main_SRCNN

March 27, 2019

0.0.1 Super-Resolution Convolutional Neural Network

```
In [9]: import os
        import cv2
        import h5py
        import math
        import numpy
        import matplotlib.pyplot as plt
        import tensorflow as tf
        import time
        %run "../lib/SRCNN/main_SRCNN_prepare_data.py" #import functions for prepare data
        %run "../lib/SRCNN/main_SRCNN_train_predict.py" #import train and predict model
```

0.0.2 Feature and Label Construction

Please make sure you have the following directories with trianing LR HR images and testing LR HR images along with our entire folder!

```
In [13]: #Set train data directories
         train_LR_dir = "../data/train_set/LR/"
         train_HR_dir = "../data/train_set/HR/"
         LR_dir_name = os.listdir(train_LR_dir)
         HR_dir_name = os.listdir(train_HR_dir)

         #Set test data directories
         test_lr_dir = "../data/test_set/LR/"
         test_super_dir = "../data/test_set/SR-I/"
         test_hr_dir = "../data/test_set/HR/"
         test_lr_name = os.listdir(test_lr_dir)
         n_test_files = len(test_lr_name)

         #weight path
         weight_path = "../lib/SRCNN/YCrCb_entire_weight.h5"

         #initial values
         n_files = len(LR_dir_name)
         Random_Crop =30 #number of sample patches
         Patch_size = 33
         learn_rate = 0.0003
```

```
In [11]: #RGB_feature , RGB_label , RGB_feature_time= feature_RGB(n_files,Random_Crop,Patch_si

In [5]: YCrCb_feature , YCrCb_label , YCrCb_feature_time = feature_YCrCb(n_files,Random_Crop,Pa

In [6]: YCrCb_feature.shape

Out[6]: (45000, 33, 33, 3)

In [7]: YCrCb_label.shape

Out[7]: (45000, 33, 33, 3)

In [129]: #Y_feature , Y_label , Y_feature_time = feature_Y_color(n_files,Random_Crop,Patch_si

In [ ]: #Save train feature h5py file
        #write_h5py(RGB_feature,RGB_label,"../lib/RGB_feature.h5")
        #write_h5py(YCrCb_feature,YCrCb_label,"../lib/YCrCb_feature.h5")
        #write_h5py(Y_feature,Y_label,"../lib/Y_feature.h5")
```

0.0.3 Train Images on three color channel with validation split

```
In [ ]: #RGB_feature,RGB_label =  read_training_data("../lib/RGB_feature.h5")
        #YCrCb_feature,YCrCb_label =  read_training_data("../lib/YCrCb_feature.h5")
        #Y_feature,Y_label =  read_training_data("../lib/Y_feature.h5")
```

Training RGB channel

```
In [156]: #RGB_model = train_model(n1=64,n2=32,n3=3,k1=9,k2=1,k3=5, Patch_size=Patch_size,lear

In [157]: #print(RGB_model.summary())

_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_45 (Conv2D)           (None, 33, 33, 64)        15616
_________________________________________________________________
conv2d_46 (Conv2D)           (None, 33, 33, 32)        2080
_________________________________________________________________
conv2d_47 (Conv2D)           (None, 33, 33, 3)         2403
=================================================================
Total params: 20,099
Trainable params: 20,099
Non-trainable params: 0
_________________________________________________________________
None


In [158]: #RGB_train,RGB_train_time = training(RGB_feature,RGB_label,RGB_model,batch=128,epoch
```

```
Train on 36000 samples, validate on 9000 samples
Epoch 1/100
36000/36000 [==============================] - 7s 184us/step - loss: 0.0140 - val_loss: 0.0062
Epoch 2/100
36000/36000 [==============================] - 5s 150us/step - loss: 0.0036 - val_loss: 0.0051
Epoch 3/100
36000/36000 [==============================] - 5s 150us/step - loss: 0.0032 - val_loss: 0.0048
Epoch 4/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0030 - val_loss: 0.0046
Epoch 5/100
36000/36000 [==============================] - 5s 148us/step - loss: 0.0029 - val_loss: 0.0045
Epoch 6/100
36000/36000 [==============================] - 5s 150us/step - loss: 0.0028 - val_loss: 0.0045
Epoch 7/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0028 - val_loss: 0.0044
Epoch 8/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0028 - val_loss: 0.0049
Epoch 9/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0027 - val_loss: 0.0044
Epoch 10/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0027 - val_loss: 0.0044
Epoch 11/100
36000/36000 [==============================] - 5s 151us/step - loss: 0.0027 - val_loss: 0.0043
Epoch 12/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0027 - val_loss: 0.0043
Epoch 13/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0027 - val_loss: 0.0043
Epoch 14/100
36000/36000 [==============================] - 5s 148us/step - loss: 0.0027 - val_loss: 0.0043
Epoch 15/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0027 - val_loss: 0.0044
Epoch 16/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0027 - val_loss: 0.0043
Epoch 17/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0027 - val_loss: 0.0043
Epoch 18/100
36000/36000 [==============================] - 5s 148us/step - loss: 0.0026 - val_loss: 0.0043
Epoch 19/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0026 - val_loss: 0.0043
Epoch 20/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0026 - val_loss: 0.0043
Epoch 21/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 22/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 23/100
36000/36000 [==============================] - 5s 148us/step - loss: 0.0026 - val_loss: 0.0045
Epoch 24/100
```

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36000/36000 [==============================] - 5s 149us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 25/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 26/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0026 - val_loss: 0.0043
Epoch 27/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 28/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 29/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 30/100
36000/36000 [==============================] - 5s 144us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 31/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 32/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 33/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 34/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0026 - val_loss: 0.0043
Epoch 35/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 36/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0026 - val_loss: 0.0042
Epoch 37/100
36000/36000 [==============================] - 5s 148us/step - loss: 0.0025 - val_loss: 0.0042
Epoch 38/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0025 - val_loss: 0.0042
Epoch 39/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0042
Epoch 40/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0025 - val_loss: 0.0043
Epoch 41/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0042
Epoch 42/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0025 - val_loss: 0.0042
Epoch 43/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 44/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 45/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 46/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0025 - val_loss: 0.0042
Epoch 47/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0025 - val_loss: 0.0042
Epoch 48/100
```

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36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 49/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 50/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 51/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 52/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 53/100
36000/36000 [==============================] - 5s 148us/step - loss: 0.0025 - val_loss: 0.0042
Epoch 54/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 55/100
36000/36000 [==============================] - 5s 149us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 56/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 57/100
36000/36000 [==============================] - 5s 150us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 58/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 59/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 60/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 61/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 62/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 63/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 64/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 65/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 66/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 67/100
36000/36000 [==============================] - 5s 146us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 68/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 69/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 70/100
36000/36000 [==============================] - 5s 144us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 71/100
36000/36000 [==============================] - 5s 147us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 72/100
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36000/36000 [==============================] - 5s 147us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 73/100
36000/36000 [==============================] - 5s 151us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 74/100
36000/36000 [==============================] - 5s 150us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 75/100
36000/36000 [==============================] - 5s 150us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 76/100
36000/36000 [==============================] - 6s 155us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 77/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 78/100
36000/36000 [==============================] - 6s 158us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 79/100
36000/36000 [==============================] - 6s 156us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 80/100
36000/36000 [==============================] - 6s 158us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 81/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 82/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 83/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 84/100
36000/36000 [==============================] - 6s 158us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 85/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 86/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 87/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 88/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 89/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 90/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041s
Epoch 91/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 92/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 93/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 94/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 95/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 96/100
```
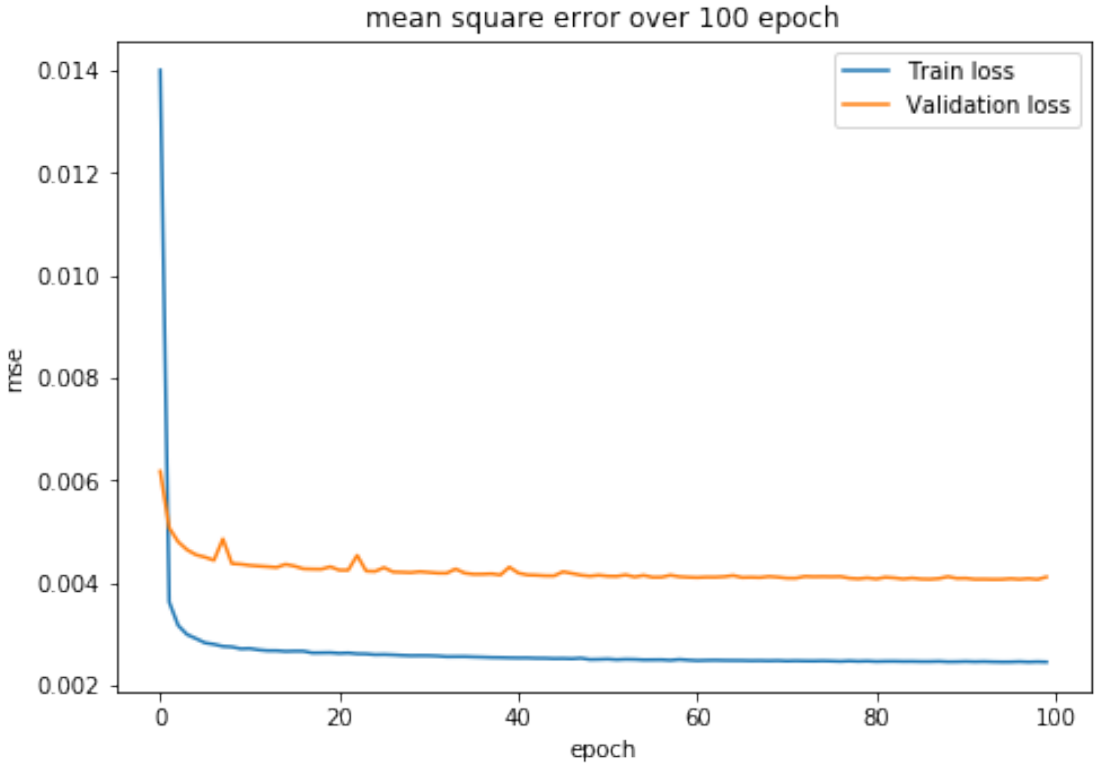

```
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 97/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 98/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 99/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
Epoch 100/100
36000/36000 [==============================] - 6s 157us/step - loss: 0.0025 - val_loss: 0.0041
```

In [268]: *#show_error(RGB_train,valid=True)*



In [206]: *#show_psnr(RGB_train,valid=True)*

```
Training mse: 0.0024530321784938377   psnr : 26.102967547489143
Validation mse: 0.004112832445444332 psnr : 23.85858983051289
```

Training YCrCb channel

In [161]: *#YCrCb_model = train_model(n1=64,n2=32,n3=3,k1=9,k2=1,k3=5, Patch_size=Patch_size,le*

In [162]: *#print(YCrCb_model.summary())*

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_48 (Conv2D)           (None, 33, 33, 64)        15616
_________________________________________________________________
conv2d_49 (Conv2D)           (None, 33, 33, 32)        2080
_________________________________________________________________
conv2d_50 (Conv2D)           (None, 33, 33, 3)         2403
=================================================================
Total params: 20,099
Trainable params: 20,099
Non-trainable params: 0
_________________________________________________________________
None
```

In [163]: *#YCrCb_train , YCrCb_train_time = training(YCrCb_feature,YCrCb_label,YCrCb_model,bat*

```
Train on 36000 samples, validate on 9000 samples
Epoch 1/100
36000/36000 [==============================] - 6s 163us/step - loss: 0.0178 - val_loss: 0.0032
Epoch 2/100
36000/36000 [==============================] - 5s 144us/step - loss: 0.0018 - val_loss: 0.0022
Epoch 3/100
36000/36000 [==============================] - 5s 144us/step - loss: 0.0013 - val_loss: 0.0019
Epoch 4/100
36000/36000 [==============================] - 5s 144us/step - loss: 0.0012 - val_loss: 0.0018
Epoch 5/100
36000/36000 [==============================] - 5s 144us/step - loss: 0.0011 - val_loss: 0.0017
Epoch 6/100
36000/36000 [==============================] - 5s 144us/step - loss: 0.0011 - val_loss: 0.0016
Epoch 7/100
36000/36000 [==============================] - 5s 145us/step - loss: 0.0010 - val_loss: 0.0016
Epoch 8/100
36000/36000 [==============================] - 5s 144us/step - loss: 0.0010 - val_loss: 0.0017
Epoch 9/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.9608e-04 - val_loss: 0.0
Epoch 10/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.8195e-04 - val_loss: 0.0
Epoch 11/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.7447e-04 - val_loss: 0.0
Epoch 12/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.7425e-04 - val_loss: 0.0
Epoch 13/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.5920e-04 - val_loss: 0.0
Epoch 14/100
```

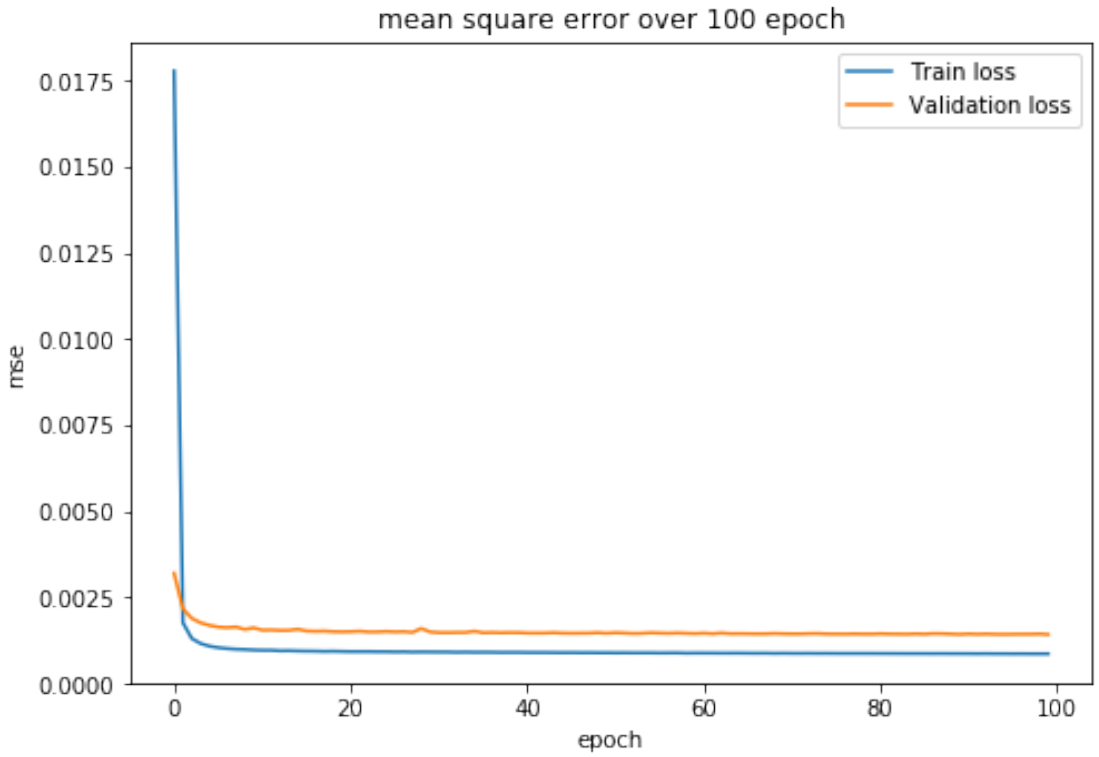
```
36000/36000 [==============================] - 5s 144us/step - loss: 9.6220e-04 - val_loss: 0.0
Epoch 15/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.5445e-04 - val_loss: 0.0
Epoch 16/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.5040e-04 - val_loss: 0.0
Epoch 17/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.4792e-04 - val_loss: 0.0
Epoch 18/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.4131e-04 - val_loss: 0.0
Epoch 19/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.4577e-04 - val_loss: 0.0
Epoch 20/100
36000/36000 [==============================] - 5s 145us/step - loss: 9.3958e-04 - val_loss: 0.0
Epoch 21/100
36000/36000 [==============================] - 5s 147us/step - loss: 9.3537e-04 - val_loss: 0.0
Epoch 22/100
36000/36000 [==============================] - 5s 145us/step - loss: 9.3564e-04 - val_loss: 0.0
Epoch 23/100
36000/36000 [==============================] - 5s 148us/step - loss: 9.3568e-04 - val_loss: 0.0
Epoch 24/100
36000/36000 [==============================] - 5s 148us/step - loss: 9.3222e-04 - val_loss: 0.0
Epoch 25/100
36000/36000 [==============================] - 5s 148us/step - loss: 9.3232e-04 - val_loss: 0.0
Epoch 26/100
36000/36000 [==============================] - 5s 146us/step - loss: 9.2700e-04 - val_loss: 0.0
Epoch 27/100
36000/36000 [==============================] - 5s 147us/step - loss: 9.3006e-04 - val_loss: 0.0
Epoch 28/100
36000/36000 [==============================] - 5s 148us/step - loss: 9.2284e-04 - val_loss: 0.0
Epoch 29/100
36000/36000 [==============================] - 5s 147us/step - loss: 9.2615e-04 - val_loss: 0.0
Epoch 30/100
36000/36000 [==============================] - 5s 146us/step - loss: 9.2448e-04 - val_loss: 0.0
Epoch 31/100
36000/36000 [==============================] - 5s 145us/step - loss: 9.2310e-04 - val_loss: 0.0
Epoch 32/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.2235e-04 - val_loss: 0.0
Epoch 33/100
36000/36000 [==============================] - 5s 144us/step - loss: 9.1692e-04 - val_loss: 0.0
Epoch 34/100
36000/36000 [==============================] - 5s 146us/step - loss: 9.2041e-04 - val_loss: 0.0
Epoch 35/100
36000/36000 [==============================] - 5s 145us/step - loss: 9.1610e-04 - val_loss: 0.0
Epoch 36/100
36000/36000 [==============================] - 5s 146us/step - loss: 9.1742e-04 - val_loss: 0.0
Epoch 37/100
36000/36000 [==============================] - 5s 146us/step - loss: 9.1619e-04 - val_loss: 0.0
Epoch 38/100
```

```
36000/36000 [==============================] - 5s 148us/step - loss: 9.1160e-04 - val_loss: 0.0
Epoch 39/100
36000/36000 [==============================] - 5s 148us/step - loss: 9.1299e-04 - val_loss: 0.0
Epoch 40/100
36000/36000 [==============================] - 5s 150us/step - loss: 9.1267e-04 - val_loss: 0.0
Epoch 41/100
36000/36000 [==============================] - 5s 149us/step - loss: 9.0921e-04 - val_loss: 0.0
Epoch 42/100
36000/36000 [==============================] - 5s 149us/step - loss: 9.0884e-04 - val_loss: 0.0
Epoch 43/100
36000/36000 [==============================] - 5s 148us/step - loss: 9.0816e-04 - val_loss: 0.0
Epoch 44/100
36000/36000 [==============================] - 5s 149us/step - loss: 9.0674e-04 - val_loss: 0.0
Epoch 45/100
36000/36000 [==============================] - 5s 148us/step - loss: 9.0369e-04 - val_loss: 0.0
Epoch 46/100
36000/36000 [==============================] - 5s 146us/step - loss: 9.0604e-04 - val_loss: 0.0
Epoch 47/100
36000/36000 [==============================] - 5s 147us/step - loss: 9.0259e-04 - val_loss: 0.0
Epoch 48/100
36000/36000 [==============================] - 5s 149us/step - loss: 9.0342e-04 - val_loss: 0.0
Epoch 49/100
36000/36000 [==============================] - 5s 149us/step - loss: 9.0106e-04 - val_loss: 0.0
Epoch 50/100
36000/36000 [==============================] - 5s 149us/step - loss: 9.0134e-04 - val_loss: 0.0
Epoch 51/100
36000/36000 [==============================] - 5s 150us/step - loss: 8.9852e-04 - val_loss: 0.0
Epoch 52/100
36000/36000 [==============================] - 5s 151us/step - loss: 8.9965e-04 - val_loss: 0.0
Epoch 53/100
36000/36000 [==============================] - 5s 152us/step - loss: 8.9799e-04 - val_loss: 0.0
Epoch 54/100
36000/36000 [==============================] - 5s 151us/step - loss: 8.9821e-04 - val_loss: 0.0
Epoch 55/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.9844e-04 - val_loss: 0.0
Epoch 56/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.9529e-04 - val_loss: 0.0
Epoch 57/100
36000/36000 [==============================] - 5s 145us/step - loss: 8.9649e-04 - val_loss: 0.0
Epoch 58/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.9775e-04 - val_loss: 0.0
Epoch 59/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.9059e-04 - val_loss: 0.0
Epoch 60/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.9341e-04 - val_loss: 0.0
Epoch 61/100
36000/36000 [==============================] - 5s 145us/step - loss: 8.9256e-04 - val_loss: 0.0
Epoch 62/100
```

```
36000/36000 [==============================] - 5s 145us/step - loss: 8.9229e-04 - val_loss: 0.0
Epoch 63/100
36000/36000 [==============================] - 5s 145us/step - loss: 8.9054e-04 - val_loss: 0.0
Epoch 64/100
36000/36000 [==============================] - 5s 144us/step - loss: 8.9039e-04 - val_loss: 0.0
Epoch 65/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.9142e-04 - val_loss: 0.0
Epoch 66/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.8857e-04 - val_loss: 0.0
Epoch 67/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.8751e-04 - val_loss: 0.0
Epoch 68/100
36000/36000 [==============================] - 5s 148us/step - loss: 8.8919e-04 - val_loss: 0.0
Epoch 69/100
36000/36000 [==============================] - 5s 145us/step - loss: 8.8491e-04 - val_loss: 0.0
Epoch 70/100
36000/36000 [==============================] - 5s 145us/step - loss: 8.8766e-04 - val_loss: 0.0
Epoch 71/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.8508e-04 - val_loss: 0.0
Epoch 72/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.8431e-04 - val_loss: 0.0
Epoch 73/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.8562e-04 - val_loss: 0.0
Epoch 74/100
36000/36000 [==============================] - 5s 144us/step - loss: 8.8334e-04 - val_loss: 0.0
Epoch 75/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.8423e-04 - val_loss: 0.0
Epoch 76/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.8210e-04 - val_loss: 0.0
Epoch 77/100
36000/36000 [==============================] - 5s 146us/step - loss: 8.8194e-04 - val_loss: 0.0
Epoch 78/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.8202e-04 - val_loss: 0.0
Epoch 79/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.8233e-04 - val_loss: 0.0
Epoch 80/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.8153e-04 - val_loss: 0.0
Epoch 81/100
36000/36000 [==============================] - 5s 148us/step - loss: 8.8090e-04 - val_loss: 0.0
Epoch 82/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.8066e-04 - val_loss: 0.0
Epoch 83/100
36000/36000 [==============================] - 5s 149us/step - loss: 8.7947e-04 - val_loss: 0.0
Epoch 84/100
36000/36000 [==============================] - 5s 148us/step - loss: 8.7934e-04 - val_loss: 0.0
Epoch 85/100
36000/36000 [==============================] - 5s 148us/step - loss: 8.7945e-04 - val_loss: 0.0
Epoch 86/100
```

```
36000/36000 [==============================] - 5s 147us/step - loss: 8.7844e-04 - val_loss: 0.0
Epoch 87/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.7767e-04 - val_loss: 0.0
Epoch 88/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.7867e-04 - val_loss: 0.0
Epoch 89/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.7760e-04 - val_loss: 0.0
Epoch 90/100
36000/36000 [==============================] - 5s 148us/step - loss: 8.7695e-04 - val_loss: 0.0
Epoch 91/100
36000/36000 [==============================] - 5s 148us/step - loss: 8.7654e-04 - val_loss: 0.0
Epoch 92/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.7469e-04 - val_loss: 0.0
Epoch 93/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.7666e-04 - val_loss: 0.0
Epoch 94/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.7356e-04 - val_loss: 0.0
Epoch 95/100
36000/36000 [==============================] - 5s 151us/step - loss: 8.7401e-04 - val_loss: 0.0
Epoch 96/100
36000/36000 [==============================] - 5s 147us/step - loss: 8.7255e-04 - val_loss: 0.0
Epoch 97/100
36000/36000 [==============================] - 5s 151us/step - loss: 8.7385e-04 - val_loss: 0.0
Epoch 98/100
36000/36000 [==============================] - 5s 151us/step - loss: 8.7134e-04 - val_loss: 0.0
Epoch 99/100
36000/36000 [==============================] - 5s 149us/step - loss: 8.7193e-04 - val_loss: 0.0
Epoch 100/100
36000/36000 [==============================] - 5s 148us/step - loss: 8.7150e-04 - val_loss: 0.0
```

In [269]: *#show_error(YCrCb_train,valid=True)*




```
In [207]: #show_psnr(YCrCb_train,valid=True)

Training mse: 0.0008714968221676018   psnr : 30.597341921656817
Validation mse: 0.0014337077744615574 psnr : 28.43539359736457
```

Training only Y color channel

```
In [166]: #Y_model = train_model(n1=64,n2=32,n3=1,k1=9,k2=1,k3=5, Patch_size=Patch_size,learn_

In [133]: #print(Y_model.summary())

_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_42 (Conv2D)           (None, 33, 33, 64)        5248
_________________________________________________________________
conv2d_43 (Conv2D)           (None, 33, 33, 32)        2080
_________________________________________________________________
conv2d_44 (Conv2D)           (None, 33, 33, 1)         801
=================================================================
Total params: 8,129
Trainable params: 8,129
```

```
Non-trainable params: 0
_________________________________________________________________
None


In [167]: #Y_train , Y_train_time = training(Y_feature,Y_label,Y_model,batch=128,epoch=100)

