In [1]:

```
# Import necessary modules

from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.applications import VGG16
from tensorflow.keras.layers import Input
from tensorflow.keras.layers import Dense
from tensorflow.keras.layers import AveragePooling2D
from tensorflow.keras.layers import Dropout
from tensorflow.keras.layers import Flatten
from tensorflow.keras.models import Model
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.utils import to_categorical

from sklearn.preprocessing import LabelBinarizer
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report, confusion_matrix

from imutils import paths
import numpy as np
import matplotlib.pyplot as plt
import argparse
import os
import cv2
```

In [2]:

```
# Load the images directories
path = "D:/brain_tumor_dataset"
print(os.listdir(path))

image_paths = list(paths.list_images(path))
print(len(image_paths))
```

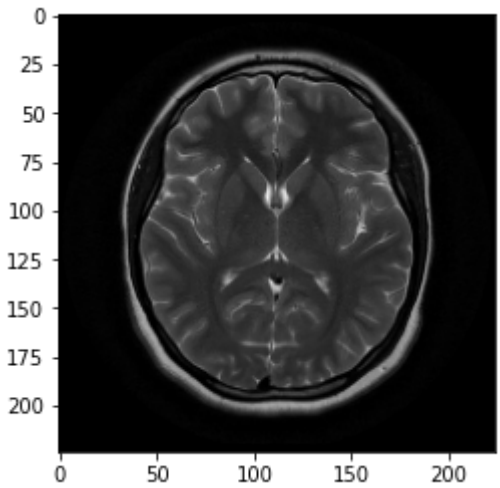
```
['no', 'yes']
253
```

In [3]:

```
#
images = []
labels = []

for image_path in image_paths:
    label = image_path.split(os.path.sep)[-2]
    image = cv2.imread(image_path)
    image = cv2.resize(image, (224, 224))

    images.append(image)
    labels.append(label)
```

In [4]:

```
# Plot an image
def plot_image(image):
    plt.imshow(image)

plot_image(images[0])
```



In [5]:

```
# Convert into numpy arrays
images = np.array(images) / 255.0
labels = np.array(labels)
```

In [6]:

```
# Perform One-hot encoding
label_binarizer = LabelBinarizer()
labels = label_binarizer.fit_transform(labels)
labels = to_categorical(labels)

print(labels[0])
```

```
[1. 0.]
```

In [7]:

```
#Split the dataset
(train_X, test_X, train_Y, test_Y) = train_test_split(images,
                                                      labels,
                                                      test_size= 0.10,
                                                      random_state= 42, stratify= l
```

In [8]:

```
# Build the Image Data Generator
train_generator = ImageDataGenerator(fill_mode= 'nearest',
                                     rotation_range= 15)
```

In [9]:

```
# Build the model
base_model = VGG16(weights= 'imagenet',
                   input_tensor= Input(shape = (224, 224, 3)),
                   include_top= False)
base_input = base_model.input
base_output = base_model.output
base_output = AveragePooling2D(pool_size=(4, 4))(base_output)
base_output = Flatten(name="flatten")(base_output)
base_output = Dense(64, activation="relu")(base_output)
base_output = Dropout(0.5)(base_output)
base_output = Dense(2, activation="softmax")(base_output)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-appl
ications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels_notop.h5 (https://
storage.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_t
f_dim_ordering_tf_kernels_notop.h5)
58892288/58889256 [==============================] - 35s 1us/step
```

In [10]:

```
# Freeze the layers
for layer in base_model.layers:
    layer.trainable = False
```

In [11]:

```
# Compile the model
model = Model(inputs = base_input, outputs = base_output)
model.compile(optimizer= Adam(learning_rate= 1e-3),
              metrics= ['accuracy'], loss= 'binary_crossentropy')
```

In [12]:

```
# Let's see the architecture summary of our model
model.summary()
```

```
Model: "model"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         [(None, 224, 224, 3)]     0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 224, 224, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 224, 224, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 112, 112, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 112, 112, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 112, 112, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 56, 56, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 56, 56, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 28, 28, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 28, 28, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 14, 14, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 7, 7, 512)         0
_________________________________________________________________
average_pooling2d (AveragePo (None, 1, 1, 512)         0
_________________________________________________________________
flatten (Flatten)            (None, 512)               0
_________________________________________________________________
dense (Dense)                (None, 64)                32832
_________________________________________________________________
dropout (Dropout)            (None, 64)                0
_________________________________________________________________
dense_1 (Dense)              (None, 2)                 130
=================================================================
Total params: 14,747,650
Trainable params: 32,962
```

```
Non-trainable params: 14,714,688
_________________________________________________________________
```

