HACETTEPE UNIVERSITY

BBM 413

ASSIGNMENT II

Name: Abdullah Atahan

Surname: Türk

Student ID: 21827943

Topics:

Mean Filter

Gaussian Filter

Kuwahara Filter

T.A: Yunus Can Bilge

MEAN FILTER

Mean filter is one of the most popular filters for smooth the image and removing the noise. According to implemented kernel size, the filter takes the neighbour pixels and calculate their mean, then change the center pixels value with the calculated mean value. In my code, the “meanFilter” function takes two arguments which are the image that will filter and the parameter for kernel size. The size of the kernel determine the image’s smoothness. According to kernel size, the number of neighbourgs that we calculate for the mean value will change. When we set the kernel value to 3, it would imply a 3x3 kernel which takes 8 neighbours and the center pixels value, but if set the kernel value to 9 then it would imply a 9x9 kernel which takes 80 neighbours and the center pixels value to calculate the mean. In a small area, the changes between the pixels will be less. As the area increases, the changes between these pixels will increase, so as the kernel increases, the mean of the pixels will be more different than the center pixel. For removing the noise, bigger kernel size would be better but we need to be careful because if the kernel size will be too large, then the image would be very blurred.

GAUSSIAN FILTER

Gaussian filter is one of the most popular filters for smooth and blur the image and removing the noise, like mean filter. Gaussian filter use a more complex filtering system than mean filter. In mean filter, we calculate the unweighted average. But in Gaussian filter, we calculate the mean according the distance between neighbours and the center value. For calculating the weighted average, we are using Gaussian Function formula.

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

In this formula, x and y values changes according to distance between the center pixel and the current neighbour pixel in the kernel. Sigma value influences how significantly the center pixel’s neighbouring pixels affect the computations result. We should determine the sigma value according to kernel

size. As the kernel value increase, sigma value should increase. Otherwise the distant neighbours in the kernel will not effect the calculation. Based on the same logic in the mean filter, we can say that as the kernel size increases, the blurring in the picture will increase and the noise will decrease in the gaussian filter as well. Also as the sigma value increase, blurring will increase again. In my implementation I used two functions which are “gaussianKernel” and “gaussianFilter”. In the kernel function, it takes one parameter that specify the kernel size. I also use a dynamic sigma value which changes according to kernel size to get better results. In filter function, I calculated the values of the pixels with using the Gaussian formula.

