BBM 415 Assignment-2

Filtering Colorful Images

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Kuwahara Results

***High resolution result could be find in the link below**
https://drive.google.com/drive/folders/1tgunQP3yGGTOTWps7PVX9iYAEjahl-4k?usp=sharing

Introduction

First of all, in this project we were need to implement three different filters which are mean, gaussian and kuwahara. Filters should be able to work with 3, 5, 7, 9 kernel sizes. We need to provide outputs for each kernel size with five different image and two different sigma values for gaussian filter results. In the report there is three part which are, effect of kernel size and sigma values on filter, behaviors of filters and comparing filters between each other.

Effect of Kernel Size And Sigma Value on Filters

In the mean filter, working with larger window size effect produce more blurred images the reason in background is adding far away pixel values to calculation with same weight with nearest neighbor pixel. Therefore calculated pixel has more difference with the real pixel. There are twenty examples on the below

Original - 3x3 - 5x5 - 7x7 - 9x9

Original - 3x3 - 5x5 - 7x7 - 9x9

Original - 3x3 - 5x5 - 7x7 - 9x9

Original - 3x3 - 5x5 - 7x7 - 9x9

Original - 3x3 - 5x5 - 7x7 - 9x9

In the gaussian filter, working with larger window size effect also produce more blurred image but with the weight of neighbor the effect is much less than the mean filter. With the sigma values changes we arrange the weight of neighbors on the result. Working with larger sigma values reduces the different between neighbors weight, therefore if we increase sigma values then should us expand kernel size also. There are forty examples on the below

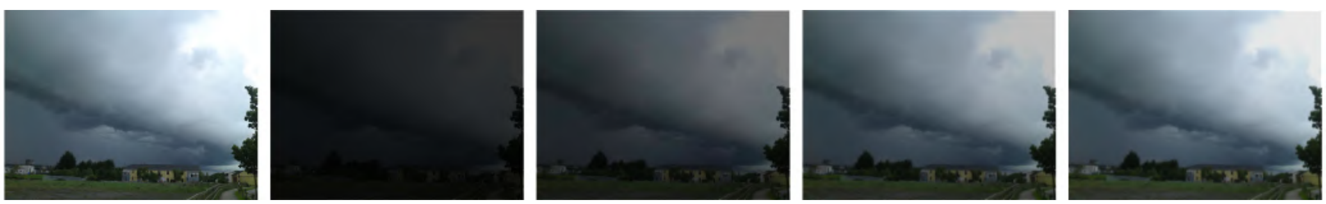
Original - 3x3 - 5x5 - 7x7 - 9x9 (Sigma = 1)

Original - 3x3 - 5x5 - 7x7 - 9x9 (Sigma = 2)

Original - 3x3 - 5x5 - 7x7 - 9x9 (Sigma = 1)

Original - 3x3 - 5x5 - 7x7 - 9x9 (Sigma = 2)

Original - 3x3 - 5x5 - 7x7 - 9x9 (Sigma = 1)



Original - 3x3 - 5x5 - 7x7 - 9x9 (Sigma = 2)

Original - 3x3 - 5x5 - 7x7 - 9x9 (Sigma = 1)

Original - 3x3 - 5x5 - 7x7 - 9x9 (Sigma = 2)

Original - 3x3 - 5x5 - 7x7 - 9x9 (Sigma = 1)

Original - 3x3 - 5x5 - 7x7 - 9x9 (Sigma = 2)

In the kuwahara filter, working with larger window size effect result much more than the working with lower window size. The reason at the background is also same, adding much more pixel to the calculation. There are twenty examples on the below

