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E9 246: Advance Image Processing

February-May 2021

Assignment 4 Report

Problem 1: JPEG Implementation

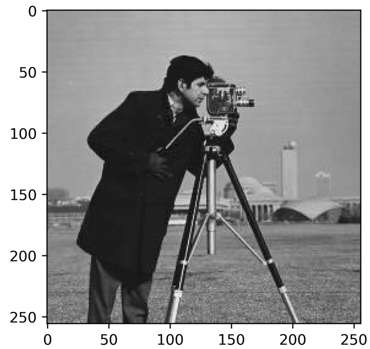
1.

$$\text{Length of output bitstream} = 115208$$
$$\text{Size in Kb} = 14.06\text{kb}$$
$$\text{Compression Ration} = 4.53$$
$$\text{MSE} = 31.56$$

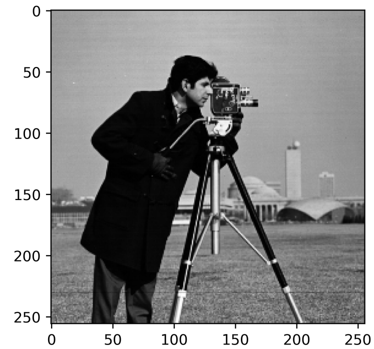
P.S: I didn't find inbuilt function to compute size of binary bit-stream , all the functions that i found was giving size of binary string and I wanted size for binary bits.

2.

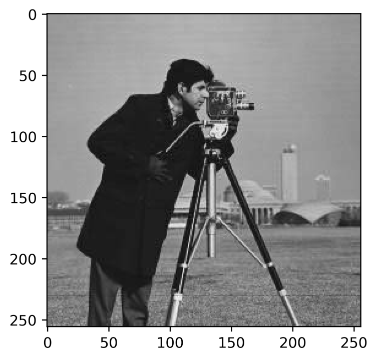
$$\text{Length of output bitstream} = 385742$$
$$\text{Size in Kb} = 47.08\text{kb}$$
$$\text{Compression Ration} = 1.35$$
$$\text{MSE} = 0.082$$



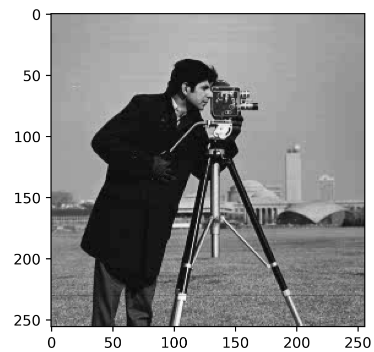
(a) Reconstructed image from (1)



(b) Reconstructed image from (2)



(a) Reconstructed image from (1)



(b) Reconstructed image from (3)

3

Obtained values are given below.

$$\text{Length of output bitstream} = 114952$$
$$\text{Size in kb} = 14.03\text{kb}$$
$$(a, b, c) = (20, 20, 30)$$
$$\text{MSE} = 16.96$$

Comparison.

- Reconstructed image obtained from (3) is more compressed in the sense that it's output bit-stream length is less than obtained from (1).
- MSE (16.96) is less compared to 31.56 from (1).
- Compression artefacts are more seen in Reconstructed image from (3) compared than (1).

4

Expression for optimal code word length is:

$$l_i = log_2(1/P_i)$$

If we can assign probabilities in decreasing order (Omitting 0) , we can achieve optimal code length. Probability distribution is given below.

Quantized DCT index	Code	Pi
0	0	–
-1,1	10x	1/2
-3,-2,2,3	110xx	1/4
-7,-6,-5,-4,4,5,6,7	1110xxx	1/8
...	...	...

