EE4704 Image Processing and Analysis

Semester 1, 2020/21

Tutorial Set C

---

1. (a) Describe a simple procedure, based on the bubble sort algorithm, for computing the median of an $k \times k$ neighbourhood. Obtain an expression for C_1, the number of comparison operations that are needed.

   (b) Instead of sorting k^2 values each time the window is moved to the next pixel, we can remove k values corresponding to the discarded pixels from the sorted list, and insert the new k values in the appropriate positions in the list. Determine the number of comparison operations, C_2 that are needed with this procedure (assuming the worst-case scenario).

   (c) Calculate the ratio C_2/C_1 for $k = 3, 5, 7$.

2. A noisy 8×8 image consists of a bright object on a dark background. The nominal gray values of the background and object are, respectively, 60 and 160.

   (a) Show the result of applying these noise reduction techniques

   - neighbourhood averaging
   - median filter
   - mid-point filter
   - alpha-trimmed mean filter with $p = 2$

   to the image. Use 3×3 windows; hence, the resulting images are of size 6×6.

   (b) Rate the effectiveness of each method in (i) handling pepper noise, and (ii) preserving edges. (A = good, B = moderate, C = poor)

60	66	66	63	70	66	52	60
64	70	60	48	76	40	76	50
70	0	52	64	76	72	50	76
64	56	50	68	58	55	74	64
60	54	71	52	158	146	162	152
51	54	60	68	164	140	142	148
66	52	75	55	160	172	171	166
58	62	50	66	156	160	168	156

   Note: The imaage is available as a text file if you wish to do the computations by MATLAB.

3. An image is contaminated by salt noise of probability 0.01. The image and its histogram are shown below.

   (a) Is the MMSE filter effective in removing noise in this case? Discuss this by considering a neighbourhood centred at a noise point (gray level = 255).

   (b) Discuss the suitability of applying image averaging to reduce noise in this image.