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Summary Report for Project 3

The objective of this lab is to restore images corrupted by different types of noise. Following the instruction, all filters used are 3x3 in size unless specified otherwise. For the salt and pepper noise, average filters and median filters at size 3x3 and 5x5 were used to remove noise density at 5%, 10%, and 20% for a grayscale image. Even at 5% noise density, average filters performed poorly by either failed to remove a large portion of the noise or greatly blurred the image. A 3x3 full mask median filter did fairly well at removing noise at 10% and lower without distorting the image too much. As for the 20% noise, all filtered failed to produce a good result with a 5x5 full mask median filter performs slightly better than the rest. However, the same result with less blur can be produced by applying a 3x3 full median filter twice. Overall, the median filter is better at removing the salt and pepper noise than the average filer.

For the Gaussian noise, the mean values are kept at zero and as the variance value increases, the noise density also increases. Comparing all the filters, the Weiner filter produced the best results for the variance of 0.01 and 0.02. Both the average and Weiner filters failed to remove the noise at variance 0.05 and 0.1. While the midpoint filter performance is not the best, it did make the noise less noticeable at a higher density, but it also blurred the images a lot and greatly affected the grayscale values at 255 and zero. Unlike the two types of noise discussed above, periodic noise was applied using the given sine wave and requires frequency domain filtering to partially remove the noise. Using a band-pass filter, the noise in a particular band surrounding the center can be removed. A larger band is needed to block more noise but it also comes with greater distortion. A criss-cross filter, on the other hand, remove less noise but it keeps the center of the image a lot sharper. With the selected image where most of the detail located in the center, a criss-cross filter produces a more desirable result.

As for the image corrupted by blur, average filters with the size of 5x5 and 7x7 were applied onto the same grayscale image. The filters were zero-padded so that it is the same size as the image before applying the inverse filter with constraint division to deblur the image and contrast enhancement to increase the brightness. The filters with low threshold values have a large number of artifacts but they also produced sharper deblurred images. The image that remained fairly sharp and without much distraction from the artifacts is one with a threshold value of 0.1 and 0.2 for 5x5 and 7x7 blurrings filters, respectively. Similarly, for motion blur, the filter that was applied has the length of motion of 9 and theta of zero. The same process was used to deblur the image as those with average filters. The results show vertical artifacts in all pictures with the best view of the license plate at a threshold of 0.02

The last section deals with restoring color images corrupted by two different types of noise. For the first part, Gaussian noise with zero mean and 0.01 variance was added to a color image before average filters and Wiener filters were applied to each RGB component to remove the noise. The results show that both filters are successful in removing all the noise. At a higher noise density level, however, average filter performance is slightly better. For the second part, image restoration was performed for a color image with 5% and 20% salt and pepper noise as well as with Gaussian noise with a mean of zero and a variance of 0.1. Each noise condition was applied to the intensity component of the image and at 20% density, the noisy images look the same as in Figure 13.21. Since noise was applied after conversion from RGB to YIQ, it remains only in the intensity components, so the use of median filters on the intensity and RGB components to remove the noise produces the same result.