KUWAHARA FILTER

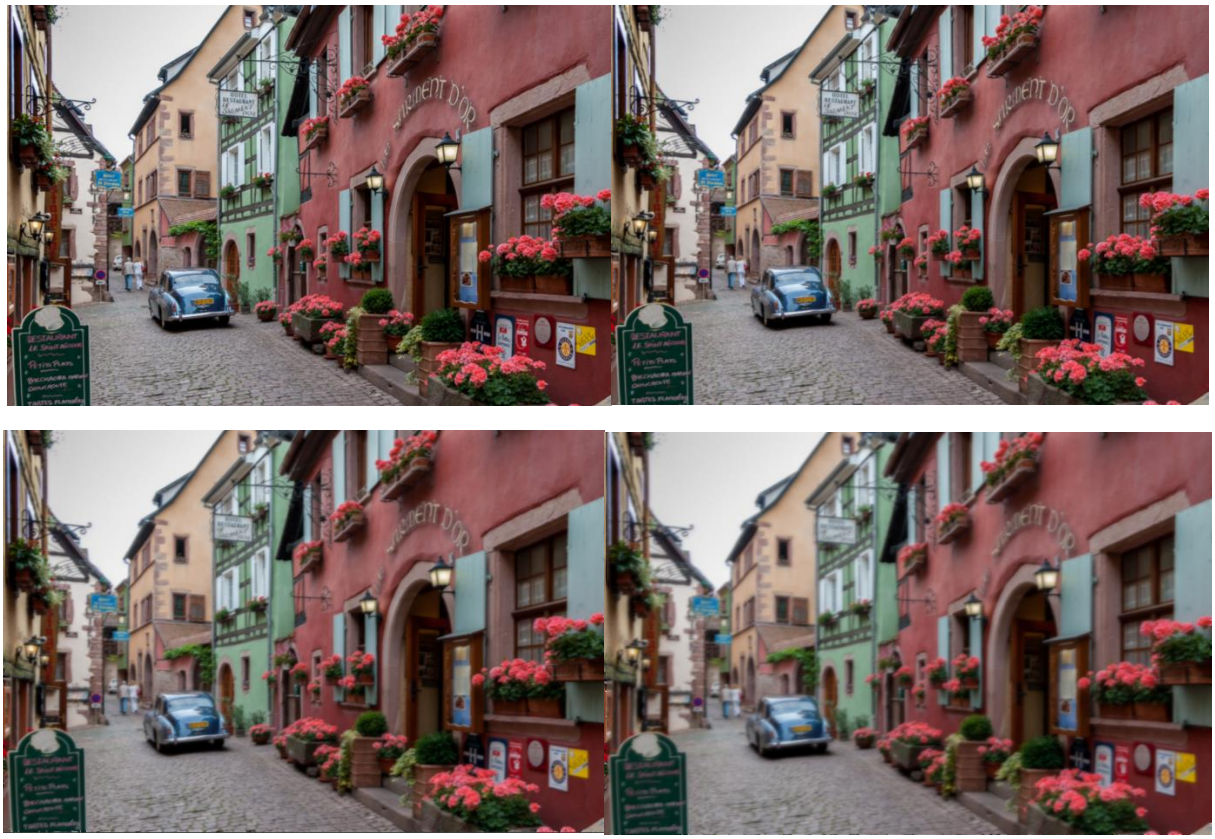
Kuwahara filter is a non linear filter for remove noise from the images. Unlike Gaussian and mean filter, Kuwahara filter is able to apply smoothing on the image while preserving the edges. The filter takes it names from its developer, Michiyoshi Kuwahara. For implement Kuwahara filter, we specify a window size. Then we separete this window to four quadrants. If the size of the window is “(2A+1)x(2A+1)” then the size of every quadrants would be “(A+1)x(A+1)”. For applying Kuwahara filter on RGB images, we need to change the color space to HSV. In HSV space, with using only “V” values, we calculate the standard deviation to understand which quadrant is the most homogeneous. After determine the quadrant area, then we calculate the mean values of that area at same coordinates in RGB color space. Finally we change the value of the center pixel with the value that we calculated. As the window gets wider, the number of pixels affecting the mean and the standard deviation increase, so we get more blurred images in larger windows. In my implemantation, I used a function named “kuwaharaFilter” which takes two parameters, image and the size of the window. I change the color space of the image to HSV and then calculate the std. After that, with using this informations I made calculations on RGB color space of the image and get the result.

