COMP 5422 Assignment

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| Due | Nov. 23 2018 |  |

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| **Submission**: All submissions including homework and project will be done online through the BB system. The normal cut-off time would be 11:59 p.m. on the specified date using the BB clock. Late homework assignment submission will be subjected to 33% penalty each day and after 3 days, the system will be closed. Grading and the late penalty will be based on your latest submission.  **Format**: You can write your solution in a digital document, or a scan of your handwritten work is also acceptable (should be neat and clean). Finally, combine all your solutions into a single \*.pdf file and submit it. | | | | |
| Name |  | Student ID |  |

1. (5 points) After digitization, a grey level image has 400 rows and 200 columns, and each pixel of it is stored by 10 bits.
   1. What is the spatial resolution of it?
   2. What is the grey-level resolution of it?
   3. How many bytes do we need to store this image?
2. (20 points) Suppose the alphabet is [A,B,C], and the known probability distribution is as follow.

|  |  |  |  |
| --- | --- | --- | --- |
| PDF | A | B | C |
| p | 0.5 | 0.4 | 0.1 |

* 1. How many bits are needed to encode the message BBB by Huffman coding? (Show your work step by step clearly, your answer is not strictly unique.)
  2. How many bits are needed to encode the message BBB by Arithmetic coding？(Show your work step by step clearly)

1. (15 points) Suppose that we have the following 4\*4 image:

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 3 | 2 | 1 |
| 3 | 5 | 6 | 4 |
| 4 | 4 | 7 | 8 |
| 5 | 7 | 8 | 7 |

* 1. What is the entropy of this image?
  2. Three of the predictors used in JPEG-LS are listed in the following table. (10)

X

B

C

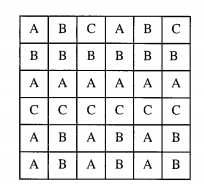
A

|  |  |
| --- | --- |
| P1 | A (horizontal predictor) |
| P2 | B (vertical predictor) |
| P3 | (A+B)/2 |

We code the image as follows, please calculate the prediction error image.

* + 1. Code the first row using P1
    2. Code the first column using P2
    3. Code the other pixels using P3

1. (30 points) For the given image (6\*6 pixels) below, it has 3 colors. Suppose color A=(255,64,0), color B=(255,64,255) and color C=(255,128,0) for the Red, Green, and Blue primaries. When storing the image, the three primaries would be saved separately as 3 different layers first and then concatenated together afterwards. (Show your work step by step clearly, your answer is not strictly unique.)



* 1. Show how you would compress the image above with the run-length encoding method and the storage size required.
  2. Show how you would compress the image above with the Huffman encoding method and the storage size required.
  3. A programmer has suggested to do direct encoding. Her idea is to have a table to store the 3 colors (A, B, C) and label them with 00, 01 and 11 (binary numbers). Show the storage size required with this encoding method.
  4. Compare the encoding methods of (a)-(c). Which one would you recommend in general (not specific to the image above)?
  5. Describe the main steps of the JPEG compression. Describe which step can adjust the compression ratio for a given image.

1. (10 points) Suppose we have a simplified version of JPEG which consists of blocks of 3\*3 pixels. The following is a sample block, calculate F(2,2) (No subtraction by 128 is required).

|  |  |  |
| --- | --- | --- |
| 234 | 231 | 200 |
| 255 | 0 | 255 |
| 128 | 128 | 131 |

1. (15 points) Suppose that the original signal is . We decompose it into 2 levels by using the Haar wavelet and the wavelet decomposition coefficients are d=[9.5,16.5,0.5,-3.5,-2,1,-2,1]. Please reconstruct the original signal .
2. (5 points) Given the display order of MPEG-1 frames: IPPPIBBPBIBP; what is the transmission order of the frames?