Theoretical questions

Question 1

Consider gaussian and median filters. Which one of them is better for eliminating salt and pepper noise and gaussian noise?

Answer:

After carrying out several experiments, we conclude that median filter is better for eliminating salt and pepper noise. Theoretically, this occurs due to the way median filter works: it selects a median value in a selected area. Salt and pepper noise adds very extreme values to the image like 255 or 0 intensities and these values usually don't affect median value in a region.

Gaussian filter doesn't eliminate salt and pepper noise: the filter only slightly changes high intensities of corrupted pixels by mixing them with nearby pixels.

Conversely, gaussian filter does a better job in eliminating gaussian noise: because the intensities of image are only slightly corrupted by values that were randomly generated by gaussian distribution, and the filter eliminates this noise. But the gaussian filter also eliminates fine details of the image.

Median filter is also good at eliminating gaussian noise: it selects median value in every region. So, it is usually the value that was corrupted less than others.

Question 2

State the difference between domain filter and range filter.

Answer:

Domain filter changes the values of pixels depending on their relative position. Like guassian filter: the pixels that are closer to the filtered pixel contribute more to the final result.

Range filter changes the values of pixels depending on their relative intensities.The pixels that are closer to the filtered pixel in a sense of intensity contribute more to the final result.

Question 3

Explain the effect of the parameters σ_d and σ_r on the way the bilateral filter works.

Answer:

If we increase the σ_d parameter, we increase the number of pixels that contribute to the final value of filtered pixel, depending on their distance to filtered pixel. But, those pixels contribute only to a certain extent, depending on the parameter σ_r: if their intensities differ not so much from intensity of filtered value. And 'differ not so much' is defined according the the σ_r parameter.

Question 4

Compare the bilateral filter to gaussian smoothing.

Answer:

Gaussian smoothing is the bilateral filter, but with an infinite σ_r parameter. So, it doesn't preserve edges. While bilateral filter smooths pixels with similar intensities: pixels that are close to each other and have big difference in intensities usually correspond to edge.

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If you take the difference of image filtered with bilateral filter and gaussian smoothing, you will get edges. This is demonstrated in our matlab code.

Quesion 5

Can you implement bilateral filter with a simple predefined convolution kernel?

Answer:

No, because differences in intensities are not consistent across all filtered pixels. Conversely, the differences in distance to the filtered pixel are constant, this is why it is possible to put this into kernel.