Image Enhancement Using Transformation

```
import cv2
import matplotlib.pyplot as plt
import numpy as np
```

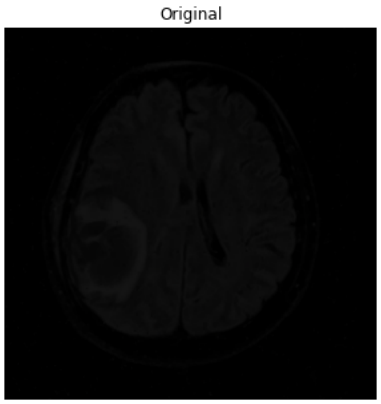
```
from google.colab import drive
drive.mount('/content/my-drive')
```

```
Mounted at /content/my-drive
```

```
def plot_img(image, edited, title1, title2, cmap_val='gray'):

    fig = plt.figure(figsize=(10, 20))

    ax1 = fig.add_subplot(2, 2, 1)
    ax1.axis("off")
    ax1.title.set_text(title1)
    ax2 = fig.add_subplot(2, 2, 2)
    ax2.axis("off")
    ax2.title.set_text(title2)

    ax1.imshow(image, cmap=cmap_val)
    ax2.imshow(edited, cmap=cmap_val)
    plt.axis('off')
```

```
image1 = cv2.imread(r'/content/Image1.png')
image1 = cv2.resize(image1, (256, 256))
brain_image = image1.copy()

print(type(brain_image))
print(brain_image.shape)
print(brain_image.dtype)
plt.figure(figsize=(5,14))
plt.imshow(brain_image)
plt.title('Original')
plt.axis('off')
```

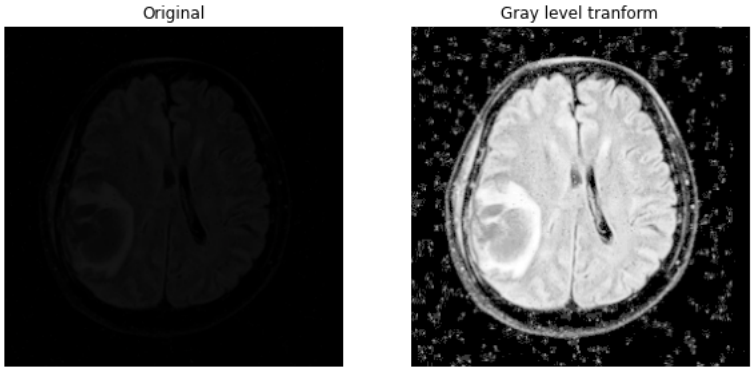
```
<class 'numpy.ndarray'>
(256, 256, 3)
uint8
(-0.5, 255.5, 255.5, -0.5)
```



Log Transformation

```
##Log transform
import math
def log_trans(img):
    height, width = img.shape[0:2]
    val = img.flatten()
    maxv = max(val)

    c = 255/(math.log(1 + maxv))
```

```
    for i in range(height):
        for j in range(width):

            new_val = int(c * (math.log( 1 + int(img[i][j]))))

            if new_val > 255:
              new_val = 255
            img[i][j] = new_val

    return img


brain_img = brain_image[:,:,0]
log_image = log_trans(brain_img.copy())
plot_img(image1, log_image, 'Original', 'Gray level tranform')
```



Sharping

```
## Sharping
kernel = np.array([[0, -1, 0],
                   [-1, 4.9, -1],
                   [0, -1, 0]])

image_sharp = cv2.filter2D(src = log_image, ddepth = -1, kernel = kernel)
plot_img(image1, image_sharp, 'Original', 'Sharpen')
```

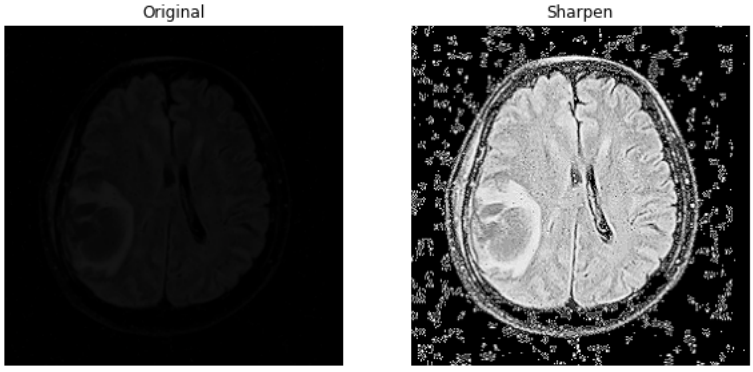
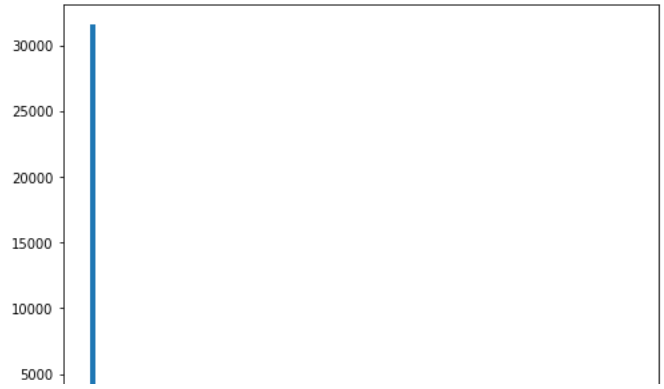


