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Digital Image Processing Fundamentals

Chapter 3

Digital Image Filtering

Answers to the Chapter Questions

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Chapter 3

Digital Image Filtering

3.3 Fast Fourier transform implementation of FIR digital filters and Block methods in the linear convolution calculation

Questions/Answers

1. When is direct implementation of FIR filters preferred to their FFT implementation?
   When the filter size is much smaller than the size of the image to be filtered, since, in such a case, the required computational complexity of the direct implementation is very low.

2. If an image of size 512×512 is filtered by an FIR filter with a window of size 11×11, what are the dimensions of the output (filtered) image? What must be the FFT length? Do the output image boundaries contain useful information?
   The dimensions of the output image are (512+11-1)×(512+11-1) = 522×522. The FFT length must be the immediately larger power of 2, that is greater than the size of the output image, i.e. 1024×1024. The output image boundaries usually do not convey useful information.

3. Why do we prefer centered FIR filter windows?
   Because they do not introduce spatial shifts to the filtered image.

4. Why do we prefer using the overlap-add method to the overlap-save one?
   Because the overlap-add method is characterized by simpler structure and is perceptually simpler.

3.4 Inverse filter implementations

Questions/Anwers

1. What are the disadvantages of the inverse filter?
   The inverse filter disadvantages are:
   - It cannot be defined in frequency regions $(\grave{u}_1,\grave{u}_2)$ where $\dot{}(\phi_1,\phi_2)$ is zero.
   - The inverse filter is very sensitive to noise presence.

3.5 Wiener filters

Questions/Answers

1. How does the Wiener filter behave if the image is corrupted by blur only?
   In this case, it behaves like an inverse filter.

2. What are the problems in the design and implementation of a Wiener filter?

The problems lie in the estimation of the blur transfer function $\dot{}(\omega_1,\omega_2)$ and of the power spectra.

3.6 Median filter algorithms

Questions/Answers

1. Why do moving average filters destroy image edges?
   Mean filters are lowpass filters. Consequently, they destroy image edges which contain high frequency components.

2. Why do median filters destroy image details?
   Median filters tend to consider small details as noise (outliers) and they destroy details.

3. Why does the median filter algorithm attain low computational complexity?
   Because it requires only comparisons for its calculation.

4. What are the advantages of multistage median filters?
   They preserve image details in horizontal, vertical and diagonal directions.

3.7 Digital filters based on order statistics

Questions/Answers

1. How can we remove mixed impulsive noise by using min/max filters?
   By applying a cascade of two such filters to the corrupted image.

2. What are the advantages of the Ætrimmed mean filters?
   They can be used as a compromise between the moving average filter and the median one by appropriately varying the value of the parameter Æ

3. What are the advantages of the L-filters?
   L-filters attain optimal coefficients for different noise distributions, a fact that makes them appropriate for a wide range of applications.

3.8 Adaptive order statistic filters

Questions/Answers

1. What are the advantages of adaptive filters?
   They have the advantage of satisfactory performance when filtering images having varying content or noise distributions, since they take under consideration the characteristics of the image to be filtered. It is obvious, of course, that the estimation accuracy of such characteristics affects their performance.

2. How do decision directed filters behave?
   Such kind of filters behave differently in different parts of the image to be filtered. Consequently, by using a combination of decision directed filters and an appropriate decision criterion, we can achieve very good filtering results.

3. What image model are SAM filters based on?
   The SAM filter is based on a two component image model. It assumes that the image is composed of a low frequency component and a high frequency one.

3.9 Histogram and histogram equalization techniques

Questions/Answers

1. What are the disadvantages of histogram equalization?
   Histogram equalization tends to amplify the noise.

2. What is the computational complexity of histogram equalization?
   Its computational complexity is of the order of O(k), where k are different greylevel values of the image.

3.10 Pseudocoloring algorithms

Questions/Answers

1. Why do doctors use pseudocolored medical images?
   They use them in order to be able to distinguish better regions with different characteristics.

3.11 Digital image halftoning

Questions/Answers

1. What are the disadvantages of halftoning by using greyscale binary fonts?
   This method of halftoning has the disadvantage of creating false lines and contours in homogeneous image regions.

3.12 Image Zooming and Interpolation algorithms

Questions/Answers

1. Why is sinc interpolation not used?
   Because of the increased computational complexity that the sinc function calculation exhibits.

2. What are the advantages of zero-order hold interpolation?
   Its low computational complexity.

3. What are the advantages of linear interpolation or spline interpolation?
   Both of these interpolation methods create smoother images but have increased computational complexity.

4. What is the use of interpolation in digital television applications?
   It is used for format conversion.