Original - 3x3 - 5x5 - 7x7 - 9x9

Original - 3x3 - 5x5 - 7x7 - 9x9

Original - 3x3 - 5x5 - 7x7 - 9x9

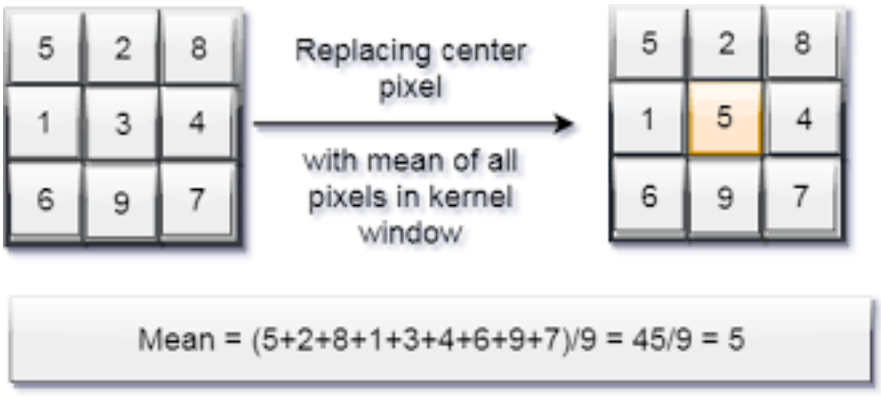
Original - 3x3 - 5x5 - 7x7 - 9x9

Original - 3x3 - 5x5 - 7x7 - 9x9

Behaviors of Filters

Mean Filter

The mean filter is a basic sliding-window spatial filter that replaces the window's center value with the average (mean) of all of the window's pixel values. The window, also known as the kernel, is typically square but it can be any shape. There is an example on below.



Mean Filter

Gaussian Filter

The gaussian filter also a basic sliding-window spatial filter as mean filter that replaces the window's center value with the average (mean) of all of the window's pixel values. The difference between mean is, there is a sigma value in the function which changes the priority of neighbor cells, with gaussian filter the nearest neighbor pixel has more effect on center pixel than other pixels. There is an example on below.

1/16

1	2	1
2	4	2
1	2	1

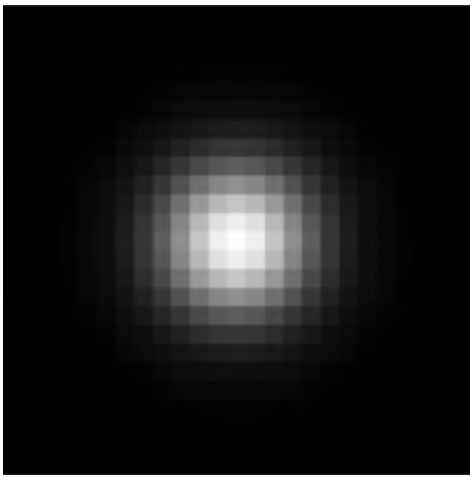
1/273

1	4	7	4	1
4	16	26	16	4
7	26	41	26	7
4	16	26	16	4
1	4	7	4	1

1/1003

0	0	1	2	1	0	0
0	3	13	22	13	3	0
1	13	59	97	59	13	1
2	22	97	159	97	22	2
1	13	59	97	59	13	1
0	3	13	22	13	3	0
0	0	1	2	1	0	0

Gaussian Filter with different window sizes



A Gaussian Filter mask

Kuwahara Filter

The kuwahara filter also a basic sliding-window spatial filter as the other filters above. The differences between others are the formula and subregions logic. In the kuwahara filter we divide window into four, In the every part we calculate local average and local standard deviation and we assign the calculated value to center value. There is an example on below.

a	a	a/b	b	b
a	a	a/b	b	b
a/c	a/c	a/b/ c/d	b/d	b/d
c	c	c/d	d	d
c	c	c/d	d	d

Kuwahara Filter mask

Comparing Filters

If we compare mean filter with gaussian filter the main difference the weight of neighbors effect on the calculated result. In the mean filter every pixel in the window has same effect on the result, therefore working with mean filter could be wrong option. On the other hand, gaussian filter gives priority to the nearest neighbors that property makes more sense on the applications than the mean filter.

If we compare kuwahara filters with the other filters again the difference between them is calculating result pixel value. In the kuwahara filter we compare subregions in the window. The mean of subregion and standard deviation gives us the fades on the picture. We chose the lowest result of subregion as result, with that calculation we chose subregion with least difference in the pixels.