Data Provided: None

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2011-12 (2.0 hours)

EEE6081 Visual Information Engineering

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. Trial answers will be ignored if they are clearly crossed out. **The numbers given after each section of a question indicate the relative weighting of that section.**

1. **a.** Explain how an 8-bit depth resolution image can be converted to a 3-bit depth resolution image. **(3)**

b. Explain the effect of bit depth reduction on the visual quality of an image containing both high spatial frequency regions and low spatial frequency regions. **(3)**

c. Compute the data rate for transmitting an uncompressed CIF video sequence in 4:2:0 format containing 8 bits per pixel per colour component and progressive 50 frames per second frame rate. **(4)**

d. Explain why it is necessary to compress digital video and why it is possible to compress digital video. **(4)**

e. Explain the purpose of the forward transform in an image/video encoder. **(3)**

f. Explain how the forward transform in a conventional lossy image encoder can be replaced in a lossless image coder. **(3)**

2.

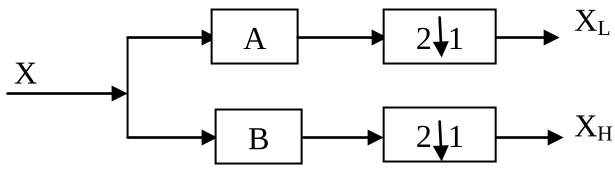

Figure 1

Figure 1 shows the analysis filter bank of the orthogonal discrete wavelet transform. A is a low pass filter with 2 coefficients and B is the corresponding high pass filter. X is the input signal consisting of 8 data elements ($x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8$). X_L and X_H are the low pass and high pass channels

a. Considering the constraints for wavelet filters, find the coefficients of filter A in Figure 1. **(4)**

b. Derive the forward transform matrix corresponding to the wavelet transform and the input data sequence X shown in Figure 1. **(4)**

c. Explain the use of the low pass channel X_L. **(4)**

d. Explain how you can use the wavelet transform in Figure 1 for removing noise in a signal. **(4)**

e. Explain how you use the wavelet transform in Figure 1 to obtain the 2-level full tree wavelet packet decomposition of an image containing 128 x 128 pixels. **(4)**

3. **a.** Explain, using diagrams, how motion is estimated for motion compensated temporal prediction in video coding. **(4)**

b. Derive an expression for estimating the complexity of the block matching algorithm for motion estimation. **(4)**

c. What is the effect of block size in estimating motion for video coding? Explain your answer with respect to the effect on compression efficiency, prediction accuracy, cost of motion vectors and error propagation. **(4)**

d. Explain how multi-resolution decomposition can be used for reducing the computational complexity of the motion estimation process. **(4)**

e. Explain how the motion vectors estimated in video coding can be used for obtaining the motion descriptors commonly used in video sequence analysis and indexing **(4)**

4.

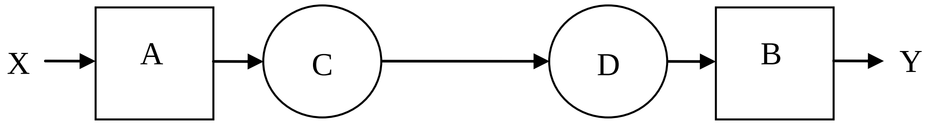

Figure 2

Figure 2 shows a block diagram of a system for creating an approximated version (Y) of a one-dimensional **signal** (X). A and B represent low pass filters. C and D represent down-sampling and interpolating (i.e., inserting zero –valued samples) by a factor of 2, respectively.

a. Explain briefly, using a diagram, how to design a pyramid-based multi-resolution representation scheme using the signal approximation scheme shown in Figure 2. **(4)**

b. If a **signal** has been transformed into a 3-level pyramid-based multi-resolution representation, explain how the pyramid transform subbands can be combined to reconstruct the original signal. **(4)**

c. Compute the sampling redundancy factor for a 3-level decomposition of the pyramid transform designed for a multi-resolution **image** representation scheme. **(4)**

d.

Image 1 Image 2 Image 3 (fused)

Figure 3: Image Fusion

Explain using a block diagram how pyramid transform-based multi-resolution image representation can be used for fusing image 1 (only the big clock is clear) and image 2 (only the small clock is clear) to obtain the fused image as in image 3 (both clocks are clear) in Figure 3. **(4)**

e.

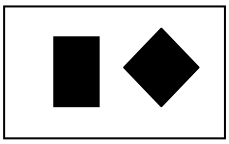

Figure 4

In the image in Figure 4, black and white represent the grey scale values 255 and 0, respectively. Sketch the sub bands of a 2-level decomposition of this image using the 2-dimensional pyramid transform. **(4)**

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