Lab 4 - Image Processing EEE330

Image compression

Report is due in **14 days** from the date of running this lab

Introduction:

This assignment focuses on the image compression, including two parts. One is an in-class quiz, which will be arranged on one class with 30 marks. The other one is a lab session for three related tasks. In these tasks, the students will design algorithms to compress and decompress images. The assessment includes the programming code and the report. The programming code should be run successfully, and the results should be correct. Moreover, the code quality will also be considered, such as efficiency, comments, robustness. The report should answer all questions in the tasks, and explain them clearly. It is recommended to add some conclusions about the whole lab.

Objectives:

To test the students on learning outcomes A, B, C, and D.

Download:

Download the file *Lab4-material.zip* from the ICE, and unzip the file into a folder *Lab4*. Now load into your Matlab workspace the following Matlab functions: `fsize, entropy_enc, entropy_dec` and `Arith07`

Matlab functions:

The following are some built-in *Matlab* functions that might be used in this session:

```
DCT2, IDCT2, ZIP
```

Hint: read the help about each of the previous functions and any other function you might use. Some Matlab functions have a section describing the *Algorithm(s)* they use; it is worth reading this section.

Tasks:

1. Image compression (**30 marks**)

   Write a Matlab function which compresses an image `im`. The function should have the following declaration:

   ```
   function [rate] = compress_im(im, Qmat, QP, N, file_name);
   ```

   This function should do the following:

   a) Evaluate the two-dimensional DCT of all the N X N non-overlapping blocks of the image `im`. (**5 marks**)
   b) To convert the floating point numbers of the 2D-DCT into integer numbers, quantize each N X N block using the following formula

   $$round\left(\frac{b_{ij}}{Sq_{ij}}\right),$$

   where b_{ij} is the i^{th} row and j^{th} column of the N X N 2D-DCT transformed block, whereas, q_{ij} is the element of the quantization matrix $\mathrm{Qmat}_{\mathrm{NxN}}$ (given in equation (1)), and *S* is a scalar value given by equation (2). (**5 marks**)

$$\mathrm{Qmat}_{\mathrm{NxN}} = \begin{bmatrix} 1 & 2 & 2 & 4 & 4 & 4 & 4 & 8 & \mathrm{L} \\ 2 & 2 & 2 & 4 & 4 & 4 & 4 & 8 & \\ 2 & 2 & 2 & 4 & 4 & 4 & 4 & 8 & \\ 4 & 4 & 4 & 4 & 4 & 4 & 4 & 8 & \\ 4 & 4 & 4 & 4 & 4 & 4 & 4 & 8 & \\ 4 & 4 & 4 & 4 & 4 & 4 & 4 & 8 & \\ 4 & 4 & 4 & 4 & 4 & 4 & 4 & 8 & \\ 8 & 8 & 8 & 8 & 8 & 8 & 8 & 8 & \\ \mathrm{M} & & & & & & & & \mathrm{O} \end{bmatrix} \quad (1)$$

   Note: In equation (1), the symbols “L, M, O” are the repeated patterns, e.g., 2 times of the digit 2, 4 times of the digit 4, 8 times of the digit 8, and so on.

$$S = \frac{100 - QP}{50}, QP > 50$$
$$S = \frac{50}{QP}, QP \le 50 \quad (2)$$

c) Please encode all the integer indexes of the 2D-DCT coefficients of the image. You can use the provided arithmetic-encoder[1] for this. (**5 marks**)
d) Save the entropy encoded vector as `file_name`. (**5 marks**)
e) Using the function `fsize` to evaluate the bit rate (in terms of bit per pixel [bpp]) of the compressed image and return it as `rate`. (**5 marks**)
f) What are the main differences between this compression engine and JPEG? (**5 marks**)

2. Image decompression (**15 marks**)

Write a Matlab function which decompresses the file `file_name` and return the corresponding image `imo`. The function should have the following declaration:

```
function [imo] = decompress_im(Qmat, QP, N, file_name);
```

This function should invert all steps in task 1 to produce the decompressed image `imo`.

3. Rate-Distortion (RD) Performance evaluation (**25 marks**)

(a) Using the developed coded on image `Lenna512.bmp`, and `N=16`, fill the following table (**5** marks)

QP	**1**	**15**	**29**	**43**	**…**	**…**	**99**
Rate [bpp]							
PSNR [dB]							

(b) Plot the PSNR versus bit rate curve for the image `Lenna512.bmp`; it is worth noticing that this curve is wrongly and commonly called RD curve in many resources. (**5 marks**)
(c) Compare the Rate-PSNR performance of your codec with that of JPEG. For the latter codec you could use the Matlab command `imwrite` with proper parameters. (**5 marks**)
(d) Compare the performance of these codecs objectively and subjectively. (**5 marks**)
(e) Evaluate the Rate-PSNR curve when `N=8` and compare the performance with the one obtained with `N=16`, which one is better, and why? (**5 marks**)
(f) Propose some approaches to enhance the RD efficiency of your codec! (**5 marks**)

[1] http://en.wikipedia.org/wiki/Arithmetic_coding

Lab Report

Write a report which should contain a **concise description** of your results and observations. Include listings of the Matlab scripts that you have written. Describe each of the images that you were asked to display, if any. The format of report should be like this, which is repeated for all questions.

Question
(a) Answers
(b) Figures if you have. Please add figure title.
(c) concise code

Submit the report electronically into ICE, and a hardcopy version into the white collecting box beside the office EB310 (Hand written reports are not accepted).

Assignment set date is the 2nd May 2018, and the due date is the 16th May 2018.

Marking scheme

80%-100% Essentially complete and correct work.

60%-79% Shows understanding, but contains a small number of errors or gaps.

40%-59% Clear evidence of a serious attempt at the work, showing some understanding, but with important gaps.

20%-39% Scrappy work, bare evidence of understanding or significant work omitted.

<20% No understanding or little real attempt made.

This page last modified on 2018-05-01 9:27 PM