Image_Super_Resolution

September 5, 2020

Image Super Resolution using Autoencoders

0.1 Project Overview and Import Libraries

[23]:
```
from tensorflow.keras.layers import Input, Dense, Conv2D, MaxPooling2D, Dropout
from tensorflow.keras.layers import Conv2DTranspose, UpSampling2D, add
from skimage.transform import resize, rescale
from tensorflow.keras.models import Model
from tensorflow.keras import regularizers
import matplotlib.pyplot as plt
from scipy import ndimage, misc
from matplotlib import pyplot
import tensorflow as tf
import numpy as np
np.random.seed(0)
import re
import os

print(tf.__version__)
```

```
2.3.0
```

0.2 What are Autoencoders?

Credit: Autoencoder Schema by Francois Chollet, 2016.

Encoder Architecture

0.3 Build the Encoder

[24]:
```
input_img = Input(shape=(256, 256, 3))
```

[25]:
```
l1 = Conv2D(64, (3, 3), padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(input_img)
```

```
l2 = Conv2D(64, (3, 3), padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(l1)

l3 = MaxPooling2D(padding = 'same')(l2)
l3 = Dropout(0.3)(l3)

l4 = Conv2D(128, (3, 3),  padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(l3)

l5 = Conv2D(128, (3, 3), padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(l4)

l6 = MaxPooling2D(padding = 'same')(l5)

l7 = Conv2D(256, (3, 3), padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(l6)

encoder = Model(input_img, l7)
```

[26]:
```
encoder.summary()
```

```
Model: "functional_7"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_2 (InputLayer)         [(None, 256, 256, 3)]     0
_________________________________________________________________
conv2d_15 (Conv2D)           (None, 256, 256, 64)      1792
_________________________________________________________________
conv2d_16 (Conv2D)           (None, 256, 256, 64)      36928
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 128, 128, 64)      0
_________________________________________________________________
dropout_2 (Dropout)          (None, 128, 128, 64)      0
_________________________________________________________________
conv2d_17 (Conv2D)           (None, 128, 128, 128)     73856
_________________________________________________________________
conv2d_18 (Conv2D)           (None, 128, 128, 128)     147584
_________________________________________________________________
max_pooling2d_5 (MaxPooling2 (None, 64, 64, 128)       0
_________________________________________________________________
conv2d_19 (Conv2D)           (None, 64, 64, 256)       295168
=================================================================
Total params: 555,328
Trainable params: 555,328
Non-trainable params: 0
```

0.4 Build the Decoder to Complete the Network

[27]:
```
l1 = Conv2D(64, (3, 3), padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(input_img)

l2 = Conv2D(64, (3, 3), padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(l1)

l3 = MaxPooling2D(padding = 'same')(l2)
l3 = Dropout(0.3)(l3)

l4 = Conv2D(128, (3, 3),  padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(l3)

l5 = Conv2D(128, (3, 3), padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(l4)

l6 = MaxPooling2D(padding = 'same')(l5)

l7 = Conv2D(256, (3, 3), padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(l6)
```

[28]:
```
l8 = UpSampling2D()(l7)

l9 = Conv2D(128, (3, 3), padding = 'same', activation = 'relu',
            activity_regularizer = regularizers.l1(10e-10))(l8)

l10 = Conv2D(128, (3, 3), padding = 'same', activation = 'relu',
             activity_regularizer = regularizers.l1(10e-10))(l9)

l11 = add([l5, l10])
l12 = UpSampling2D()(l11)

l13 = Conv2D(64, (3, 3), padding = 'same', activation = 'relu',
             activity_regularizer = regularizers.l1(10e-10))(l12)

l14 = Conv2D(64, (3, 3), padding = 'same', activation = 'relu',
             activity_regularizer = regularizers.l1(10e-10))(l13)

l15 = add([l14, l2])

decoded = Conv2D(3, (3, 3), padding = 'same',
                 activation = 'relu', activity_regularizer = regularizers.
 ↪l1(10e-10))(l15)
```

```
autoencoder = Model(input_img, decoded)
autoencoder_hfenn = Model(input_img, decoded)
```

[29]:
```
autoencoder.summary()
```

```
Model: "functional_9"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_2 (InputLayer)         [(None, 256, 256, 3)      0
_________________________________________________________________
conv2d_20 (Conv2D)           (None, 256, 256, 64)      1792
_________________________________________________________________
conv2d_21 (Conv2D)           (None, 256, 256, 64)      36928
_________________________________________________________________
max_pooling2d_6 (MaxPooling2D (None, 128, 128, 64)     0
_________________________________________________________________
dropout_3 (Dropout)          (None, 128, 128, 64)      0
_________________________________________________________________
conv2d_22 (Conv2D)           (None, 128, 128, 128      73856
_________________________________________________________________
conv2d_23 (Conv2D)           (None, 128, 128, 128      147584
_________________________________________________________________
max_pooling2d_7 (MaxPooling2D (None, 64, 64, 128)      0
_________________________________________________________________
conv2d_24 (Conv2D)           (None, 64, 64, 256)       295168
_________________________________________________________________
up_sampling2d_2 (UpSampling2D (None, 128, 128, 256     0
_________________________________________________________________
conv2d_25 (Conv2D)           (None, 128, 128, 128      295040
_________________________________________________________________
```

```
------------------
conv2d_26 (Conv2D)              (None, 128, 128, 128 147584      conv2d_25[0][0]
__________________________________________________________________________________
------------------
add_2 (Add)                     (None, 128, 128, 128 0           conv2d_23[0][0]
                                                                 conv2d_26[0][0]
__________________________________________________________________________________
------------------
up_sampling2d_3 (UpSampling2D)  (None, 256, 256, 128 0           add_2[0][0]
__________________________________________________________________________________
------------------
conv2d_27 (Conv2D)              (None, 256, 256, 64) 73792
up_sampling2d_3[0][0]
__________________________________________________________________________________
------------------
conv2d_28 (Conv2D)              (None, 256, 256, 64) 36928       conv2d_27[0][0]
__________________________________________________________________________________
------------------
add_3 (Add)                     (None, 256, 256, 64) 0           conv2d_28[0][0]
                                                                 conv2d_21[0][0]
__________________________________________________________________________________
------------------
conv2d_29 (Conv2D)              (None, 256, 256, 3)  1731        add_3[0][0]
==================================================================================
==================
Total params: 1,110,403
Trainable params: 1,110,403
Non-trainable params: 0
__________________________________________________________________________________
------------------
```

