Homework 3 (Due: 5/1st)

(1) Write a Matlab or Python code for the 4:2:0 image compression technique.

B = C420(A), where A is the input color image and B is the reconstructed image. Just use the interpolation method for reconstruction. The code should be handed out by NTUCool. (Note: The command rgb2ycbcr cannot be used.)   (25 scores)

(2) Why the Mel-frequency cepstrum is more suitable for dealing with the acoustic signal than the original cepstrum?   (10 scores)

(3) Suppose that the cepstrum of $x[n]$ is

$$\hat{x}[2] = 1 \qquad \hat{x}[n] = 0 \quad \text{otherwise}$$

Please determine $x[n]$.   (10 scores)

(4) Suppose that, for a stringed instrument, the frequency of Do is 250Hz. (a) Determine the string length corresponding to Do if the speed of sound at 15°C is considered. (b) What is the string length corresponding to La?   (10 scores)

(5) (a) Why a music signal is easier to compress than other vocal signals? (Write at least 3 reasons) (b) Why a cartoon / mark image is easier to compress than other images? (Write at least 2 reasons) (10 scores)

(6) Suppose that there are three vocal signals (i) $-\cos(1200\pi t)$; (ii) $\sin(5400\pi t)$; (iii) $\cos(20000\pi t)$. (a) Which one sounds the loudest? (b) Which one is the most suitable to sound? (10 scores)

(7) (a) Why we always use the DCT instead of the DFT and the KLT to image compression? (Write two reasons).   (b) Why we apply the 8x8 DCT instead of performing the DCT on the whole image in the JPEG process? (Write three reasons). (10 scores)

(8) Suppose that $P(x =$ 'a'$) = 0.45$, $P(x =$ 'b'$) = 0.3$, $P(x =$ 'c'$) = 0.16$, $P(x =$ 'd'$) = 0.06$, $P(x =$ 'e'$) = 0.03$.

(a) What is the entropy of x?

(b) Determine the coding tree of x when using the Huffman code in the binary (二進位) system.

(c) What is the average coding length for each input when using the Huffman code to encode x? (15 scores)

(Extra): Answer the questions according to your student ID number.

(ended with (3, 8), (4, 9), (0, 5), (1, 6))