apple_red_2', 'apple_red_3', 'apple_red_delicios_1', 'apple_red_ye
llow_1', 'apple_rotten_1', 'cabbage_white_1', 'carrot_1', 'cucumber_1', 'cucumber_3', 'eggplant_violet_1', 'pear_1', 'pear_3',
'zucchini_1', 'zucchini_dark_1']
```

In [3]:

```
Folder paths in training data which have different fruit image data in it

lder_paths = [
  r"D:\Python Languages\Navttac AI course\OpenCvDataSet\fruits-360-original-size\fruits-360-original-size\Training\apple_6",
  r"D:\Python Languages\Navttac AI course\OpenCvDataSet\fruits-360-original-size\fruits-360-original-size\Training\apple_braebur
   r"D:\Python Languages\Navttac AI course\OpenCvDataSet\fruits-360-original-size\fruits-360-original-size\Training\pear_3",
   r"D:\Python Languages\Navttac AI course\OpenCvDataSet\fruits-360-original-size\fruits-360-original-size\Training\cucumber_1",
  ]
```

In [4]:

```
dataset = []

for i in folder_paths:
    folder_name = os.path.basename(i)
    for file_name in os.listdir(i):

        path = os.path.join(i,file_name)
        if os.path.isfile(path):
            img = cv2.imread(path , cv2.IMREAD_GRAYSCALE)

            if img is not None:
                img_res = cv2.resize(img, (250,250))
                flatten_img = img_res.flatten()

                flattened_image = img_res.flatten().tolist()
                dataset.append(flattened_image + [folder_name])
```

In [5]:
```
## convert the matrix into dataFrame and change last column name into Label

img_df = pd.DataFrame(data =dataset)
img_df.rename(columns={img_df.iloc[:, -1].name : "label"},inplace=True)
img_df
```

Out[5]:

	0	1	2	3	4	5	6	7	8	9	...	62491	62492	62493	62494	62495	62496	62497	62498	62499	label
0	255	255	255	255	255	255	255	255	255	255	...	255	255	255	255	255	255	255	255	255	apple_6
1	255	255	255	255	255	255	255	255	255	255	...	255	255	255	255	255	255	255	255	255	apple_6
2	255	255	255	255	255	255	255	255	255	255	...	255	255	255	255	255	255	255	255	255	apple_6
3	255	255	255	255	255	255	255	255	255	255	...	255	255	255	255	255	255	255	255	255	apple_6
4	255	255	255	255	255	255	255	255	255	255	...	255	255	255	255	255	255	255	255	255	apple_6
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
874	255	255	255	255	255	255	255	255	255	255	...	255	255	255	255	255	255	255	255	255	cucumber_1
875	255	255	255	255	255	255	255	255	255	255	...	255	255	255	255	255	255	255	255	255	cucumber_1
876	255	255	255	255	255	255	255	255	255	255	...	255	255	255	255	255	255	255	255	255	cucumber_1
877	255	255	255	255	255	255	255	255	255	255	...	255	255	255	255	255	255	255	255	255	cucumber_1
878	255	255	255	255	255	255	255	255	255	255	...	255	255	255	255	255	255	255	255	255	cucumber_1

879 rows × 62501 columns

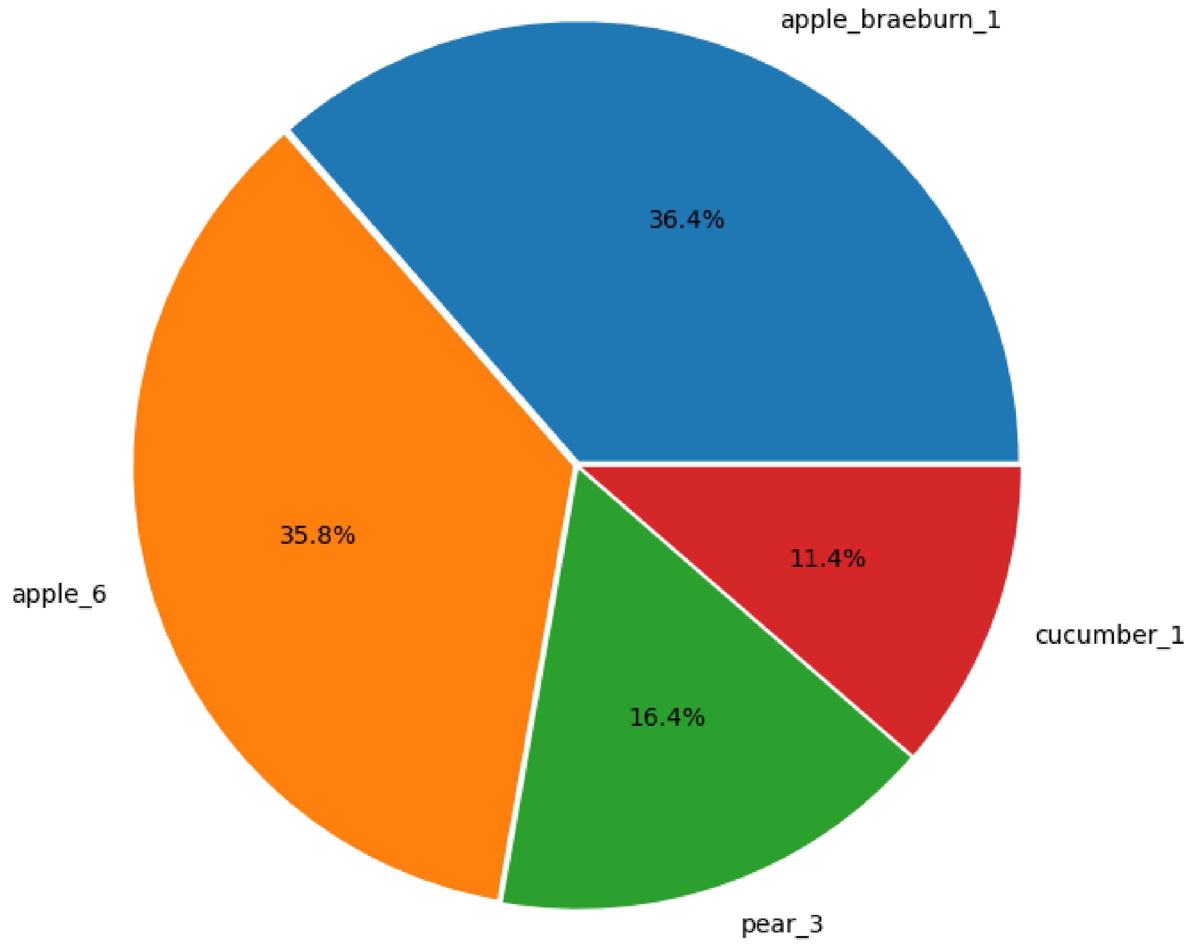
In [6]:
```
## store file to csv
img_df.to_csv("../OpenCvDataSet/image_dataframe.csv",index = False)
```

In [7]:
```
## Count the label value in row
y = img_df.iloc[: , -1]
y.value_counts()
```

Out[7]:
```
apple_braeburn_1    320
apple_6             315
pear_3              144
cucumber_1          100
Name: label, dtype: int64
```

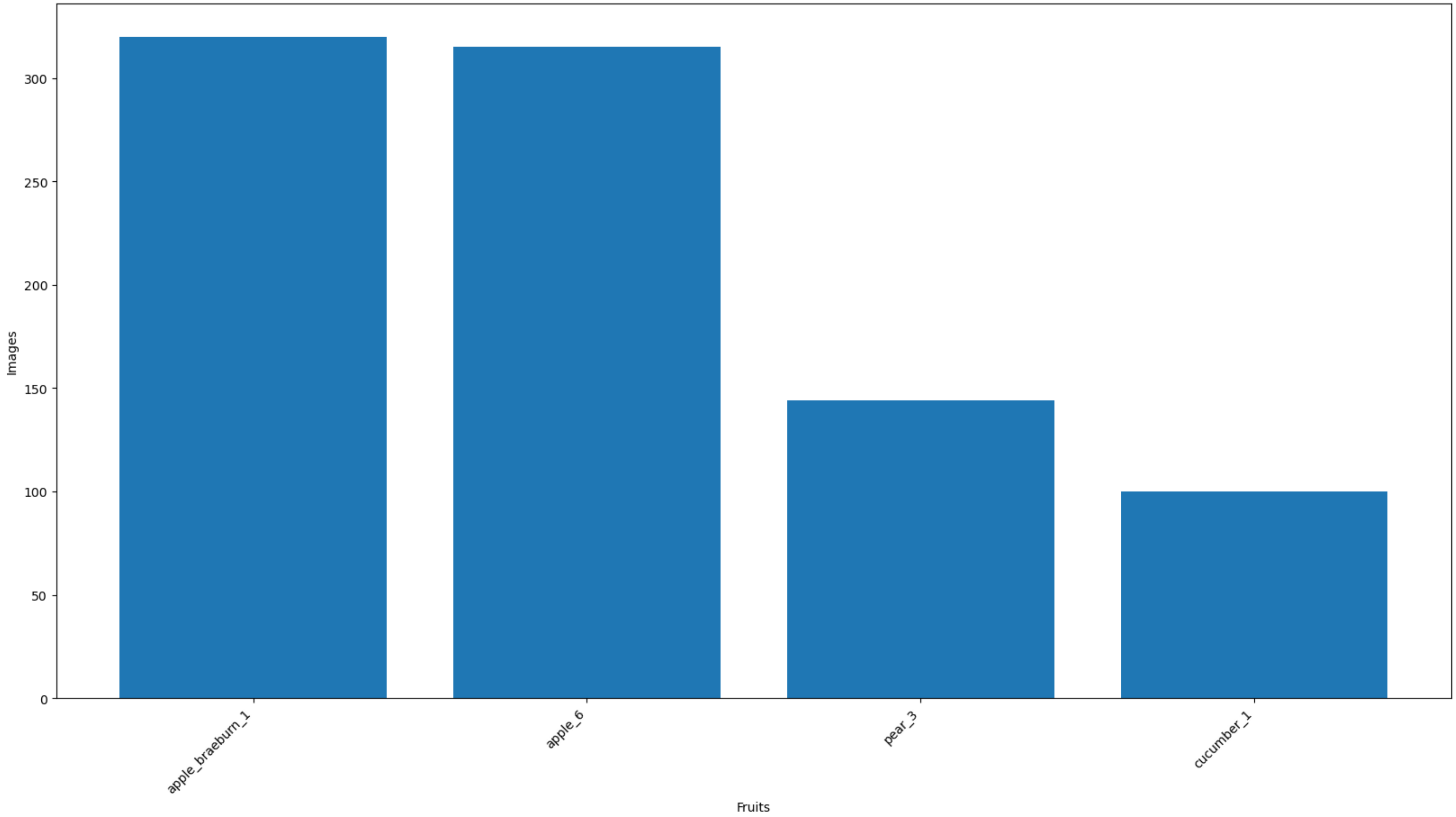
In [8]:

```
## Show the pie chart of label data
plt.figure(figsize=(8,8))
plt.pie(y.value_counts(),labels=y.value_counts().index,autopct='%1.1f%%',explode = [0.01 for i in range(len(y.value_counts()))]
```



In [9]:
```
## show the bar graph of Label Data
plt.figure(figsize=(20,10))
plt.bar(y.value_counts().index, y.value_counts().values ,)
plt.xticks(rotation=45, ha='right');
plt.xlabel("Fruits")
plt.ylabel("Images")
```

Out[9]:
```
Text(0, 0.5, 'Images')
```



In [10]:

```
x = img_df.drop("label" , axis =1)
y = img_df.iloc[:,-1]
```

In [11]:

```
## scale the Values in Range of 0 to 1 & label encode the value of y


x_scaled = x/255
encoder = LabelEncoder()
y_encoded = encoder.fit_transform(y)
encoder.classes_
```

Out[11]:

```
array(['apple_6', 'apple_braeburn_1', 'cucumber_1', 'pear_3'],
      dtype=object)
```

In [12]:

```
## Train Test split

x_train ,x_test ,y_train ,y_test  =  train_test_split(x_scaled , y_encoded ,test_size = 0.2 ,random_state = 42)
x_train.shape,y_train.shape
```

Out[12]:

```
((703, 62500), (703,))
```

Deep Learning

In [13]:

```
import tensorflow as tf
from tensorflow.keras import Sequential  ## used for init our ANN model
from keras.layers import Dense  ## used for different layer structure
```

In [14]:

```
## Save the sequential function into classifier
## he Sequential class allows us to build ANN but as a sequence of layers.
model = Sequential()

# Add a dense layer with 128 units and 'relu' activation function as the input layer
model.add(Dense(128, activation='relu', input_shape=(250*250,)))

# Add another dense layer with 64 units and 'relu' activation function
model.add(Dense(64, activation='relu'))

# Add the output layer with the number of classes (number of unique labels) and 'softmax' activation function
model.add(Dense(len(encoder.classes_), activation='softmax'))

# Compile the model with 'categorical_crossentropy' loss function and 'adam' optimizer
model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])

# Print the model summary
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 dense (Dense)               (None, 128)               8000128   
                                                                 
 dense_1 (Dense)             (None, 64)                8256      
                                                                 
 dense_2 (Dense)             (None, 4)                 260       
                                                                 
=================================================================
Total params: 8008644 (30.55 MB)
Trainable params: 8008644 (30.55 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

In [15]:

```
## Encode y_labels using onehotencoder

from keras.utils import to_categorical

y_train_encoded = to_categorical(y_train)
y_test_encoded = to_categorical(y_test)
model.fit(x_train ,y_train_encoded ,batch_size = 32 ,epochs = 10 ,validation_split = 0.2)
```

```
Epoch 1/10
18/18 [==============================] - 6s 252ms/step - loss: 6.5220 - accuracy: 0.6050 - val_loss: 1.3113 - val_accuracy: 0.
7305
Epoch 2/10
18/18 [==============================] - 3s 175ms/step - loss: 0.4202 - accuracy: 0.9110 - val_loss: 0.0531 - val_accuracy: 0.
9787
Epoch 3/10
18/18 [==============================] - 3s 176ms/step - loss: 0.0251 - accuracy: 0.9893 - val_loss: 7.2317e-05 - val_accurac
y: 1.0000
Epoch 4/10
18/18 [==============================] - 3s 176ms/step - loss: 4.3871e-05 - accuracy: 1.0000 - val_loss: 2.4241e-05 - val_accu
racy: 1.0000
Epoch 5/10
18/18 [==============================] - 3s 167ms/step - loss: 5.4403e-05 - accuracy: 1.0000 - val_loss: 2.5259e-05 - val_accu
racy: 1.0000
Epoch 6/10
18/18 [==============================] - 3s 167ms/step - loss: 4.9184e-05 - accuracy: 1.0000 - val_loss: 2.0866e-05 - val_accu
racy: 1.0000
Epoch 7/10
18/18 [==============================] - 3s 166ms/step - loss: 3.8395e-05 - accuracy: 1.0000 - val_loss: 1.7756e-05 - val_accu
racy: 1.0000
Epoch 8/10
18/18 [==============================] - 3s 166ms/step - loss: 3.1925e-05 - accuracy: 1.0000 - val_loss: 1.4847e-05 - val_accu
racy: 1.0000
Epoch 9/10
18/18 [==============================] - 3s 166ms/step - loss: 2.6621e-05 - accuracy: 1.0000 - val_loss: 1.3022e-05 - val_accu
racy: 1.0000
Epoch 10/10
18/18 [==============================] - 3s 168ms/step - loss: 2.3081e-05 - accuracy: 1.0000 - val_loss: 1.1609e-05 - val_accu
racy: 1.0000
```

Out[15]:

```
<keras.src.callbacks.History at 0x145ca40e560>
```

In [16]:
```
## Predict the value

y_predict_encoded = model.predict(x_test)
y_pred = np.argmax(y_predict_encoded,axis = 1)
```

```
6/6 [==============================] - 0s 24ms/step
```

In [17]:
```
y_test,y_pred
```

Out[17]:
```
(array([1, 0, 2, 1, 0, 3, 1, 1, 2, 0, 1, 3, 2, 1, 1, 0, 1, 0, 0, 3, 3, 1,
        2, 0, 0, 3, 2, 0, 3, 0, 0, 2, 0, 1, 1, 0, 0, 0, 2, 1, 1, 0, 0, 0,
        0, 0, 0, 1, 0, 1, 1, 1, 2, 1, 2, 1, 1, 1, 3, 1, 2, 3, 0, 2, 3, 0,
        1, 1, 2, 3, 2, 1, 0, 1, 1, 2, 1, 0, 3, 3, 1, 1, 1, 0, 3, 1, 1, 1,
        2, 1, 2, 1, 2, 0, 0, 1, 3, 1, 3, 3, 0, 1, 0, 1, 0, 0, 1, 3, 0, 2,
        0, 1, 1, 0, 1, 1, 1, 1, 3, 0, 1, 0, 1, 2, 0, 0, 1, 3, 1, 2, 1, 1,
        0, 0, 3, 3, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 0, 2, 3, 1, 3,
        0, 3, 2, 1, 1, 0, 0, 0, 1, 3, 0, 3, 0, 0, 0, 0, 2, 1, 0, 1, 1, 0]),
 array([1, 0, 2, 1, 0, 3, 1, 1, 2, 0, 1, 3, 2, 1, 1, 0, 1, 0, 0, 3, 3, 1,
        2, 0, 0, 3, 2, 0, 3, 0, 0, 2, 0, 1, 1, 0, 0, 0, 2, 1, 1, 0, 0, 0,
        0, 0, 0, 1, 0, 1, 1, 1, 2, 1, 2, 1, 1, 1, 3, 1, 2, 3, 0, 2, 3, 0,
        1, 1, 2, 3, 2, 1, 0, 1, 1, 2, 1, 0, 3, 3, 1, 1, 1, 0, 3, 1, 1, 1,
        2, 1, 2, 1, 2, 0, 0, 1, 3, 1, 3, 3, 0, 1, 0, 1, 0, 0, 1, 3, 0, 2,
        0, 1, 1, 0, 1, 1, 1, 1, 3, 0, 1, 0, 1, 2, 0, 0, 1, 3, 1, 2, 1, 1,
        0, 0, 3, 3, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 0, 2, 3, 1, 3,
        0, 3, 2, 1, 1, 0, 0, 0, 1, 3, 0, 3, 0, 0, 0, 0, 2, 1, 0, 1, 1, 0],
       dtype=int64))
```

