HACETTEPE UNIVERSITY

Department of Computer Engineering

BBM415 Fundamentals of Image Processing Lab

Assignment – 2

Fall 2021-2022

Due Date: 12:00:00, 2021/12/11 Saturday

Student Name:

Muhammed Seyfullah Bilgin

Mean Filter

Mean (average) filtering basically is a smoothing algorithm. Mean filtering replaces each pixel value in an image with the mean (`average') value of its neighbors according to window size of filtering array, including itself. This eliminates pixel values which are irrelevant to their surroundings. Generally smaller window sizes such as 3x3 is used in this filtering. As seen below example sets, Detail in the image is lost as the window size gets larger. Also, edges are less clear as the window size gets larger.

A single pixel has very high value than the neighbours can badly affect the average value of all pixels.

original

3x3

5x5

7x7

9x9

Original

3x3

5x5

7x7

9x9

Gaussian Filter

Gaussian Filter is convolution of a gaussian kernel which is calculated by following formula.

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

In this kernel, value increases as get closer to the center.

value decreases from center to corner. Edges also have greater value than korners. Here, basic gaussian kernel:

The Gaussian filter is a non-uniform low pass filter. It basically reduces detail and noise similar to mean filter. Gaussian filters might not preserve image brightness. For that reason, we can normalize values after algorithm to preserve brightness .We need to enhance images before implementing computer vision algorithms. Gaussian filter can be used to

enhance image before computer vision algorithms. It s similar to mean filter especially in small window sizes like 3x3,5x5.

Detail in the image is lost as the window size gets larger similar to mean filter. However, in large windows sizes, it s easier than mean filter in gaussain filter to see sharp edges like writings on the wall. Gaussian filter weigh pixels a bell-curve around the center pixel. This means that farther pixels get lower weights but in mean-filter, just average the pixel values of all neighboring pixels. Mean filter is equivalent to giving an equal weight to all pixels around the center regardless of the distance from the center pixel. Gaussian filter is much better at separating frequencies than mean filter.

original
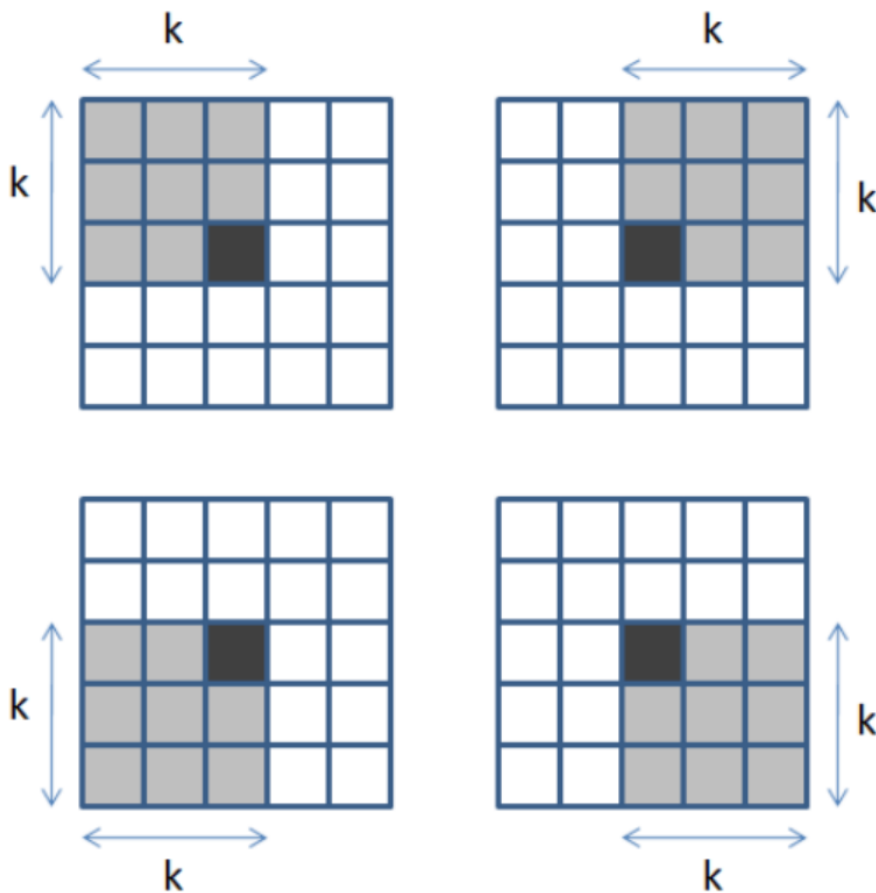

3x3

5x5

7x7

9x9

Original

3x3

5x5

7x7

9x9

Kuwahara Filter

Kuwahara filter is a nonlinear smoothing algorithm. It basically divide into 4 part of each subregion according to window size as seen as below. The pixels located on the borders between two regions belong to both regions resulting in an overlap between the sub-regions.

It finds part which has minimum variance than the other 3 parts. Then, it assigns average RGB values of that part to center of that subregion. The central pixel will have the average value in relation to the edges. These all are performed in whole image. It can be formulazied as:

$$Q_i(x, y) = \begin{cases} [x, x+a] \times [y, y+a] & \text{if } i = 1 \\ [x-a, x] \times [y, y+a] & \text{if } i = 2 \\ [x-a, x] \times [y-a, y] & \text{if } i = 3 \\ [x, x+a] \times [y-a, y] & \text{if } i = 4 \end{cases}$$

$$\Phi(x, y) = m_i(x, y) \text{ where } i = \arg\min_j \sigma_j(x, y)$$

Kuwahara filter considers the homogeneity of the regions, ensuring that the edges are preserved. Larger window sizes usually create more abstract images and smaller window sizes creates images that better preserve their details as seen as examples. For example we cant even realize writings on the wall in 3x3 window size of first example set. Window sizes are chosen from odd numbers to preserve symmetry as we did in the assignment.

Edges are preserved when smoothing makes it especially useful for feature extraction and segmentation. That s why it s useful for medical imaging. It also can be useful for artistic imaging because it removes textures and preserves sharp edges.

It uses a sliding window approach to access every pixel in the image similar to gaussian filter and mean filter. It creates more sharp images in the boundaries unlike mean and gaussian.

Disadvantage of kuwahara is a case which more than one sub regions have the same variance and regions have same variance may have different means. It does not give guarantee to have a clear objects from the set of images. It may produce spectral degradation.
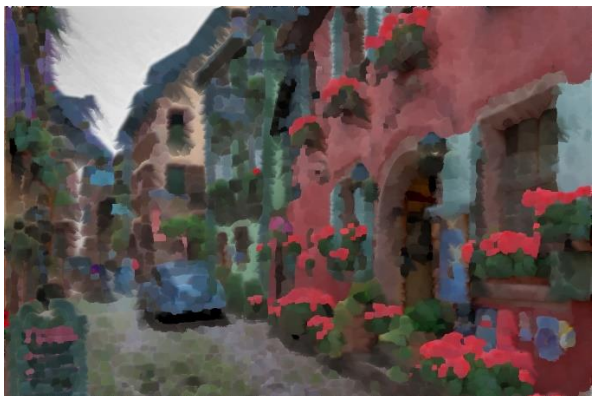
Original

3x3

5x5

7x7

9x9

Original

3x3

5x5

7x7

9x9