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FACULTY OF EGINEERING

Digital Image Processing
LECTURE-23

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OUTLINE

- ❖Use of PCA for denoising
- ❖Patch similarity
- ❖MCQ
- ❖References

Use of PCA for denoising

- This “non-local” principle can be combined with PCA for denoising.
- Consider a clean image I corrupted by additive Gaussian noise of mean zero and standard deviation σ, to give noisy image J as follows: J = I + N, N ~ Gaussian distribution of mean 0 and standard deviation σ.
- Given J, we want to estimate I, i.e. we want to denoise J.
- Consider a small p x p patch – denoted qref - in J.
- Step 1: We will collect together some L patches {q1 ,q2 ,…,qL } from J that are structurally similar to qref – pick the L nearest neighbors of qref .
- Note: even if J is noisy, there is enough information in it to judge similarity if we assume σ << average intensity of the true image I.
- Step 2: Assemble these L patches into a matrix of size p 2 x L. Let us denote this matrix as Xre

Use of PCA for denoising

Spread spectrum filters are not always possible in many applications.

• The inverse filter approach on previous slides made no explicit use of the knowledge of the noise model.

• The Wiener filter is one approach which makes use of knowledge of the statistical properties of the noise besides the degradation function.

• It attempts to remove both noise as well as the blur.

•Its aim is to produce an estimate of the underlying image such that the expected mean square error between the true and estimated images is minimized

Use of PCA for denoising

Consider a small p x p patch – denoted qref - in J.

• **Step 1:** We will collect together some L patches {q1 ,q2 ,…,qL } from J that are structurally similar to qref – pick the L nearest neighbors of qref .

• Note: even if J is noisy, there is enough information in it to judge similarity if we assume σ << average intensity of the true image I.

• **Step 2:** Assemble these L patches into a matrix of size p 2 x L. Let us denote this matrix as Xref.

Step 3: Find the eigenvectors of Xref Xref T to produce an eigenvector matrix V.

• **Step 4:** Project each of the (noisy) patches {q1 ,q2 ,…,qL } onto V and compute their eigencoefficient vectors denoted as {α1 , α2 ,…, αL } where αi = V Tqi .

• **Step 5:** Now, we need to manipulate the eigencoefficients of qref in order to denoise it.

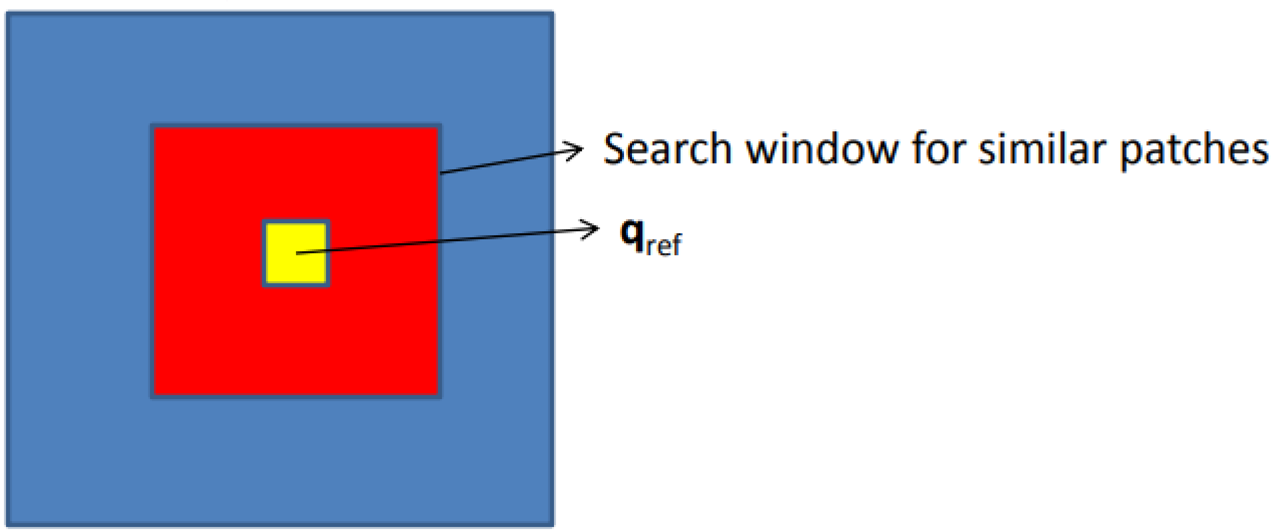
Patch similarity: Use of PCA for denoising

To compute L nearest neighbors of qref, restrict your search to a window around qref.

• For every patch within the window, compute the sum of squared differences with qref, i.e. compute: .

$$\sum_{i=1}^{p}\sum_{j=1}^{p}(q_{ref}(i,j)-s(i,j))^2$$

• Pick L patches with the least distance



MCQ

1. The objective of sharpening spatial filters is/are to ___________

   a) Highlight fine detail in an image

   b) Enhance detail that has been blurred because of some error

   c) Enhance detail that has been blurred because of some natural effect of some method of image acquisition

   d) All of the mentioned

2. Sharpening is analogous to which of the following operations?

   a) To spatial integration

   b) To spatial differentiation

   c) All of the mentioned

   d) None of the mentioned

3. Which of the following fact(s) is/are true about sharpening spatial filters using digital differentiation?

   a) Sharpening spatial filter response is proportional to the discontinuity of the image at the point where the derivative operation is applied

   b) Sharpening spatial filters enhances edges and discontinuities like noise

   c) Sharpening spatial filters deemphasizes areas that have slowly varying gray-level values

   d) All of the mentioned

MCQ

4. Which of the facts(s) is/are true for the first order derivative of a digital function?

    a) Must be nonzero in the areas of constant grey values

    b) Must be zero at the onset of a gray-level step or ramp discontinuities

    c) Must be nonzero along the gray-level ramps

    d) None of the mentioned

5. Which of the facts(s) is/are true for the second order derivative of a digital function?

    a) Must be zero in the flat areas

    b) Must be nonzero at the onset and end of a gray-level step or ramp discontinuities

    c) Must be zero along the ramps of constant slope

    d) All of the mentioned

References

- https://www.javatpoint.com/digital-image-processing-tutorial
- https://www.geeksforgeeks.org/
- Digital Image Processing 2nd Edition, Rafael C. Gonzalvez and Richard E. Woods. Published by: Pearson Education.
- Digital Image Processing and Computer Vision, R.J. Schalkoff. Published by: JohnWiley and Sons, NY.
- Fundamentals of Digital Image Processing, A.K. Jain. Published by Prentice Hall,Upper Saddle River, NJ.