

ECE 418 Lab 8

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In this lab we find compare the effects of different filters, mainly gaussian filter, log filter and median filter, on images with gaussian and salt-and-pepper noise and see what applying the filter results in. We also check what happens when we apply the median filter on a salt-and-pepper noise image multiple times and see if that changes the image when compared to the applying the filter only once.

We first create the noisy images by using the `imnoise()` function to create two noisy images one with gaussian noise and one with salt and pepper noise. Resulting in the following images:

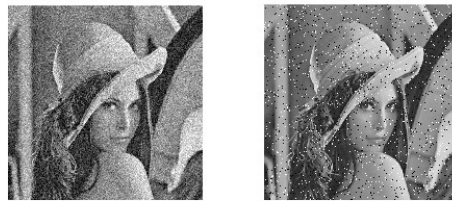


Figure 1 Gaussian noise Image(left) and Salt and Pepper noise Image(right)

We then apply Gaussian filter to the both the noisy images and following are the results:



Figure 2 Gaussian Filter with window size 5 increasing from 0.25, 0.5, and 1 applied on gaussian image(top) and salt and pepper image(bottom)



Figure 3 Gaussian Filter with window size 10 increasing from 0.25, 0.5, and 1 applied on gaussian image(top) and salt and pepper image(bottom)

We also apply the log filter on both the noisy images which produces the following results:

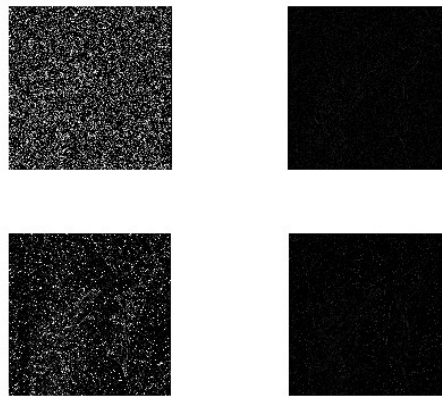


Figure 4 Log Filter with window size 5 increasing from 0.5 and 1 applied on gaussian image(top) and salt and pepper image(bottom)

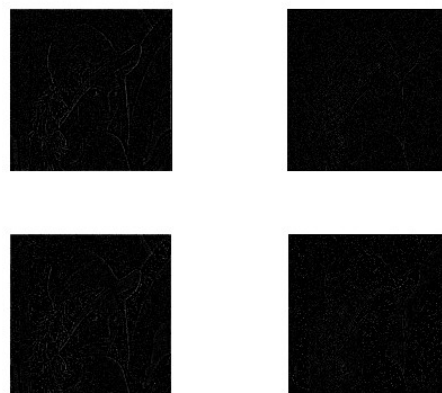


Figure 5 Log Filter with window size 10 increasing from 0.5 and 1 applied on gaussian image(top) and salt and pepper image(bottom)

Q1. We can see from the images produced that Gaussian filter applied on the noisy image with Gaussian noise produces an image that appears to have less noise than the original noisy image. The log filter, however, seems to be producing an image that highlights the edges in the image and making the edges more detectible. Overall we can see that the best Gaussian filter is the one with window size 10 and main lobe size 1. The best log filter, however, is the filter with size 10 with standard deviation 0.5. It seems like the Gaussian filter is overall better at filtering out the noise at higher window size and higher main lobe size. However, the log filter seems to be the better at detecting edges with larger window size and lower standard deviation.

We then applied the Median filter on the noisy images and found the following results:



Figure 6 Median Filter of size 3, 6, and 9 applied to gaussian image(top) and salt and pepper image(bottom)

Q2. Linear filters are effective in removing noise in cases where the noise has a lower magnitude but contains a large amount of noise in an image. Whereas median filter is effective for images with low amount of noise however the magnitude of noise is really high. Moreover, the linear filters don't preserve the edges of an image well whereas the median filters preserve the edge structure effectively. Therefore, the linear filter works better for the Gaussian noisy image whereas the median filter works better for the salt and pepper noisy image. Since salt and pepper noise creates extreme intensity values in the images, when using linear filters on the images, the resulting image might still have really high intensities due to the initial high intensities increasing the average intensity value in the neighbourhood. However, when working with Gaussian noisy image the linear filter works because the Gaussian noise has a normal density distribution on the image intensities which can be lowered down by taking into account the neighbouring pixels. Whereas median filters work better with salt and pepper noisy image because it the median isn't affected heavily due to an outlier so it gives a more realistic pixel intensity value for the current pixel for salt and pepper images.

We then also perform median filter to the lena image 50 times resulting in the following image:



Figure 7 Median filter applied to the salt and pepper noisy image 50 times

Q3. When median filter is applied multiple times to an image, the resulting image is going to converge since we will reach a point in the application where the median of the neighbouring pixels is going to be the same as the current pixel value and hence the filter would have no additional effect on the image therefore the image will converge to the stable resulting image.

Overall this week we compared how different filters would effect different noisy images and evaluate the advantages and disadvantages of each of the filters used.