[30]:
```
autoencoder.compile(optimizer = 'adadelta', loss = 'mean_squared_error')
```

0.5 Create Dataset and Specify Training Routine

[31]:
```
def train_batches(just_load_dataset=False):

    batches = 256

    batch = 0
    batch_nb = 0
    max_batches = -1

    ep = 4
```

```
    images = []
    x_train_n = []
    x_train_down = []

    x_train_n2 = []
    x_train_down2 = []

    for root, dirnames, filenames in os.walk("data/cars_train"):
        for filename in filenames:
            if re.search("\.(jpg|jpeg|JPEG|png|bmp|tiff)$", filename):
                if batch_nb == max_batches:
                    return x_train_n2, x_train_down2
                filepath = os.path.join(root, filename)
                image = pyplot.imread(filepath)
                if len(image.shape) > 2:

                    image_resized = resize(image, (256, 256)) # Resize the␣
↪image so that every image is the same size
                    x_train_n.append(image_resized) # Add this image to the␣
↪high res dataset
                    dwn1 = rescale(image_resized, 2)
                    x_train_down.append(rescale(dwn1,0.5))
                    batch += 1
                    if batch == batches:
                        batch_nb += 1

                        x_train_n2 = np.array(x_train_n)
                        x_train_down2 = np.array(x_train_down)

                        if just_load_dataset:
                            return x_train_n2, x_train_down2

                        print('Training batch', batch_nb, '(', batches, ')')

                        autoencoder.fit(x_train_down2, x_train_n2,
                            epochs=ep,
                            batch_size=10,
                            shuffle=True,
                            validation_split=0.15)

                        x_train_n = []
                        x_train_down = []

                        batch = 0

    return x_train_n2, x_train_down2
```

0.6 Load the Dataset and Pre-trained Model

[32]:
```
x_train_n, x_train_down = train_batches(just_load_dataset = True)
```

[33]:
```
autoencoder.load_weights('data/sr.img_net.mse.final_model5.no_patch.weights.
↪best.hdf5')
```

0.7 Model Predictions and Visualizing the Results

[34]:
```
encoder.load_weights('data/encoder_weights.hdf5')
```

[35]:
```
encoded_imgs = encoder.predict(x_train_down)
```

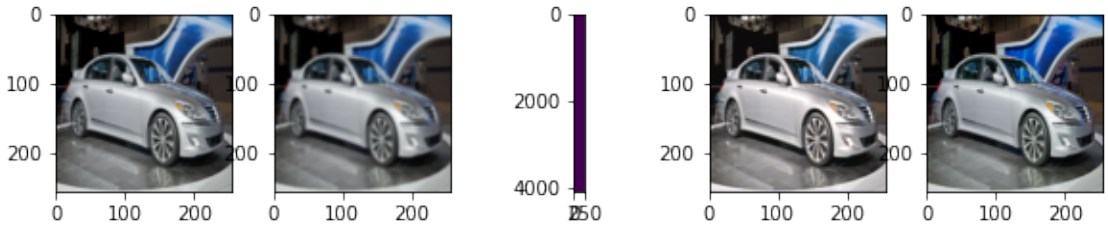
[36]:
```
encoded_imgs.shape
```

[36]:
```
(256, 64, 64, 256)
```

[37]:
```
sr1 = np.clip(autoencoder.predict(x_train_down), 0.0, 1.0)
```

[38]:
```
image_index = 251
```

[39]:
```
plt.figure(figsize = (20, 20))
i = 1
ax = plt.subplot(10, 10, i)
plt.imshow(x_train_down[image_index])
i += 1
ax = plt.subplot(10, 10, i)
plt.imshow(x_train_down[image_index], interpolation = "bicubic")
i += 1
ax = plt.subplot(10, 10, i)
plt.imshow(encoded_imgs[image_index].reshape((64*64, 256)))
i += 1
ax = plt.subplot(10, 10, i)
plt.imshow(sr1[image_index])
i += 1
ax = plt.subplot(10, 10, i)
plt.imshow(x_train_n[image_index])
plt.show()
```


0
100
200
0
100
200
0
2000
4000
0
100
200
0
100
200

[ ]: