Final Project Write Up

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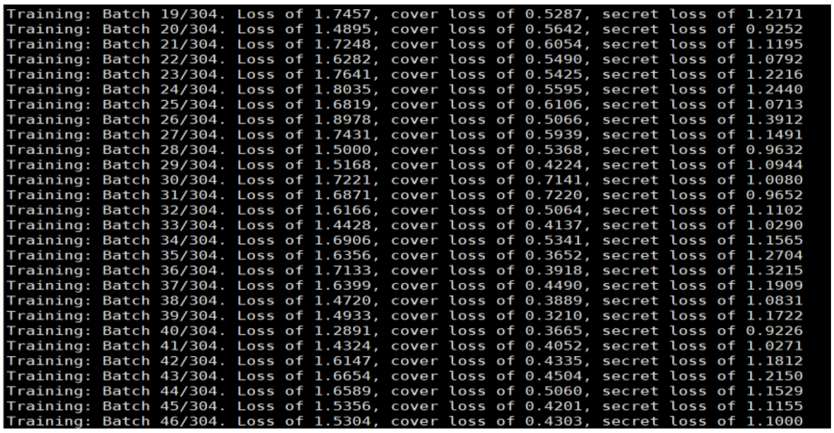
1.1 Performance

1.1.1. LSB

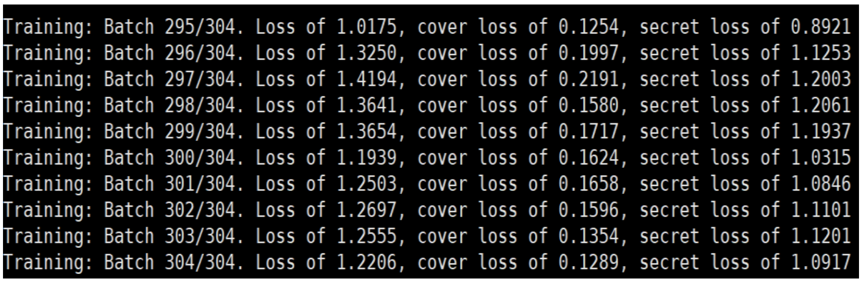
Test only on test sets.

1.1.2. NN

Training process



```
Training: Batch 19/304. Loss of 1.7457, cover loss of 0.5287, secret loss of 1.2171
Training: Batch 20/304. Loss of 1.4895, cover loss of 0.5642, secret loss of 0.9252
Training: Batch 21/304. Loss of 1.7248, cover loss of 0.6054, secret loss of 1.1195
Training: Batch 22/304. Loss of 1.6282, cover loss of 0.5490, secret loss of 1.0792
Training: Batch 23/304. Loss of 1.7641, cover loss of 0.5425, secret loss of 1.2216
Training: Batch 24/304. Loss of 1.8035, cover loss of 0.5595, secret loss of 1.2440
Training: Batch 25/304. Loss of 1.6819, cover loss of 0.6106, secret loss of 1.0713
Training: Batch 26/304. Loss of 1.8978, cover loss of 0.5066, secret loss of 1.3912
Training: Batch 27/304. Loss of 1.7431, cover loss of 0.5939, secret loss of 1.1491
Training: Batch 28/304. Loss of 1.5000, cover loss of 0.5368, secret loss of 0.9632
Training: Batch 29/304. Loss of 1.5168, cover loss of 0.4224, secret loss of 1.0944
Training: Batch 30/304. Loss of 1.7221, cover loss of 0.7141, secret loss of 1.0080
Training: Batch 31/304. Loss of 1.6871, cover loss of 0.7220, secret loss of 0.9652
Training: Batch 32/304. Loss of 1.6166, cover loss of 0.5064, secret loss of 1.1102
Training: Batch 33/304. Loss of 1.4428, cover loss of 0.4137, secret loss of 1.0290
Training: Batch 34/304. Loss of 1.6906, cover loss of 0.5341, secret loss of 1.1565
Training: Batch 35/304. Loss of 1.6356, cover loss of 0.3652, secret loss of 1.2704
Training: Batch 36/304. Loss of 1.7133, cover loss of 0.3918, secret loss of 1.3215
Training: Batch 37/304. Loss of 1.6399, cover loss of 0.4490, secret loss of 1.1909
Training: Batch 38/304. Loss of 1.4720, cover loss of 0.3889, secret loss of 1.0831
Training: Batch 39/304. Loss of 1.4933, cover loss of 0.3210, secret loss of 1.1722
Training: Batch 40/304. Loss of 1.2891, cover loss of 0.3665, secret loss of 0.9226
Training: Batch 41/304. Loss of 1.4324, cover loss of 0.4052, secret loss of 1.0271
Training: Batch 42/304. Loss of 1.6147, cover loss of 0.4335, secret loss of 1.1812
Training: Batch 43/304. Loss of 1.6654, cover loss of 0.4504, secret loss of 1.2150
Training: Batch 44/304. Loss of 1.6589, cover loss of 0.5060, secret loss of 1.1529
Training: Batch 45/304. Loss of 1.5356, cover loss of 0.4201, secret loss of 1.1155
Training: Batch 46/304. Loss of 1.5304, cover loss of 0.4303, secret loss of 1.1000
```



```
Training: Batch 295/304. Loss of 1.0175, cover loss of 0.1254, secret loss of 0.8921
Training: Batch 296/304. Loss of 1.3250, cover loss of 0.1997, secret loss of 1.1253
Training: Batch 297/304. Loss of 1.4194, cover loss of 0.2191, secret loss of 1.2003
Training: Batch 298/304. Loss of 1.3641, cover loss of 0.1580, secret loss of 1.2061
Training: Batch 299/304. Loss of 1.3654, cover loss of 0.1717, secret loss of 1.1937
Training: Batch 300/304. Loss of 1.1939, cover loss of 0.1624, secret loss of 1.0315
Training: Batch 301/304. Loss of 1.2503, cover loss of 0.1658, secret loss of 1.0846
Training: Batch 302/304. Loss of 1.2697, cover loss of 0.1596, secret loss of 1.1101
Training: Batch 303/304. Loss of 1.2555, cover loss of 0.1354, secret loss of 1.1201
Training: Batch 304/304. Loss of 1.2206, cover loss of 0.1289, secret loss of 1.0917
```

1.2. Work

1.2.1. LSB principle

First, the decimal pixel value with secret information is converted to binary data.

Then, the least significant bit of the corresponding carrier data is replaced by each bit of the binary secret information.

Finally, the obtained binary data containing secret information is converted to decimal pixel value, thus obtaining the image containing secret information.

1.2.2. NN principle

Steganography has two important components: encryption and decryption.

Suppose you have a raw image and a secret image.

Encryption: As the sender, your task is to merge the original and secret images into one image. The purpose is twofold. First, your result must be an image, and if that image is far from the original, it will attract the attention of others. That would be considered a failure. Second, your resulting image must also convey information about the secret image. It's not that simple, because any mix of information changes each other. The question is how much we can afford.

Decryption: After the encrypted section, your resulting image will contain two pieces of information from the original and the secret image. You can use a neural network to encrypt and decrypt with Encoder and decoder.

1.2.3. I implemented two tasks: encrypting and decrypting the image with LSB and neural network, and verifying the effect on the Kodak dataset.

When I implemented the LSB algorithm, I embedded the information in the lowest pixel of the image point to ensure that the embedded information is not visible.

When I implemented the neural network, I divided the whole network into three subnets, includes PrepNetwork, HidingNetwork and RevealNetwork. The PrepNetwork encodes the secret pictures and then the output is connected to cover pictures. The connected pictures is entered into the HidingNetwork. The output of HidingNetwork is entered into RevealNetwork, and decoded reconstructed pictures. Finally, we compute the rmse loss between reconstructed pictures and secret pictures. It's worth mentioning that I put gaussian in HidingNetwork to enhance network generalization capability.

1.3. Issue

1.3.1. The input image and the output image have different sizes.

1.3.2. The network cannot be converged.

1.4. How to solve issues

1.4.1. Adjust the parameter values of the convolution layer so that the size of the input image and the output image are the same.

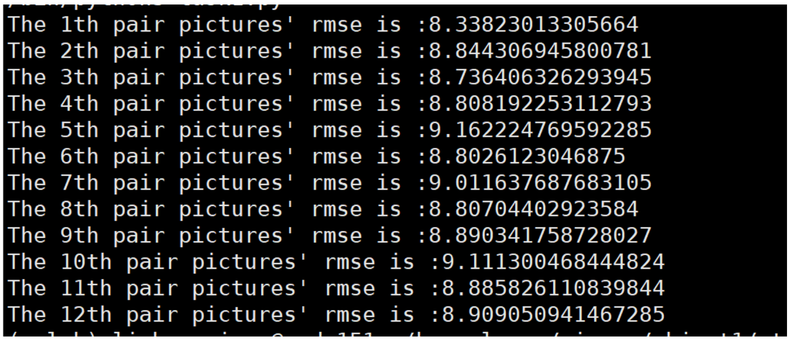
1.4.2. Adjust the learning rate, batch size and other parameters to make the network convergence.

2. Results on kodak

Kodak dataset includes 24 pictures. I paired them in pairs, one as the cover image and one as the secret image, into 12 groups

2.1. LSB results

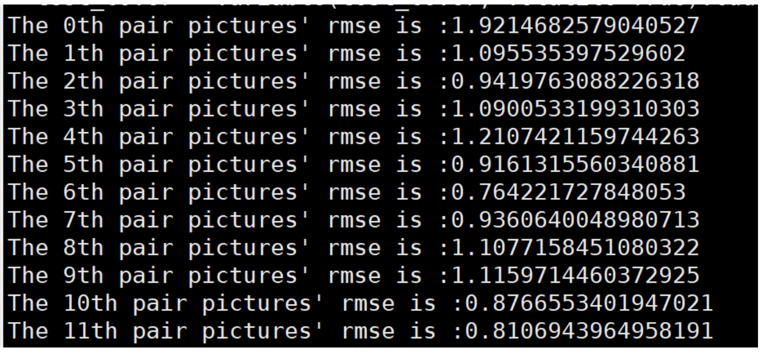
Test results for test set images



```
The 1th pair pictures' rmse is :8.33823013305664
The 2th pair pictures' rmse is :8.844306945800781
The 3th pair pictures' rmse is :8.736406326293945
The 4th pair pictures' rmse is :8.808192253112793
The 5th pair pictures' rmse is :9.162224769592285
The 6th pair pictures' rmse is :8.8026123046875
The 7th pair pictures' rmse is :9.011637687683105
The 8th pair pictures' rmse is :8.80704402923584
The 9th pair pictures' rmse is :8.890341758728027
The 10th pair pictures' rmse is :9.111300468444824
The 11th pair pictures' rmse is :8.885826110839844
The 12th pair pictures' rmse is :8.909050941467285
```

2.2. NN results

Test results for test set images



```
The 0th pair pictures' rmse is :1.9214682579040527
The 1th pair pictures' rmse is :1.095535397529602
The 2th pair pictures' rmse is :0.9419763088226318
The 3th pair pictures' rmse is :1.0900533199310303
The 4th pair pictures' rmse is :1.2107421159744263
The 5th pair pictures' rmse is :0.9161315560340881
The 6th pair pictures' rmse is :0.764221727848053
The 7th pair pictures' rmse is :0.9360640048980713
The 8th pair pictures' rmse is :1.1077158451080322
The 9th pair pictures' rmse is :1.1159714460372925
The 10th pair pictures' rmse is :0.8766553401947021
The 11th pair pictures' rmse is :0.8106943964958191
```