Image Enhancement Using increasing Contrast

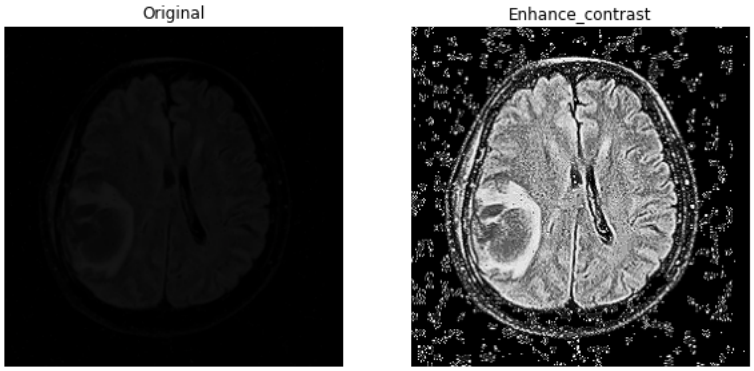
```
img = np.asarray(image_sharp)

flat = img.flatten()

plt.figure(figsize=(8,6))
plt.hist(flat, bins=100)
```

```
(array([3.1571e+04, 1.0000e+01, 2.2000e+01, 1.4000e+01, 3.5000e+01,
        8.0000e+00, 6.8000e+01, 5.0100e+02, 8.0000e+00, 2.8000e+01,
        3.3000e+01, 5.0000e+00, 2.7000e+01, 1.9100e+02, 1.2000e+01,
        2.9000e+01, 1.6100e+02, 2.2000e+01, 2.7000e+01, 2.6000e+01,
        6.8200e+02, 8.0000e+00, 6.4000e+01, 1.1600e+02, 1.5000e+01,
        6.0000e+01, 5.3000e+01, 1.1900e+02, 3.3000e+01, 5.4000e+02,
        2.4000e+01, 3.7000e+01, 8.5000e+01, 9.3000e+01, 3.8000e+01,
        2.7000e+01, 2.7500e+02, 3.3000e+01, 6.3000e+01, 1.2200e+02,
        1.1500e+02, 9.5000e+01, 1.1700e+02, 1.1820e+03, 2.6000e+01,
        1.6000e+02, 1.1600e+02, 8.2000e+01, 7.7000e+01, 3.1400e+02,
        1.2900e+02, 6.3000e+01, 5.6900e+02, 1.1900e+02, 1.1100e+02,
        2.6100e+02, 2.8600e+02, 1.0700e+02, 4.6600e+02, 3.4800e+02,
        1.3600e+02, 6.1900e+02, 1.7700e+02, 3.2400e+02, 5.6400e+02,
        1.6470e+03, 3.1500e+02, 7.3500e+02, 5.5700e+02, 3.7100e+02,
        1.1900e+03, 4.7100e+02, 9.6100e+02, 4.9200e+02, 9.9700e+02,
        7.3000e+02, 9.3100e+02, 7.5100e+02, 1.1280e+03, 7.3900e+02,
        1.0460e+03, 1.0140e+03, 5.1500e+02, 1.0610e+03, 4.8700e+02,
        6.9200e+02, 7.4600e+02, 4.0400e+02, 1.3150e+03, 5.7200e+02,
        4.1000e+02, 3.9700e+02, 2.7200e+02, 2.3900e+02, 2.3900e+02,
        2.9200e+02, 1.5600e+02, 1.2300e+02, 1.2600e+02, 1.5670e+03]),
 array([  0.  ,   2.55,   5.1 ,   7.65,  10.2 ,  12.75,  15.3 ,  17.85,
         20.4 ,  22.95,  25.5 ,  28.05,  30.6 ,  33.15,  35.7 ,  38.25,
         40.8 ,  43.35,  45.9 ,  48.45,  51.  ,  53.55,  56.1 ,  58.65,
         61.2 ,  63.75,  66.3 ,  68.85,  71.4 ,  73.95,  76.5 ,  79.05,
         81.6 ,  84.15,  86.7 ,  89.25,  91.8 ,  94.35,  96.9 ,  99.45,
        102.  , 104.55, 107.1 , 109.65, 112.2 , 114.75, 117.3 , 119.85,
        122.4 , 124.95, 127.5 , 130.05, 132.6 , 135.15, 137.7 , 140.25,
        142.8 , 145.35, 147.9 , 150.45, 153.  , 155.55, 158.1 , 160.65,
        163.2 , 165.75, 168.3 , 170.85, 173.4 , 175.95, 178.5 , 181.05,
        183.6 , 186.15, 188.7 , 191.25, 193.8 , 196.35, 198.9 , 201.45,
        204.  , 206.55, 209.1 , 211.65, 214.2 , 216.75, 219.3 , 221.85,
        224.4 , 226.95, 229.5 , 232.05, 234.6 , 237.15, 239.7 , 242.25,
        244.8 , 247.35, 249.9 , 252.45, 255.  ]),
 <a list of 100 Patch objects>)
```




```
# PMF of all the pixels
def get_histogram(image, bins):

    histogram = np.zeros(bins, dtype=int)