EXAMPLES

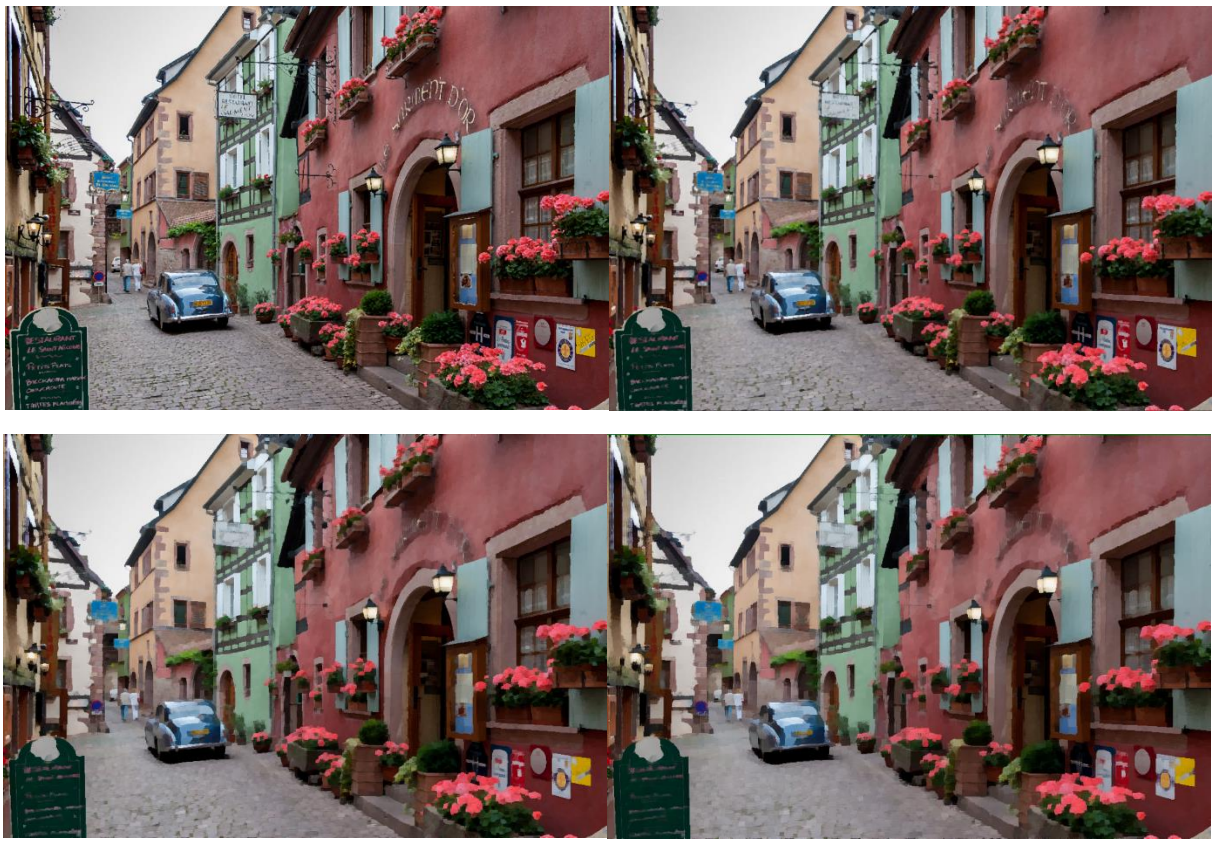
In all of my examples for all filters, I will list the original image and filtered images with kernel sizes’ 3, 5, 7, 9 respectively.

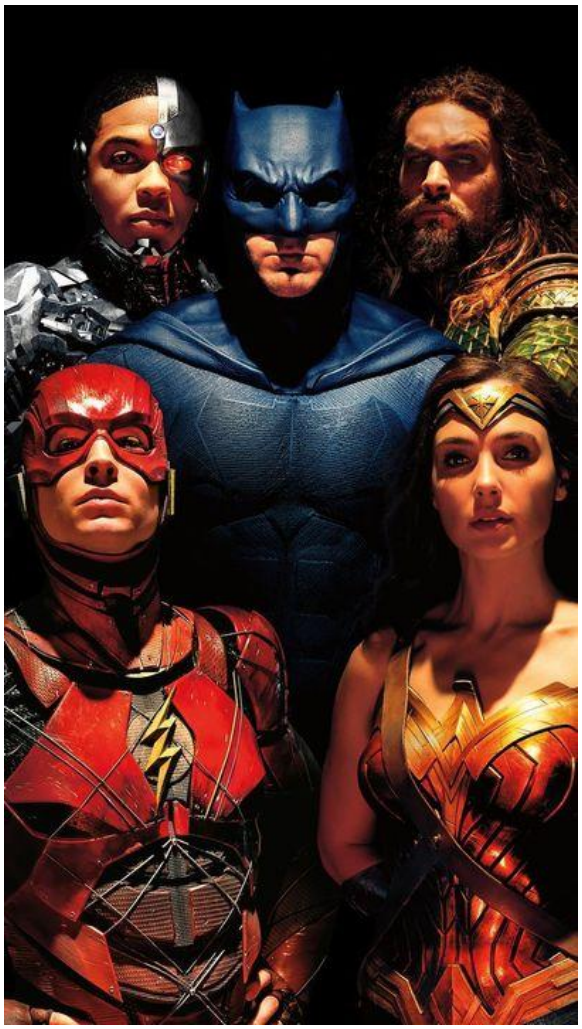
Mean Filter Results:

Gaussian Filter:



Kuwahara Filter:



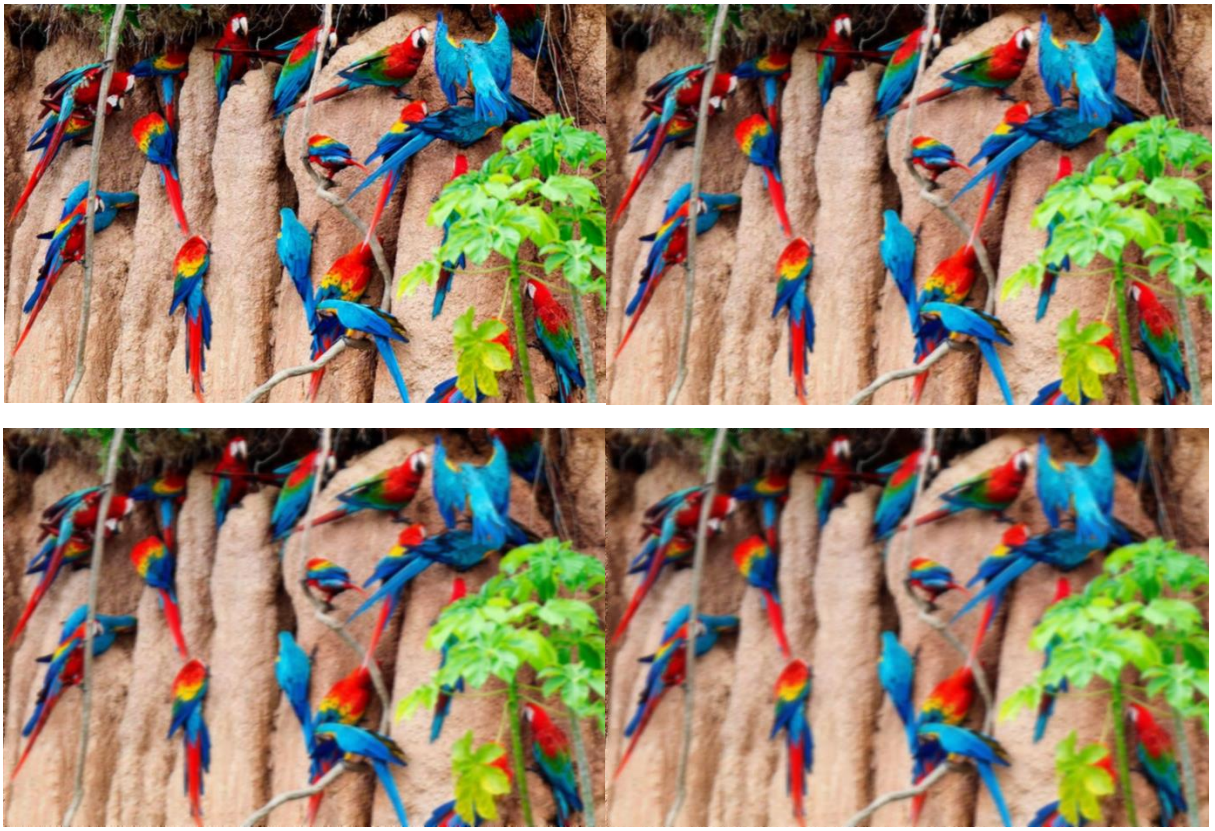


Mean Filter:

Gaussian Filter:

Kuwahara Filter:

Mean Filter:



Gaussian Filter:

Kuwahara Filter:

Mean Filter:

Gaussian Filter:

Kuwahara Filter:

Mean Filter:

Gaussian Filter:

Kuwahara Filter:

We can see that, in all examples, the images got blurred, smoothed and the noise of the images decreased. For all of the filters, as the size of the kernel or window increase, blur increase and we get images with less noise. According to results, we can say that Kuwahara filter smoothes images really well and it gives them the appearance of a watercolor painting. For noise removing, especially according to my last example, Gaussian filter can be the best solution. Mean filter is good for noise removing too but using a weighted average filter would get better results. Kuwahara filter removes noises well too but it blurs the picture too much.

REFERENCES

1. https://en.wikipedia.org/wiki/Kuwahara_filter
2. https://medium.com/swlh/what-is-a-kuwahara-filter-77921ce286f2
3. https://link.springer.com/article/10.1007/s11760-015-0791-3
4. https://en.wikipedia.org/wiki/Gaussian_blur
5. https://datacarpentry.org/image-processing/06-blurring/
6. http://www.librow.com/articles/article-5
7. https://homepages.inf.ed.ac.uk/rbf/HIPR2/median.htm
8. https://www.youtube.com/watch?v=7QVpC1BcgE8&ab_channel=DeepEigen