Train on 36000 samples, validate on 9000 samples
Epoch 1/100
36000/36000 [==============================] - 4s 124us/step - loss: 0.0113 - val_loss: 0.0048
Epoch 2/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0028 - val_loss: 0.0043
Epoch 3/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0026 - val_loss: 0.0041
Epoch 4/100
36000/36000 [==============================] - 4s 106us/step - loss: 0.0025 - val_loss: 0.0040
Epoch 5/100
36000/36000 [==============================] - 4s 104us/step - loss: 0.0024 - val_loss: 0.0039
Epoch 6/100
36000/36000 [==============================] - 4s 104us/step - loss: 0.0024 - val_loss: 0.0038
Epoch 7/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0023 - val_loss: 0.0038
Epoch 8/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0023 - val_loss: 0.0038
Epoch 9/100
36000/36000 [==============================] - 4s 104us/step - loss: 0.0023 - val_loss: 0.0038
Epoch 10/100
36000/36000 [==============================] - 4s 105us/step - loss: 0.0023 - val_loss: 0.0038
Epoch 11/100
36000/36000 [==============================] - 4s 105us/step - loss: 0.0023 - val_loss: 0.0038
Epoch 12/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0023 - val_loss: 0.0037
Epoch 13/100
36000/36000 [==============================] - 4s 104us/step - loss: 0.0023 - val_loss: 0.0037
Epoch 14/100
36000/36000 [==============================] - 4s 104us/step - loss: 0.0023 - val_loss: 0.0037
Epoch 15/100
36000/36000 [==============================] - 4s 104us/step - loss: 0.0023 - val_loss: 0.0037
Epoch 16/100
36000/36000 [==============================] - 4s 104us/step - loss: 0.0023 - val_loss: 0.0037
Epoch 17/100
36000/36000 [==============================] - 4s 105us/step - loss: 0.0023 - val_loss: 0.0037
Epoch 18/100
36000/36000 [==============================] - 4s 106us/step - loss: 0.0022 - val_loss: 0.0037
Epoch 19/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0037
Epoch 20/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0037
```

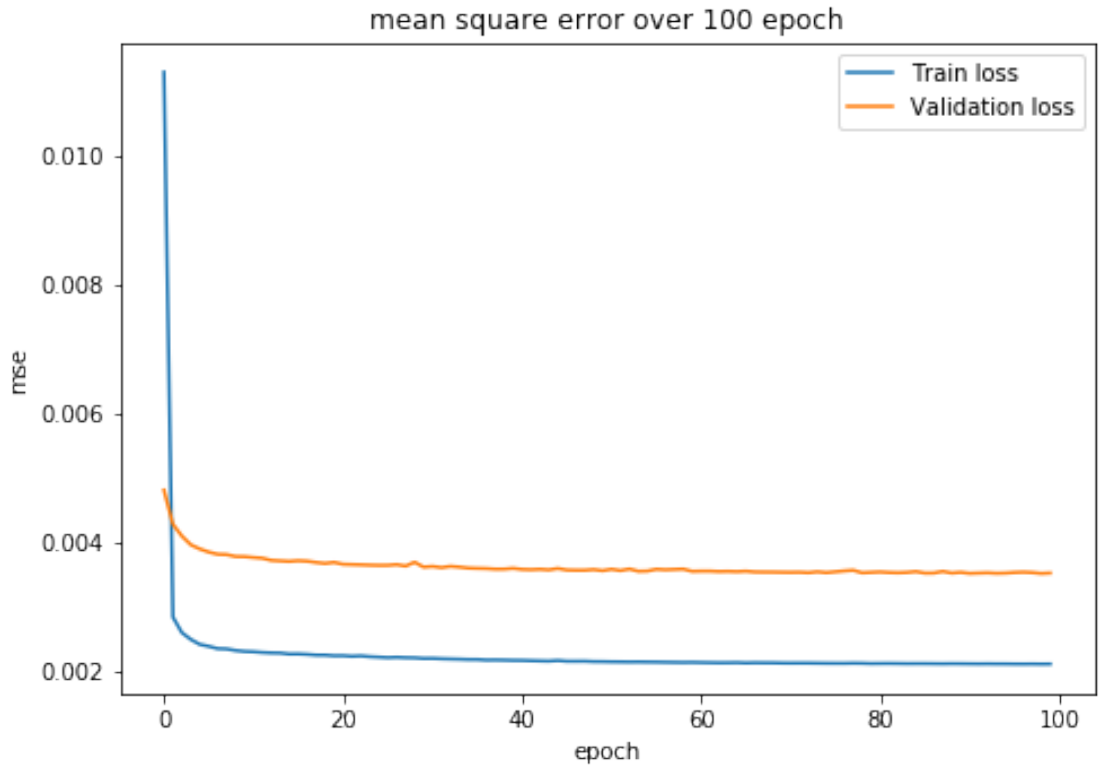
```
Epoch 21/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0037
Epoch 22/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 23/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 24/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 25/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 26/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 27/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 28/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 29/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0037
Epoch 30/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 31/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 32/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 33/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 34/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 35/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 36/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 37/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 38/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 39/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 40/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 41/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 42/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 43/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 44/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0021 - val_loss: 0.0036
```

```
Epoch 45/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0022 - val_loss: 0.0036
Epoch 46/100
36000/36000 [==============================] - 4s 104us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 47/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 48/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 49/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 50/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 51/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 52/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 53/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 54/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 55/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 56/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 57/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 58/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 59/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 60/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 61/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 62/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 63/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 64/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 65/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 66/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 67/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 68/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
```

```
Epoch 69/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 70/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 71/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 72/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 73/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 74/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 75/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 76/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 77/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 78/100
36000/36000 [==============================] - 4s 101us/step - loss: 0.0021 - val_loss: 0.0036
Epoch 79/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 80/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 81/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 82/100
36000/36000 [==============================] - 4s 101us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 83/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 84/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 85/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 86/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 87/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 88/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 89/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 90/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 91/100
36000/36000 [==============================] - 4s 103us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 92/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
```

```
Epoch 93/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 94/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 95/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 96/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 97/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 98/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 99/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
Epoch 100/100
36000/36000 [==============================] - 4s 102us/step - loss: 0.0021 - val_loss: 0.0035
```

In [270]: *#show_error(Y_train,valid=True)*



In [204]: *#show_psnr(Y_train,valid=True)*

```
Training mse: 0.0021034414246678354   psnr : 26.770695774419625
Validation mse: 0.003515105029154155 psnr : 24.540616940010196
```

0.0.4 Train images on YCrCb color channel with entire training set

```
In [170]: YCrCb_model_entire = train_model(n1=64,n2=32,n3=3,k1=9,k2=1,k3=5, Patch_size=Patch_s