    for pixel in image:
        histogram[pixel] += 1

    return histogram


hist = get_histogram(img, 256)


def cumsum_func(histogram):
    cumsum = np.zeros(256, dtype=int)
    cumsum[0] = histogram[0]
    for i in range(1, histogram.size):
        cumsum[i] = cumsum[i-1] + histogram[i]
    return cumsum

cs = cumsum_func(hist)


nj = (cs - cs.min()) * 255
N = cs.max() - cs.min()

# re-normalize the cumsum
cs = nj / N
```

```
# back to uint8
# can't use floating point values in images
cs = cs.astype('uint8')


img_new = cs[flat]
img_new = img_new.reshape(img.shape)
plot_img(image1, img_new.reshape(img.shape),'Original', 'Enhance_contrast')
```




```
img1 = np.asarray(img_new)

flat1 = img1.flatten()

plt.figure(figsize=(8,6))
plt.hist(flat1, bins=100)
```

```
(array([31728.,   524.,    78.,   251.,   217.,    91.,   663.,   226.,
          150.,    82.,   624.,   158.,   232.,   139.,   263.,    72.,
          114.,  1208.,   237.,   121.,   210.,   310.,   158.,   408.,
          108.,   341.,   108.,   286.,   147.,   242.,   382.,   227.,
          223.,   243.,   389.,   124.,   200.,   298.,   439.,   170.,
         1304.,   378.,     0.,   672.,   233.,   324.,   279.,   364.,
          428.,   490.,   471.,   159.,   407.,   395.,   208.,   284.,
          655.,   342.,   450.,   280.,   243.,   688.,     0.,   751.,
          627.,   103.,   398.,   290.,   653.,   446.,   396.,   322.,
          410.,   282.,   515.,   142.,   614.,   305.,   487.,   316.,
          376.,   397.,   349.,   323.,    81.,   299.,  1016.,   412.,
          160.,   248.,   407.,   254.,   276.,   133.,   239.,   143.,
          361.,   120.,   139.,  1501.]),
 array([  0.  ,   2.55,   5.1 ,   7.65,  10.2 ,  12.75,  15.3 ,  17.85,
         20.4 ,  22.95,  25.5 ,  28.05,  30.6 ,  33.15,  35.7 ,  38.25,
         40.8 ,  43.35,  45.9 ,  48.45,  51.  ,  53.55,  56.1 ,  58.65,
         61.2 ,  63.75,  66.3 ,  68.85,  71.4 ,  73.95,  76.5 ,  79.05,
         81.6 ,  84.15,  86.7 ,  89.25,  91.8 ,  94.35,  96.9 ,  99.45,
        102.  , 104.55, 107.1 , 109.65, 112.2 , 114.75, 117.3 , 119.85,
        122.4 , 124.95, 127.5 , 130.05, 132.6 , 135.15, 137.7 , 140.25,
        142.8 , 145.35, 147.9 , 150.45, 153.  , 155.55, 158.1 , 160.65,
        163.2 , 165.75, 168.3 , 170.85, 173.4 , 175.95, 178.5 , 181.05,
        183.6 , 186.15, 188.7 , 191.25, 193.8 , 196.35, 198.9 , 201.45,
        204.  , 206.55, 209.1 , 211.65, 214.2 , 216.75, 219.3 , 221.85,
        224.4 , 226.95, 229.5 , 232.05, 234.6 , 237.15, 239.7 , 242.25,
        244.8 , 247.35, 249.9 , 252.45, 255.  ]),
 <a list of 100 Patch objects>)
```