Probability Distribution Can be written as,

$$P = (1/2)^k, k = 1, 2, ...$$

Problem 2: Bit allocation

In this question we were asked to compute (R_1,R_2).
We can write,

$$\mathbb{E}\left[X_1 - \hat{X}_1\right]^2 = \sigma_1 2^{-2R_1} = 5 * 2^{-2R_1}$$

$$\mathbb{E}\left[X_2 - \hat{X}_2\right]^2 = \sigma_1 2^{-2R_2} = 10 * 2^{-2R_2}$$

We can form optimization problem as,

$$\text{Minimise: } 5 * 2^{-2R_1} + 10 * 2^{-2R_2}$$
$$\text{Subject to: } R_1 + R_2 = 3$$

Now we can solve optimization problem.

$$\text{Minimise: } 5 * 2^{-2R_1} + 10 * 2^{-2(3-R_1)}$$

$$\frac{d}{dR_1}(5 * 2^{-2R_1} + 10 * 2^{-2(3-R_1)}) = 0$$

By solving further we get,

$$(R_1, R_2)\text{=(1.25,1.75)}$$

Using R_1, R_2 we get K_1=2.37, K_1=3.36

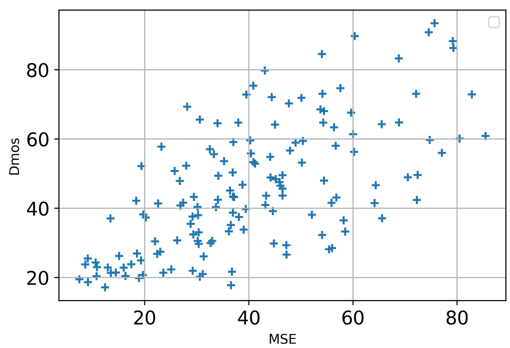
How to allocate bits.

Since K_1, K_2 are not integers we can round-off them.After rounding of K_1=2,K_1=3. With the help of quantization points , we divide the interval (x_{min}, x_{max}) (for both distribution separately) and allocate DCT coefficient to nearest neighbour.

Problem 3 : Comparison of perceptual quality.

MSE vs Dmos.

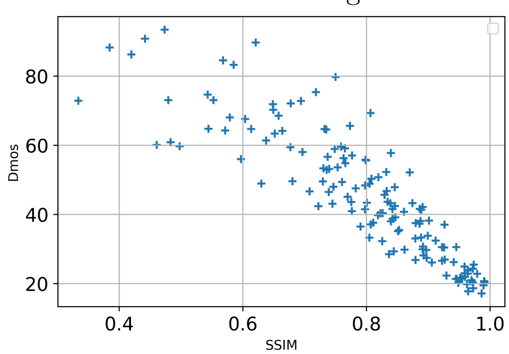
Perceptual quality measures should reflect human opinion.In the case of MSE , variation of dmos is ambiguous. From figure presented , we can infer that for fixed dmos , let's say 40, MSE varies in range [15,80], Which shows for the same perceptual quality MSE can vary too much. So MSE is not quite good measure for quality. Also we can see the positive correlation between MSE and Dmos.



SPRCC=0.653

SSIM vs Dmos.

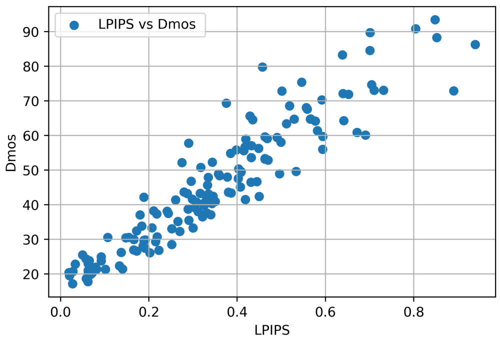
SSIM is very good measure quality compared to MSE. For low value of Dmos (Good quality image) SSIM tends to 1. SSIM vs dmos show nearly linear relationship (-ve Correlated) between them.Since SSIM takes account of neighbourhood it's certainly be better than MSE.



SPRCC=-0.91

LPIPS vs Dmos

LPIPS seem to be very good measure compared to MSE and SSIM because there is very low correlation between LPIPS and Dmos , also relation-ship between them is close to linear.



SPRCC=0.94