University of Toronto Faculty of Applied Science and Engineering

MIDTERM EXAMINATION 2 ECE462H1S, Multimedia Systems

March 24, 2023, 12:10 pm -13:00 pm Instructor: D. Hatzinakos

Instructions:

- 1. The exam counts for 15% of the overall mark.
- 2. Please answer all questions. Do not show only final answers. You should demonstrate how the answer has been obtained by including intermediate results and explanations wherever needed.
- 3. Write your name and student number on top of all submitted pages.
- 4. All answers must be written in the provided examination paper

QUESTIONS

1. Assume that in an EZW based compression of a 4x4 image f(x,y), the decoder receives the following information

2-Level Haar -based wavelet transform To=16 Do=11000000 So=1 D1=10000011110000 S1=010

Also the following codes have been used

Zerotree root	zr	00
Significant positive	sp	11
Significant negative	sn	01
Isolated zero	iz	10

What is the reconstructed 2-pass wavelet transform? (3 points)

2 Continuing question 1, find the reconstructed image corresponding to the reconstructed 2pass wavelet transform (2 points)

The 4-point and 2-point Haar matrices are defined as

$$H = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 & 0 & 0\\ 0 & 0 & 1 & 1\\ 1 & -1 & 0 & 0\\ 0 & 0 & 1 & -1 \end{bmatrix}, \qquad H1 = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1\\ 1 & -1 \end{bmatrix},$$

- 3 Given an 1 level wavelet transform of a 16x16 pixels image we consider the following 3 compression scenarios:
 - a) A total average bit rate of 2 bpp (bits per pixel) is considered. In particular 32 bits are allocated in the LL sub band and 0 bits in the rest of the sub bands
 - b) A total average bit rate of 2bpp is considered. In particular 16 bits are allocated in the LL sub band, 6 bits are allocated in each of the LH and HL sub bands and 4 bits are allocated in the HH sub bund.
 - c) A total average bit rate of 1.5 bpp is considered.

Please discuss and compare these 3 cases regarding the quality of the reconstructed image (2 points)

4 A video sequence is coded by using the following GOP (group of pictures) display order :

I1, B2, B3, P4, B5, B6, P7, B8

What is the transmitted bit stream order? (2 points)

- 5 In the data hiding color image application discussed in class, provide a reason on why we may not wish to hide the chrominance information in the highest resolution sub band of the Luminace wavelet transform. (2 points)
- 6 What is asymmetrical coding in video encoding? Name one asymmetrical encoder. Is such an encoder appropriate for teleconferencing applications? (2 points)
- 7 In a 4-level 2-D Wavelet transform of size NxN what is the size (resolution) of the largest sub-band and what is the size (resolution of the smallest sub-band? What is the overall number of sub-bands? (1 point)
- 8 What the two basic type of redundancies explored by a video encoder in order to compress the video? What is approximately the compression achieved by an MPEG2 encoder? (1 point)



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$$\begin{aligned} \overline{A}^{T}_{T}A &= \frac{1}{2} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} 2^{4} & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & -1 \\ 1 & -1 \end{bmatrix} \\ &= \frac{1}{2} \begin{bmatrix} 2^{24} & 2^{4} \end{bmatrix} = \begin{bmatrix} 1^{23} & 1^{23} \\ 1^{23} & 1^{23} \end{bmatrix} \\ &= \frac{1}{2} \begin{bmatrix} 2^{24} & 2^{4} \end{bmatrix} = \begin{bmatrix} 1^{23} & 1^{23} \\ 1^{23} & 1^{23} \end{bmatrix} \\ \hline \begin{array}{c} \overline{C} & 1 \\ 1^{2} & 1^{2} & 0 \end{bmatrix} \begin{bmatrix} 1^{23} & 1^{23} & 1^{23} \\ 1^{23} & 1^{23} & 0 \end{bmatrix} \\ &= \frac{1}{2} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1^{23} & 1^{23} & 1^{23} \\ 0 & 0 & 0 \end{bmatrix} \\ &= \frac{1}{2} \begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 1^{23} & 1^{2} & 1^{2} & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \\ &= \frac{1}{2} \begin{bmatrix} 1^{33} & 1^{2} & 1^{2} & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ \end{bmatrix} \\ &= \frac{1}{2} \begin{bmatrix} 1^{33} & 1^{3} & 1^{4} & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ \end{bmatrix} \\ &= \frac{1}{2} \begin{bmatrix} 1^{3} & 1^{3} & 1^{4} & 0 \\ 1^{3} & 1^{3} & 0 & 0 \\ 1^{3} & 0 &$$

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MPGAZ questes an astropt it appointels (2.5 Mbps