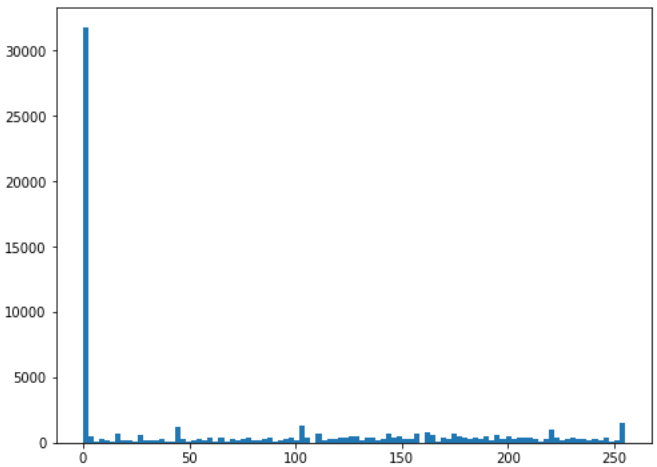


Image Enhancement Using Deep Learning

Work on this dataset:

https://www.kaggle.com/navoneel/brain-mri-images-for-brain-tumor-detection

```
from keras.preprocessing import image
from keras.layers import add, Conv2D, Input, Reshape
import tensorflow as tf
```

```
tf.config.list_physical_devices('GPU')
tf.test.gpu_device_name()
```

```
'/device:GPU:0'
```

```
def apply_lowcontrast(image, intensity):
  hsv = cv2.cvtColor(image, cv2.COLOR_BGR2HSV) #convert it to hsv
  hsv[...,2] = hsv[...,2] * intensity
  return cv2.cvtColor(hsv, cv2.COLOR_HSV2BGR)
```

```
def add_noise(image):
  noisy_image = image + 0.23 * np.random.randn(*image.shape)
  noisy_image = np.clip(noisy_image, 0, 1)
  return noisy_image
```

```
def PreProcessData(ImagePath):
    X = []
    y = []
    for imageDir in list(os.listdir(ImagePath)):

        img = image.load_img(ImagePath + imageDir)
        img = image.img_to_array(img)
        img = img/255
        img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        img_y = cv2.resize(img, (256,256))

        intensity = np.random.randint(5, 90)/1000.0

        noised_img = add_noise(img_y)
        lowLightImg_x = apply_lowcontrast(img_y, intensity)

        X.append(lowLightImg_x)
        y.append(img_y)

    X1 = np.array(X)
    y1 = np.array(y)

    return X1,y1
```

```
import os
path = '/content/my-drive/My Drive/MRI Brain/'
X_train , y_train = PreProcessData(path)
```

```
Input_Sample = Input(shape=(256, 256, 3))
###-----------------------------------------------------------------------------------
model_1 = Conv2D(16,(3,3), activation='relu',padding='same',strides=1)(Input_Sample)
model_1 = Conv2D(32,(3,3), activation='relu',padding='same',strides=1)(model_1)
model_1 = Conv2D(64,(2,2), activation='relu',padding='same',strides=1)(model_1)
###-----------------------------------------------------------------------------------
model_2 = Conv2D(32,(3,3), activation='relu',padding='same',strides=1)(Input_Sample)
model_2 = Conv2D(64,(2,2), activation='relu',padding='same',strides=1)(model_2)
###-----------------------------------------------------------------------------------
model_2_1 = Conv2D(64,(2,2), activation='relu',padding='same',strides=1)(model_2)
#-----------------------------------###ADD###---------------------------------------
model_add_1 = add([model_1, model_2, model_2_1])

#-----------------------------------#Extension#---------------------------------------
model_3 = Conv2D(64,(3,3), activation='relu',padding='same',strides=1)(model_add_1)
model_3 = Conv2D(32,(3,3), activation='relu',padding='same',strides=1)(model_3)
model_3 = Conv2D(16,(2,2), activation='relu',padding='same',strides=1)(model_3)
```

```
###-------------------------------------------------------------------------------------
model_3_1 = Conv2D(32,(3,3), activation='relu',padding='same',strides=1)(model_add_1)
model_3_1 = Conv2D(16,(2,2), activation='relu',padding='same',strides=1)(model_3_1)
###-------------------------------------------------------------------------------------
model_3_2 = Conv2D(16,(2,2), activation='relu',padding='same',strides=1)(model_add_1)
#-----------------------------------###ADD###-----------------------------------------
model_add_2 = add([model_3_1, model_3_2, model_3])

#-----------------------------------#Extension#-----------------------------------------
model_4 = Conv2D(16,(3,3), activation='relu',padding='same',strides=1)(model_add_2)
###-------------------------------------------------------------------------------------
model_4_1 = Conv2D(16,(3,3), activation='relu',padding='same',strides=1)(model_add_1)
#-----------------------------------###ADD###-----------------------------------------
model_add_3 = add([model_4_1, model_add_2, model_4])

#-----------------------------------#Extension#-----------------------------------------
model_5 = Conv2D(16,(3,3), activation='relu',padding='same',strides=1)(model_add_3)
model_5 = Conv2D(16,(2,2), activation='relu',padding='same',strides=1)(model_add_3)

model_5 = Conv2D(3,(3,3), activation='relu',padding='same',strides=1)(model_5)



from keras.models import Model

Model_Enhancer = Model(inputs=Input_Sample, outputs=model_5)


Model_Enhancer.compile(optimizer = 'adam', loss='mean_squared_error')
Model_Enhancer.summary()
```

```
Model: "model"
_________________________________________________________________________________________________
 Layer (type)                Output Shape              Param #     Connected to
=================================================================================================
 input_1 (InputLayer)        [(None, 256, 256, 3       0           []
                             )]

 conv2d (Conv2D)             (None, 256, 256, 16       448         ['input_1[0][0]']
                             )

 conv2d_3 (Conv2D)           (None, 256, 256, 32       896         ['input_1[0][0]']
                             )

 conv2d_1 (Conv2D)           (None, 256, 256, 32       4640        ['conv2d[0][0]']
                             )

 conv2d_4 (Conv2D)           (None, 256, 256, 64       8256        ['conv2d_3[0][0]']
                             )

 conv2d_2 (Conv2D)           (None, 256, 256, 64       8256        ['conv2d_1[0][0]']
                             )

 conv2d_5 (Conv2D)           (None, 256, 256, 64       16448       ['conv2d_4[0][0]']
                             )

 add (Add)                   (None, 256, 256, 64       0           ['conv2d_2[0][0]',
                             )                                      'conv2d_4[0][0]',
                                                                    'conv2d_5[0][0]']

 conv2d_6 (Conv2D)           (None, 256, 256, 64       36928       ['add[0][0]']
                             )

 conv2d_9 (Conv2D)           (None, 256, 256, 32       18464       ['add[0][0]']
                             )

 conv2d_7 (Conv2D)           (None, 256, 256, 32       18464       ['conv2d_6[0][0]']
                             )

 conv2d_10 (Conv2D)          (None, 256, 256, 16       2064        ['conv2d_9[0][0]']
                             )

 conv2d_11 (Conv2D)          (None, 256, 256, 16       4112        ['add[0][0]']
                             )

 conv2d_8 (Conv2D)           (None, 256, 256, 16       2064        ['conv2d_7[0][0]']
                             )

 add_1 (Add)                 (None, 256, 256, 16       0           ['conv2d_10[0][0]',
                             )                                      'conv2d_11[0][0]',
                                                                    'conv2d_8[0][0]']
```