In [172]: train_start_time = time.time()
          YCrCb_train_entire = YCrCb_model_entire.fit(YCrCb_feature,YCrCb_label,batch_size=128
          train_entire_time =  time.time() - train_start_time
```

```
Epoch 1/100
45000/45000 [==============================] - 6s 141us/step - loss: 0.0092
Epoch 2/100
45000/45000 [==============================] - 6s 130us/step - loss: 0.0016
Epoch 3/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0013
Epoch 4/100
45000/45000 [==============================] - 6s 131us/step - loss: 0.0012
Epoch 5/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0012
Epoch 6/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0011
Epoch 7/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0011 0s
Epoch 8/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0011
Epoch 9/100
45000/45000 [==============================] - 6s 133us/step - loss: 0.0011
Epoch 10/100
45000/45000 [==============================] - 6s 130us/step - loss: 0.0011
Epoch 11/100
45000/45000 [==============================] - 6s 130us/step - loss: 0.0011
Epoch 12/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0011
Epoch 13/100
45000/45000 [==============================] - 6s 128us/step - loss: 0.0011
Epoch 14/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0011
Epoch 15/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0011
Epoch 16/100
45000/45000 [==============================] - 6s 130us/step - loss: 0.0011
Epoch 17/100
45000/45000 [==============================] - 6s 131us/step - loss: 0.0011
Epoch 18/100
45000/45000 [==============================] - 6s 132us/step - loss: 0.0010
```

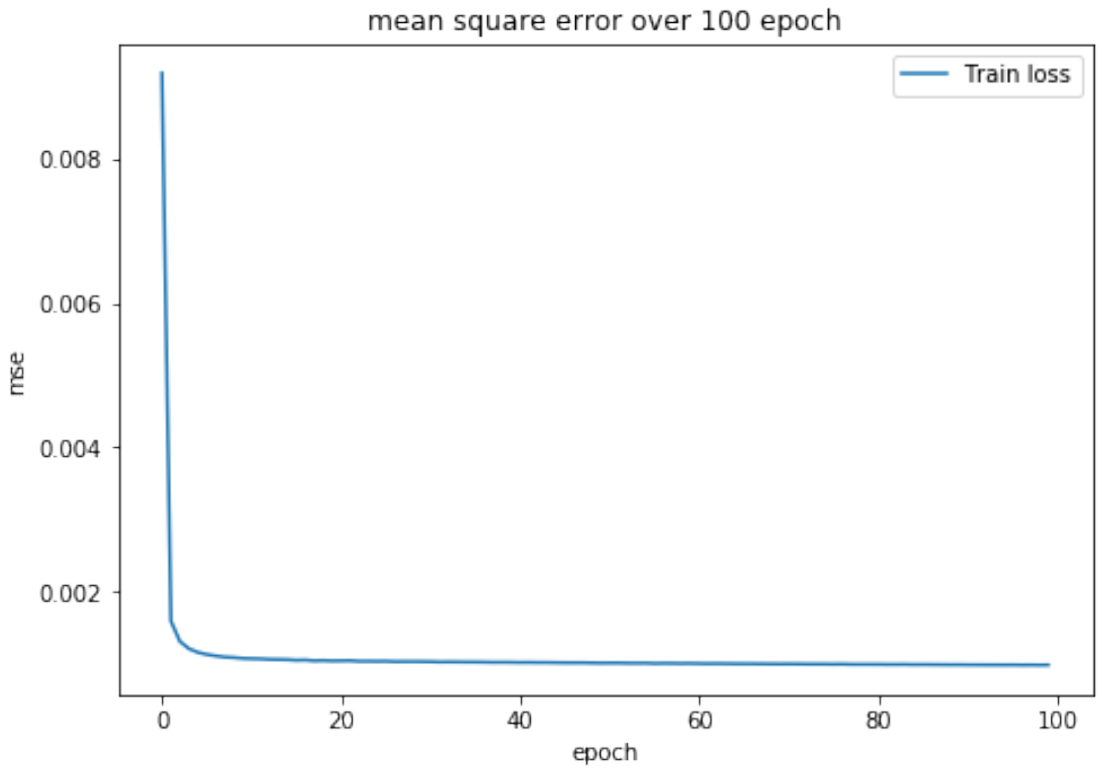
```
Epoch 19/100
45000/45000 [==============================] - 6s 133us/step - loss: 0.0010
Epoch 20/100
45000/45000 [==============================] - 6s 131us/step - loss: 0.0010
Epoch 21/100
45000/45000 [==============================] - 6s 128us/step - loss: 0.0010
Epoch 22/100
45000/45000 [==============================] - 6s 130us/step - loss: 0.0010
Epoch 23/100
45000/45000 [==============================] - 6s 131us/step - loss: 0.0010
Epoch 24/100
45000/45000 [==============================] - 6s 128us/step - loss: 0.0010
Epoch 25/100
45000/45000 [==============================] - 6s 130us/step - loss: 0.0010
Epoch 26/100
45000/45000 [==============================] - 6s 128us/step - loss: 0.0010
Epoch 27/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 28/100
45000/45000 [==============================] - 6s 126us/step - loss: 0.0010
Epoch 29/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 30/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 31/100
45000/45000 [==============================] - 6s 126us/step - loss: 0.0010
Epoch 32/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 33/100
45000/45000 [==============================] - 6s 126us/step - loss: 0.0010
Epoch 34/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 35/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 36/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 37/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 38/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 39/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 40/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 41/100
45000/45000 [==============================] - 6s 126us/step - loss: 0.0010
Epoch 42/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
```