In [13]:

```
batch_size = 8
train_steps = len(train_X) // batch_size
validation_steps = len(test_X) // batch_size
epochs = 10
```

In [14]:

```
# Fit the model
history = model.fit_generator(train_generator.flow(train_X,
                                                   train_Y,
                                                   batch_size = batch_size),
                              steps_per_epoch= train_steps,
                              validation_data = (test_X, test_Y),
                              validation_steps= validation_steps,
                              epochs= epochs)
```

```
WARNING:tensorflow:From <ipython-input-14-261dfbd5bc3e>:2: Model.fit_gener
ator (from tensorflow.python.keras.engine.training) is deprecated and will
be removed in a future version.
Instructions for updating:
Please use Model.fit, which supports generators.
Epoch 1/10
28/28 [==============================] - 82s 3s/step - loss: 0.6881 - accu
racy: 0.6164 - val_loss: 0.6093 - val_accuracy: 0.6154
Epoch 2/10
28/28 [==============================] - 74s 3s/step - loss: 0.6869 - accu
racy: 0.5845 - val_loss: 0.5695 - val_accuracy: 0.6154
Epoch 3/10
28/28 [==============================] - 81s 3s/step - loss: 0.6073 - accu
racy: 0.6804 - val_loss: 0.5344 - val_accuracy: 0.8462
Epoch 4/10
28/28 [==============================] - 78s 3s/step - loss: 0.6101 - accu
racy: 0.6530 - val_loss: 0.4963 - val_accuracy: 0.9231
Epoch 5/10
28/28 [==============================] - 76s 3s/step - loss: 0.5888 - accu
racy: 0.6758 - val_loss: 0.4408 - val_accuracy: 0.9231
Epoch 6/10
28/28 [==============================] - 79s 3s/step - loss: 0.5536 - accu
racy: 0.7671 - val_loss: 0.4115 - val_accuracy: 0.9231
Epoch 7/10
28/28 [==============================] - 77s 3s/step - loss: 0.5209 - accu
racy: 0.7580 - val_loss: 0.3826 - val_accuracy: 0.9615
Epoch 8/10
28/28 [==============================] - 79s 3s/step - loss: 0.5578 - accu
racy: 0.7123 - val_loss: 0.3463 - val_accuracy: 0.9231
Epoch 9/10
28/28 [==============================] - 69s 2s/step - loss: 0.5187 - accu
racy: 0.7489 - val_loss: 0.3621 - val_accuracy: 0.9231
Epoch 10/10
28/28 [==============================] - 70s 3s/step - loss: 0.4823 - accu
racy: 0.7812 - val_loss: 0.3307 - val_accuracy: 0.9615
```

In [15]:

```
# Evaluate the model
predictions = model.predict(test_X, batch_size= batch_size)
predictions = np.argmax(predictions, axis= 1)
actuals = np.argmax(test_Y, axis= 1)
```

In [16]:

```
# Print Classification report and Confusion matrix
print(classification_report(actuals, predictions,
                            target_names= label_binarizer.classes_))

cm = confusion_matrix(actuals, predictions)
print(cm)
```

```
              precision    recall  f1-score   support

          no       0.91      1.00      0.95        10
         yes       1.00      0.94      0.97        16

    accuracy                           0.96        26
   macro avg       0.95      0.97      0.96        26
weighted avg       0.97      0.96      0.96        26

[[10  0]
 [ 1 15]]
```

In [17]:

```
# Final accuracy of our model
total = sum(sum(cm))
accuracy = (cm[0, 0] + cm[1, 1]) / total
print("Accuracy: {:.4f}".format(accuracy))
```

```
Accuracy: 0.9615
```

In [18]:

```
# Plot the losses and accuracies
N = epochs
plt.style.use("ggplot")
plt.figure()
plt.plot(np.arange(0, N), history.history["loss"],
         label= "train_loss")
plt.plot(np.arange(0, N), history.history["val_loss"],
         label= "val_loss")

plt.plot(np.arange(0, N), history.history["accuracy"],
         label= "train_acc")
plt.plot(np.arange(0, N), history.history["val_accuracy"],
         label= "val_acc")

plt.title("Training Loss and Accuracy on Brain Dataset")
plt.xlabel("Epoch")
plt.ylabel("Loss / Accuracy")
plt.legend(loc= "lower left")
plt.savefig("plot.jpg")
```