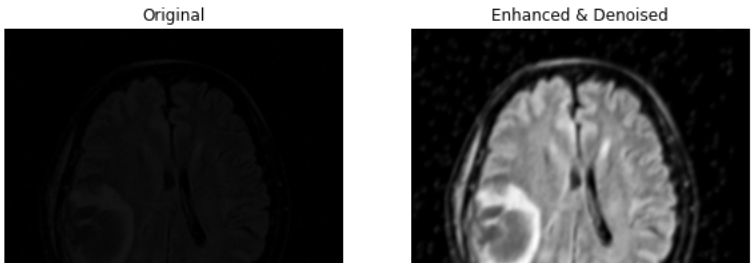
```
conv2d_13 (Conv2D)          (None, 256, 256, 16  9232        ['add[0][0]']
                            )

conv2d_12 (Conv2D)          (None, 256, 256, 16  2320        ['add_1[0][0]']
                            )

add_2 (Add)                 (None, 256, 256, 16  0           ['conv2d_13[0][0]',
```

epoch * steps_per_epoch < number of images in dataset

```
def GenerateInputs(X, y):
    for i in range(len(X)):
        X_input = X[i].reshape(1, 256, 256, 3)
        y_input = y[i].reshape(1, 256, 256, 3)
        yield (X_input,y_input)

history = Model_Enhancer.fit(GenerateInputs(X_train, y_train), epochs=25, verbose=1, steps_per_epoch = 10, shuffle=True)
```

```
Epoch 1/25
10/10 [==============================] - 32s 84ms/step - loss: 0.0356
Epoch 2/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0315
Epoch 3/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0206
Epoch 4/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0441
Epoch 5/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0279
Epoch 6/25
10/10 [==============================] - 1s 84ms/step - loss: 0.0297
Epoch 7/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0636
Epoch 8/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0210
Epoch 9/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0202
Epoch 10/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0193
Epoch 11/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0274
Epoch 12/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0209
Epoch 13/25
10/10 [==============================] - 1s 84ms/step - loss: 0.0869
Epoch 14/25
10/10 [==============================] - 1s 84ms/step - loss: 0.0397
Epoch 15/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0421
Epoch 16/25
10/10 [==============================] - 1s 82ms/step - loss: 0.0261
Epoch 17/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0313
Epoch 18/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0254
Epoch 19/25
10/10 [==============================] - 1s 82ms/step - loss: 0.0182
Epoch 20/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0226
Epoch 21/25
10/10 [==============================] - 1s 84ms/step - loss: 0.0233
Epoch 22/25
10/10 [==============================] - 1s 82ms/step - loss: 0.0118
Epoch 23/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0194
Epoch 24/25
10/10 [==============================] - 1s 83ms/step - loss: 0.0208
Epoch 25/25
10/10 [==============================] - 1s 82ms/step - loss: 0.0292
```

