



The
University
Of
Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2011-2012 (1.5 hours)

EEE6086 Video Processing and Analysis 6

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. Calculate the impulse response of the cascade of a horizontal $[1, 3, 1]$ filter and a horizontal $[1, 2, 1]$ filter. What kind of filter is the cascade and what effect can be realised by applying this filter on an image? (5)

- b. Calculate the impulse response of the cascade of a horizontal $[1, 2, 1]$ filter and a vertical $[1, 0, -1]$ filter. What kind of filter is the cascade and what effect can be realised by applying this filter on an image? (5)

- c. Show how an edge enhancement filter can be obtained by using the following 3×3 low-pass filter. Make sure the filter coefficients are normalised.

$$1/15 \begin{array}{|c|c|c|} \hline 1 & 2 & 1 \\ \hline 2 & 3 & 2 \\ \hline 1 & 2 & 1 \\ \hline \end{array}$$

(4)

- d. Show the outputs of a 3×3 median filter and a 3×3 α -trimmed-mean filter ($\alpha=3$) on the following 5×5 image window. Output pixels on the border can be ignored.

90	30	30	30	90
30	90	60	90	30
30	30	90	240	30
30	90	30	90	60
90	30	30	30	90

(6)

2. a. Draw the diagrams of both the training and filtering processes of the “Trained Filter” in the application of integrated sharpening/deblurring and resolution upscaling. Make sure the “Trained Filter” is designed specific for this application. (6)
- b. Classification is critical for the “Trained Filter”. Adaptive Dynamic Range Coding (ADRC) is usually used to classify local structures. Explain how ADRC works. Write down the ADRC code of the following 3x3 image window.

80	52	55
81	83	57
85	88	89

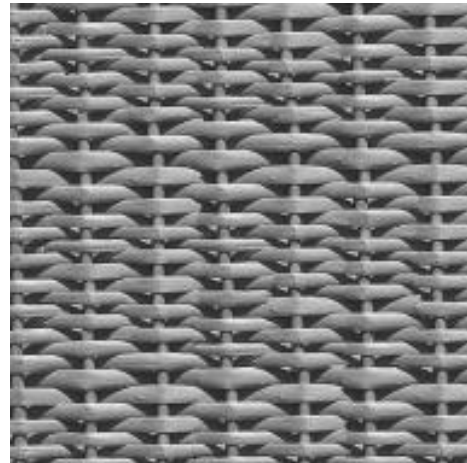
- (4)
- c. In the application of deblocking, is ADRC enough for classification and why? How to design a more effective classifier for deblocking? (5)
- d. What are the similarities and differences between the trained filter and the New Edge Directed Interpolation (NEDI)? (5)

3. a. Image enhancement techniques are usually applied to make legacy video look more pleasant in modern displays. Name two enhancement techniques that usually do not require motion estimation, and two enhancement techniques in which motion compensation is often critical. (4)
- b. What is the major drawback of a full search motion estimator? Name two classical methods to tackle this drawback. (3)
- c. The 3-Dimensional Recursive Search (3DRS) block matcher is a very efficient true motion estimator. What are the two assumptions this algorithm based on? What constitutes the candidate set of the 3DRS blocking matching algorithm? (5)
- d. Motion compensated frame rate up-conversion will be problematic in a video sequence where the foreground object moves fast in front of the background. Name two methods that can be applied to solve this problem? (4)
- e. Describe how a simple motion adaptive de-interlacing method works. (4)

4. a. Compared with Gaussian filters, what is the advantage of the bilateral filter? What are the three difficulties of the bilateral filter? (5)
- b. Describe the similarities and differences between the bilateral filter and the non-local means algorithm. Which of the two methods tends to be computationally more expensive and why? (6)
- c. If Gaussian noise is added to the two images in Figure 1, which of the above two methods would you use for denoising, respectively? Why? (4)
- d. What are the two groups of methods for texture synthesis? Name three applications of texture synthesis. (5)



(a)



(b)

FIGURE 1. TWO IMAGES.

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