```
Epoch 43/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 44/100
45000/45000 [==============================] - 6s 126us/step - loss: 0.0010
Epoch 45/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 46/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 47/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 48/100
45000/45000 [==============================] - 6s 126us/step - loss: 0.0010
Epoch 49/100
45000/45000 [==============================] - 6s 127us/step - loss: 0.0010
Epoch 50/100
45000/45000 [==============================] - 6s 131us/step - loss: 0.0010
Epoch 51/100
45000/45000 [==============================] - 6s 128us/step - loss: 0.0010
Epoch 52/100
45000/45000 [==============================] - 6s 130us/step - loss: 0.0010
Epoch 53/100
45000/45000 [==============================] - 6s 131us/step - loss: 0.0010
Epoch 54/100
45000/45000 [==============================] - 6s 131us/step - loss: 0.0010
Epoch 55/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0010
Epoch 56/100
45000/45000 [==============================] - 6s 130us/step - loss: 0.0010
Epoch 57/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0010
Epoch 58/100
45000/45000 [==============================] - 6s 128us/step - loss: 0.0010
Epoch 59/100
45000/45000 [==============================] - 6s 128us/step - loss: 0.0010
Epoch 60/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0010
Epoch 61/100
45000/45000 [==============================] - 6s 130us/step - loss: 0.0010
Epoch 62/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0010
Epoch 63/100
45000/45000 [==============================] - 6s 130us/step - loss: 0.0010
Epoch 64/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0010
Epoch 65/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0010
Epoch 66/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0010
```

```
Epoch 67/100
45000/45000 [==============================] - 6s 128us/step - loss: 0.0010
Epoch 68/100
45000/45000 [==============================] - 6s 129us/step - loss: 0.0010
Epoch 69/100
45000/45000 [==============================] - 6s 132us/step - loss: 9.9962e-04
Epoch 70/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.9837e-04
Epoch 71/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.9969e-04
Epoch 72/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.9864e-04
Epoch 73/100
45000/45000 [==============================] - 6s 127us/step - loss: 9.9727e-04
Epoch 74/100
45000/45000 [==============================] - 6s 133us/step - loss: 9.9711e-04
Epoch 75/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.9674e-04
Epoch 76/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.9536e-04
Epoch 77/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.9663e-04
Epoch 78/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.9393e-04
Epoch 79/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.9349e-04
Epoch 80/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.9353e-04
Epoch 81/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.9358e-04
Epoch 82/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.9216e-04
Epoch 83/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.9177e-04
Epoch 84/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.9282e-04
Epoch 85/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.9010e-04
Epoch 86/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.9113e-04
Epoch 87/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.9017e-04
Epoch 88/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.8934e-04
Epoch 89/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.8841e-04
Epoch 90/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.8845e-04
```

```
Epoch 91/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.8727e-04
Epoch 92/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.8687e-04
Epoch 93/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.8626e-04
Epoch 94/100
45000/45000 [==============================] - 6s 130us/step - loss: 9.8632e-04 0s - loss: 9.85
Epoch 95/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.8561e-04
Epoch 96/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.8639e-04
Epoch 97/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.8459e-04
Epoch 98/100
45000/45000 [==============================] - 6s 128us/step - loss: 9.8556e-04
Epoch 99/100
45000/45000 [==============================] - 6s 129us/step - loss: 9.8391e-04
Epoch 100/100
45000/45000 [==============================] - 6s 130us/step - loss: 9.8564e-04
```

```
In [271]: show_error(YCrCb_train_entire,valid=False)
```



```
In [203]: show_psnr(YCrCb_train_entire,valid=False)
```

```
Training mse: 0.000985644418704841   psnr : 30.06279732976197
```

```
In [218]: #Save weights
          #save_weight(RGB_model,"../lib/RGB_weight.h5")
          #save_weight(YCrCb_model,"../lib/YCrCb_weight.h5")
          #save_weight(Y_model,"../lib/Y_weight.h5")
          save_weight(YCrCb_model_entire,weight_path)
```

0.0.5 Predict Images

```
In [9]: #Load model and weights
        SRCNN_pred= predict_model(n1=64,n2=32,n3=3,k1=9,k2=1,k3=5,learn_rate=learn_rate,channe
        SRCNN_pred.load_weights(weight_path)
```

```
In [10]: predict_time = predicting(SRCNN_pred,n_test_files,test_lr_dir,test_hr_dir,test_lr_nam
```

0.0.6 Summarize Running Time

```
In [11]: print('Feature and label construction time : {} sec'.format(YCrCb_feature_time))
```

```
Feature and label construction time : 25.709649562835693 sec
```

```
In [244]: #Training time recorded by using gpu-gtx1070
          print('Training time : {} sec'.format(YCrCb_train_time))
```

```
Training time : 528.7112383842468 sec
```

```
In [ ]: print('writing SR images time : {} sec'.format(predict_time))
```

```
In [13]: PSNR = []
         for i in range(n_test_files):
             SR = cv2.imread(os.path.join(test_super_dir,test_lr_name[i]))
             HR = cv2.imread(os.path.join(test_hr_dir,test_lr_name[i]))
             PSNR.append(get_psnr(HR,SR))
```

```
In [ ]: print('Testing data average psnr: {} '.format(numpy.mean(PSNR)))
```

0.0.7 References

https://github.com/MarkPrecursor/SRCNN-keras

https://github.com/tegg89/SRCNN-Tensorflow

Dong, C., Loy, C. C., He, K., & Tang, X. (2016). Image super-resolution using deep convolutional networks. IEEE transactions on pattern analysis and machine intelligence, 38(2), 295-307.https://arxiv.org/pdf/1501.00092.pdf