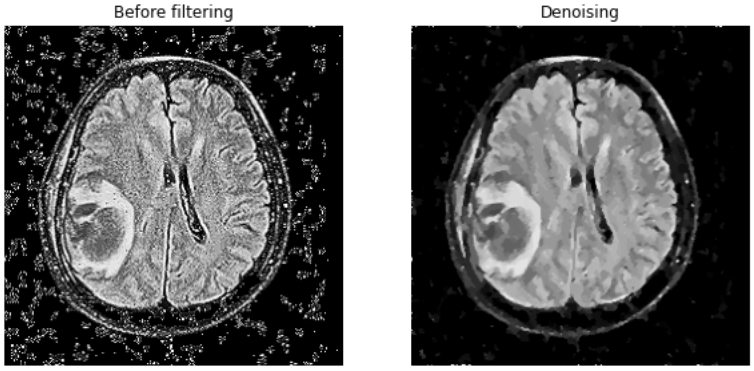
```
brain_image1 = brain_image.copy()
Prediction = Model_Enhancer.predict(brain_image1.reshape(1, 256, 256, 3))
Prediction = Prediction.reshape(256,256,3)
brain_image1[:,:,:] = Prediction[:,:,:]
plot_img(brain_image, brain_image1[:,:,0], 'Original', 'Enhanced & Denoised')
```



Denoising image using Median Filter

```
def median_filter(img, size):
    r_img = img.copy()
    height, width = r_img.shape[0:2]
    for row in range(size, height-size):
        for column in range(size, width-size):
            r_img[row][column] = np.median(r_img[row - size : row + (size+1), column - size : column + (size+1)])

    return r_img

size = int(input("Enter the size of filter: "))
r_img = median_filter(img_new, size)

plot_img(img_new, r_img, 'Before filtering', 'Denoising')
```

```
Enter the size of filter: 1
```



Denoising using Autoencoder

```
from keras.models import Model
from keras.layers import Conv2D, MaxPooling2D, UpSampling2D, Input
from tensorflow.keras.optimizers import SGD, Adam
import tensorflow as tf
```

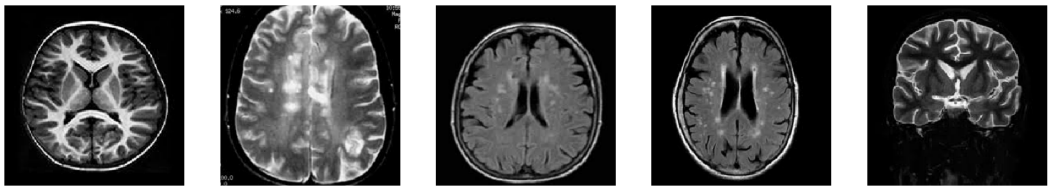
```
from google.colab import drive
drive.mount('/content/my-drive')
```

```
Drive already mounted at /content/my-drive; to attempt to forcibly remount, call drive.mount("/content/my-drive", force_remount=True).
```

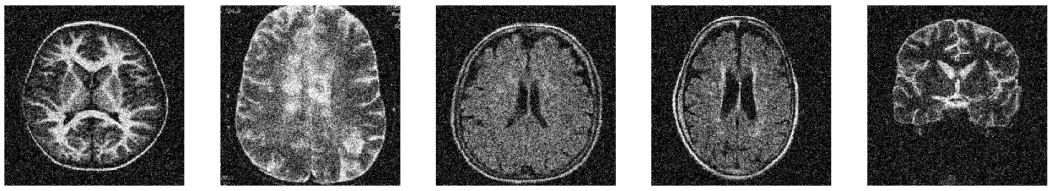
```
import os
train_images=sorted(os.listdir('my-drive/My Drive/MRI Brain')) #Taking a list of the images' name then sorting
```

```
from keras.preprocessing import image

# Read images from the dataset and add
# Normalize images and turn to list of arrays

train_image=[]
for im in train_images:
  img=image.load_img('my-drive/My Drive/MRI Brain/'+im, target_size=(256,256),color_mode='grayscale')
  img=image.img_to_array(img)
  img=img/255
```

```
  train_image.append(img)

train_df=np.array(train_image)


#Subplotting 5 images
def plot_image(dataset):
  f,ax=plt.subplots(1,5)
  f.set_size_inches(30,10)
  for i in range(5,10):
    ax[i-5].imshow(dataset[i].reshape(256,256), cmap='gray')
    ax[i-5].axis('off')
  plt.show()


#Adding random noise
def add_noise(image):
  noisy_image = image + 0.24 * np.random.randn(*image.shape)
  noisy_image = np.clip(noisy_image, 0, 1)
  return noisy_image


# Add noise to each image
noised_df=[]
for img in train_df:
  noisy=add_noise(img)
  noised_df.append(noisy)

noised_df=np.array(noised_df)


plot_image(train_df)
```



```
plot_image(noised_df)
```



```
xnoised = noised_df[:121] # X train --> Noisy images for training
xtestnoised = noised_df[121:] # X test --> Noisy images for validation and test
xtrain = train_df[:121] # y train --> without noise
xtest = train_df[121:] # y test --> without noise


input = Input(shape=(256,256,1))
#enoder
x = Conv2D(64, (3,3), activation='relu', padding='same')(input)
x1 = MaxPooling2D((2,2), padding='same')(x)
x2 = Conv2D(64, (3,3), activation='relu', padding='same')(x1)
x3 = MaxPooling2D((2,2), padding='same')(x2)
```

```
#decoder
x4 = Conv2D(64, (3,3), activation='relu', padding='same')(x3)
x5 = UpSampling2D((2,2))(x4)
x6 = Conv2D(64, (3,3), activation='relu', padding='same')(x5)
x7 = UpSampling2D((2,2))(x6)
x8 = Conv2D(1, (3,3), activation='sigmoid', padding='same')(x7)

#model
autoencoder = Model(inputs=input, outputs=x8)
autoencoder.compile(optimizer='adam', loss='binary_crossentropy')


autoencoder.summary()
```

```
Model: "model_3"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_4 (InputLayer)        [(None, 256, 256, 1)]     0

 conv2d_27 (Conv2D)          (None, 256, 256, 64)      640

 max_pooling2d_4 (MaxPooling  (None, 128, 128, 64)     0
 2D)

 conv2d_28 (Conv2D)          (None, 128, 128, 64)      36928

 max_pooling2d_5 (MaxPooling  (None, 64, 64, 64)       0
 2D)

 conv2d_29 (Conv2D)          (None, 64, 64, 64)        36928

 up_sampling2d_4 (UpSampling  (None, 128, 128, 64)     0
 2D)

 conv2d_30 (Conv2D)          (None, 128, 128, 64)      36928

 up_sampling2d_5 (UpSampling  (None, 256, 256, 64)     0
 2D)

 conv2d_31 (Conv2D)          (None, 256, 256, 1)       577

=================================================================
Total params: 112,001
Trainable params: 112,001
Non-trainable params: 0
_________________________________________________________________
```

