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BSc in Computer Science

CS4405: Multimedia Compression and Delivery

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Answer all questions.

90 minutes

1. These questions deal with *dithering algorithms* for gray level pictures (color information plays no role). The distinction between *normal* and *ordered* dithering is irrelevant for these questions.

   We consider the three matrices below as possible candidates for a 2×2 *dither matrix*:

$$M_1 = \begin{bmatrix} 2 & 1 \\ 3 & 0 \end{bmatrix}, \quad M_2 = \begin{bmatrix} 1 & 2 \\ 3 & 0 \end{bmatrix}, \quad M_3 = \begin{bmatrix} 2 & 1 \\ 3 & 2 \end{bmatrix}$$

   a) Which matrix (M_1 or M_2 or M_3) is most suitable as 2×2 dither matrix?
   Justify your answer. (*9 marks*)

   b) Consider three gray level image files I_1, I_2 and I_3. These files differ in the number of bits per pixel which are internally used for storing the gray level (luminance information) of the corresponding pixel. In I_1 2 bit are used, in I_2 3 bit and in I_3 8 bit are used.
   Which of these 3 image files can be displayed with the dither matrix you have chosen in your answer to a.)?
   Justify your answer. (*9 marks*)

2. The questions below deal with common file formats for still color images.

   a) Recall that 16bpp means *16 bit per pixel*.
   Explain the reason why most 8bpp file formats utilize a *color look-up table* while 24bpp and 32bpp file formats do not contain such tables. (*8 marks*)

   b) Recall that JPEG compression utilizes the RGB-to-YUV color space transformation. The U-component and the V-component are usually reduced to a lower spatial resolution (also known as *downsampling*) before the application of the intrinsic compression.
   Explain the reasons for this step. (*9 marks*)

   c) Classical cathode ray tubes have a gamma value of approximately 2.2. What would images on these displays look like, if *too much gamma correction* was applied so that *over-compensation* occurs?
   Justify your answer. (*9 marks*)

3. These questions deal with some general aspects of digital compression algorithms.

   a) The JPEG image file format is a de-facto standard for storage of photographic images. However, software packages for image manipulation (such as Photoshop or Gimp) never use this format for their native file storage.
   Explain the reason for this situation. (*9 marks*)

   b) Outline a simple and fast computer algorithm for displaying low resolution previews of JPEG image files. For example, the resolution of such a preview (thumbnail) is often 8 times lower than the original resolution.
   Your algorithm should exploit convenient features of the JPEG compression algorithm. In your answer, you do not have to write code or pseudo code. (*9 marks*)

4. These questions deal with the concept of *information entropy*.

   a) Consider a message string s_a with an information entropy of $H = 3.5$ bits per symbol.
   What is the smallest possible number of different symbols in s_a?
   Justify your answer. (*9 marks*)

   b) Consider another message string s_b which is composed of four different symbols A, B, C, D. Lets assume that Huffman coding *does not actually compress* the string. In other words, we assume that the application of Huffman coding to s_b will result in a data stream that occupies approximately the *same amount of memory* as s_b.
   Calculate (approximately) the information entropy of s_b. (*9 marks*)