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Methodology of Non-Local Means Algorithm in detail. (0.5 mark)

The NL-means algorithm is used to denoise the given noisy image. So, First we are given the noisy image. We will then apply padding to that input image to make it bigger so that when we apply the NL Means algorithm the size of the input image does not change. Padding can be applied such that the borders of the padded image have reflection of the given input image.
For example:
Input Image:

2	3	5
1	2	4
0	6	7

Then padded image will be as follows:

2	2	3	5	5
2	2	3	5	5
1	1	2	4	4
0	0	6	7	7
0	0	6	7	7

Or simply we can add zeros to the border and do the padding like if Input Image is as follows:

2	3	5
1	2	4
0	6	7

Then padded image can be as follows:

0	0	0	0	0
0	2	3	5	0
0	1	2	4	0
0	0	6	7	0
0	0	0	0	0

After padding we need to do the following for each pixel of the input image:
Total_weight=0
pixels=0
For the given pixel, find the area around that pixel which needs to be compared(say compar_area). After that compare the above obtained area with every similar area(say target_area) in the large window area. Find the euclidean distance for each target_area when compared with the compar_area. Apply the softmax function to the above calculated distance to obtain the weight and add the weight to total weight. Update the pixel value by adding weight* target_area to it.

The final value corresponding to the given pixel of the input image will be pixels/Total_weight. This way we will obtain the pixel value for each input pixel value. And hence we will obtain the denoised output image.

Metrics (MSE and PSNR) obtained for both the denoising methods for all the 10 images tabulated properly. (0.5 mark)

NL Means Denoising Method results and Gaussian Filter method results for gaussian noise input image:

Image No	PSNR(NL Means)	MSE(NL Means)	PSNR(Gaussian Filter)	MSE(Gaussian Filter)
1	29.94	65.86	31.53	45.72
2	28.68	88.18	30.63	56.26
3	29.19	78.32	30.18	62.35
4	29.47	73.43	30.96	52.12
5	30.05	64.27	29.95	65.79
6	28.29	96.47	29.39	74.84
7	29.27	76.97	30.02	64.69
8	29.13	79.44	29.29	76.53
9	30.38	59.63	30.92	52.65
10	29.64	70.51	29.80	67.98

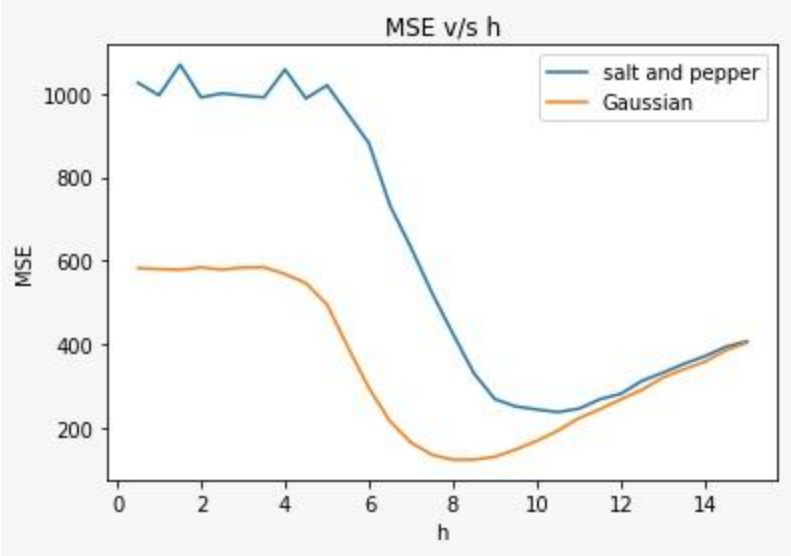
NL Means Denoising Method results and Gaussian Filter method results for Salt and pepper noise input image:

Image No	PSNR (NL Means)	MSE (NL Means)	PSNR (Gaussian Filter)	MSE (Gaussian Filter)
1	33.34	30.15	32.20	39.22
2	29.60	71.31	30.97	51.95
3	30.81	53.96	30.79	54.20
4	31.99	41.11	31.48	46.29
5	32.05	40.58	32.73	34.68
6	28.50	91.82	29.51	72.78
7	30.44	58.77	31.10	50.46
8	29.82	67.76	29.59	71.43
9	32.84	33.84	31.67	44.29
10	32.05	40.51	31.64	44.56

Understanding of the sigma h, small window and big window Parameters. (0.5 mark)

The parameter big window is the area under which we will compare different pixels with the given pixel. The small window is the area around a pixel which needs to be compared with the same sized area around the given pixel. So, the small window and big window helps us to calculate the weights for the given pixel.
The h parameter is basically the multiplication constant for the weight calculation using the euclidean distance formula. We don't directly take the euclidean distance value for the weight calculation rather we divide it by the h parameter and hence we can say that it is one kind of normalization factor.

For optimization of MSE and time:
When plotting for mse optimization against h value, I got the following results for small window =2 and big window =5



For this case, h_gauss=7.9 and h_snp= 10.3

For Optimization of time:
As we increase the window size, the time was increasing. So, take small window size as 3 and big window size as 5. It will consume less time.

Comments on your observations about which method proves better for different noise types. (0.5 mark)

From the mse & psnr metrics table for different methods we can conclude that gaussian filtering is better for Gaussian noise input image whereas for salt and pepper noise input image we can see that, for some images Gaussian filter is giving good results and for rest NL Means algorithm is giving good results.