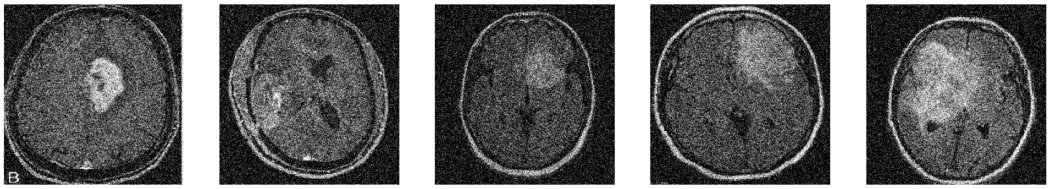
```
autoencoder.fit(xnoised,
                xtrain,
                epochs=20,
                batch_size=10,
                validation_data=(xtestnoised, xtest))
```

```
Epoch 1/20
13/13 [==============================] - 3s 190ms/step - loss: 0.6117 - val_loss: 0.5252
Epoch 2/20
13/13 [==============================] - 2s 168ms/step - loss: 0.4579 - val_loss: 0.4544
Epoch 3/20
13/13 [==============================] - 2s 166ms/step - loss: 0.4385 - val_loss: 0.4395
Epoch 4/20
13/13 [==============================] - 2s 167ms/step - loss: 0.4209 - val_loss: 0.4269
Epoch 5/20
13/13 [==============================] - 2s 166ms/step - loss: 0.4093 - val_loss: 0.4180
Epoch 6/20
13/13 [==============================] - 2s 166ms/step - loss: 0.4042 - val_loss: 0.4162
Epoch 7/20
13/13 [==============================] - 2s 167ms/step - loss: 0.4020 - val_loss: 0.4143
Epoch 8/20
13/13 [==============================] - 2s 167ms/step - loss: 0.3998 - val_loss: 0.4129
Epoch 9/20
13/13 [==============================] - 2s 167ms/step - loss: 0.3990 - val_loss: 0.4120
Epoch 10/20
13/13 [==============================] - 2s 166ms/step - loss: 0.3979 - val_loss: 0.4120
Epoch 11/20
13/13 [==============================] - 2s 165ms/step - loss: 0.3981 - val_loss: 0.4113
Epoch 12/20
13/13 [==============================] - 2s 165ms/step - loss: 0.3965 - val_loss: 0.4106
Epoch 13/20
13/13 [==============================] - 2s 167ms/step - loss: 0.3963 - val_loss: 0.4099
Epoch 14/20
13/13 [==============================] - 2s 166ms/step - loss: 0.3965 - val_loss: 0.4097
```