In [18]:
```
## Evaluation Metrics
print("Confusion Matric\n",confusion_matrix(y_test , y_pred))

print("\n\nAccuracy_score:" , accuracy_score(y_test ,y_pred))
```

```
Confusion Matric
 [[62  0  0  0]
 [ 0 65  0  0]
 [ 0  0 23  0]
 [ 0  0  0 26]]


Accuracy_score: 1.0
```

In [19]:

```
joblib.dump(model , "../TrainedModels/DL_ANN_ClassifierModel.pkl")
joblib.dump(encoder , "../TrainedModels/DL_ANN_Classifier_LabelEncoder.pkl")
```

Out[19]:

```
['../TrainedModels/DL_ANN_Classifier_LabelEncoder.pkl']
```

Deployment

In [20]:

```
## import model and encoder
model1   =  joblib.load("../TrainedModels/DL_ANN_ClassifierModel.pkl")
encoder1 = joblib.load("../TrainedModels/DL_ANN_Classifier_LabelEncoder.pkl")
```

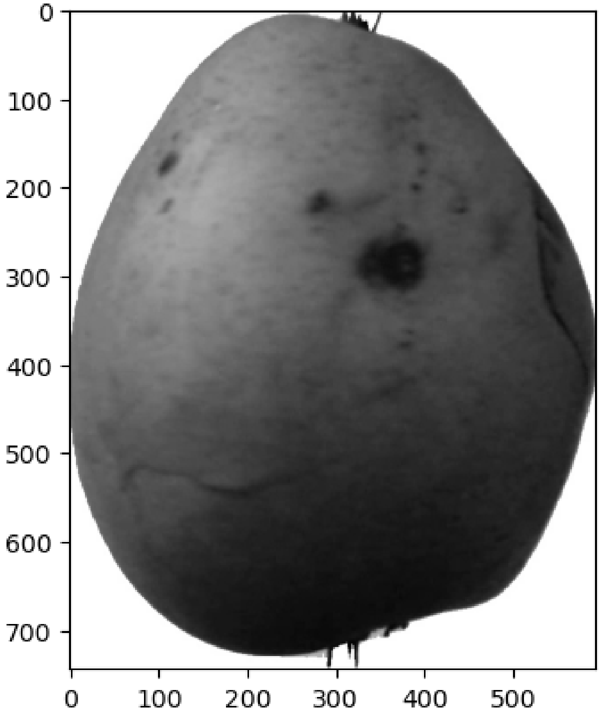
In [21]:

```
##  Make function for preprocessing and predicting
labels = {i:label for i,label in enumerate(encoder1.classes_)}

def preprocessing(path):
    input_img = cv2.imread(path,cv2.IMREAD_GRAYSCALE)
    global  imgsh
    imgsh  = input_img
    resized_input_image = cv2.resize(input_img, (250, 250))
    flattened_input_image = resized_input_image.flatten().tolist()
    ##Scale the image before converting it into dataFrame
    return pd.DataFrame(np.array([flattened_input_image]) / 255)


def prediction(path):
    y_preprocessed = preprocessing(path)
    y = model1.predict(y_preprocessed)
    y_max = np.argmax(y)
    return y_max


y_p = prediction("../OpenCvDataSet/fruits-360-original-size/fruits-360-original-size/Test/pear_3/r0_115.jpg")
print("\n\nThe fruit is",labels[y_p])
plt.imshow(cv2.cvtColor(imgsh,cv2.COLOR_BGR2RGB) )
```

```
1/1 [==============================] - 0s 131ms/step


The fruit is pear_3
```

Out[21]:

```
<matplotlib.image.AxesImage at 0x145d3863ac0>
```



In [ ]:

```

```

In [ ]:

```

```