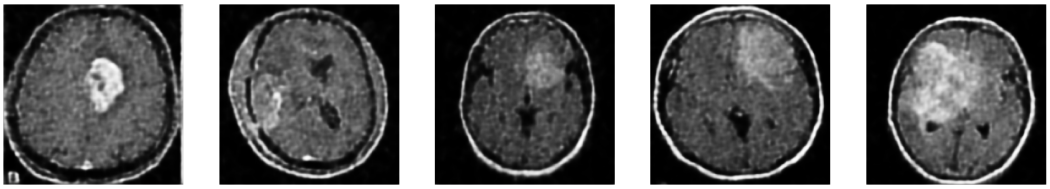
```
Epoch 15/20
13/13 [==============================] - 2s 166ms/step - loss: 0.3956 - val_loss: 0.4119
Epoch 16/20
13/13 [==============================] - 2s 167ms/step - loss: 0.3958 - val_loss: 0.4093
Epoch 17/20
13/13 [==============================] - 2s 166ms/step - loss: 0.3943 - val_loss: 0.4088
Epoch 18/20
13/13 [==============================] - 2s 165ms/step - loss: 0.3945 - val_loss: 0.4109
Epoch 19/20
13/13 [==============================] - 2s 166ms/step - loss: 0.3950 - val_loss: 0.4088
Epoch 20/20
13/13 [==============================] - 2s 165ms/step - loss: 0.3936 - val_loss: 0.4099
<keras.callbacks.History at 0x7fd30c4d7f10>
```

```
dtest = []
for images in xtestnoised[8:18]:
  dtest.append(images)

# Normalizing my own image test and add it to the testing images list
img1=image.img_to_array(img_new)
img1=img1/255
dtest.append(img1)
dtest_arr = np.array(dtest)

pred= autoencoder.predict(dtest_arr)
```

```
plot_image(dtest_arr) #Plotting 5 first images before denoising
```



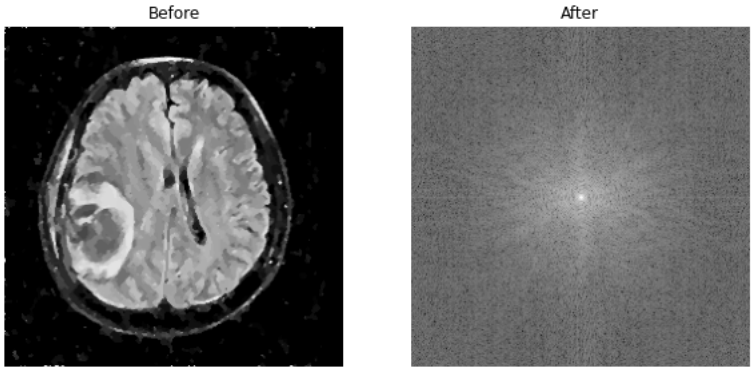
```
plot_image(pred) #Plotting after denoising
```



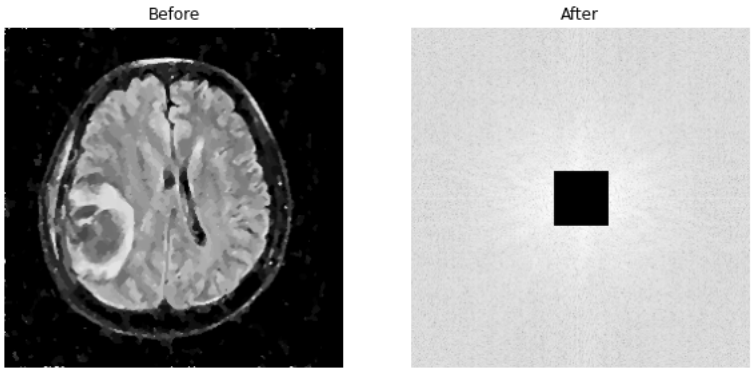
```
plot_img(img_new, pred[10].reshape(256,256), 'Before Denoising', 'After Autoencoder Denoising')
```

Edge Detection Using Highpass filtering

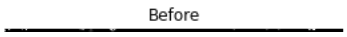
```
### Fourier Transform --> Real and Imaginary value

F1 = np.fft.fft2(r_img)
F2 = np.fft.fftshift(F1) # Zero frequency in the center of the image
mag = 20 * np.log(np.abs(F2) + 1e-6) #Saving the complex numbers as real numbers

plot_img(r_img, mag, 'Before', 'After')
```

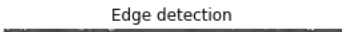



```
(w, h) = r_img.shape
half_w, half_h = np.int32(w/2), np.int32(h/2)

#### highpass filter
n = 20 # The higher the number, the higher scales of the image therefore the details are much less shown

F2[ half_w-n:half_w+n+1 , half_h-n:half_h+n+1 ] = 0 # select all but the first 40x40 (low) frequencies

mag1 = 20 * np.log(np.abs(F2) + 1e-6)

plot_img(r_img, mag1, 'Before', 'After')
```




```
mag2 = np.fft.ifft2(np.fft.ifftshift(F2)) # Inverse Fourier Transform
mag2 = np.real(mag2) #Taking only the real values
plot_img(r_img, mag2, 'Before', 'Edge detection')
```






```
plot_img(r_img, r_img+mag2, 'Before', 'After')
```