

## Exercise 1



Figure 1: The original Barbara (left) and Kodak (right) images given to us in the problem statement.



Figure 2: Barbara (left) and Kodak (right) images where zero mean Gaussian noise with  $\sigma = 5$  is added.



Figure 3: Mean-shift filtering of Barbara (left) and Kodak (right) images where zero mean Gaussian noise with  $\sigma = 5$  is added using  $\sigma_s = 0.1$  and  $\sigma_r = 0.1$ . We observe that there is no significant filtering effect in the images due to low sigma value.

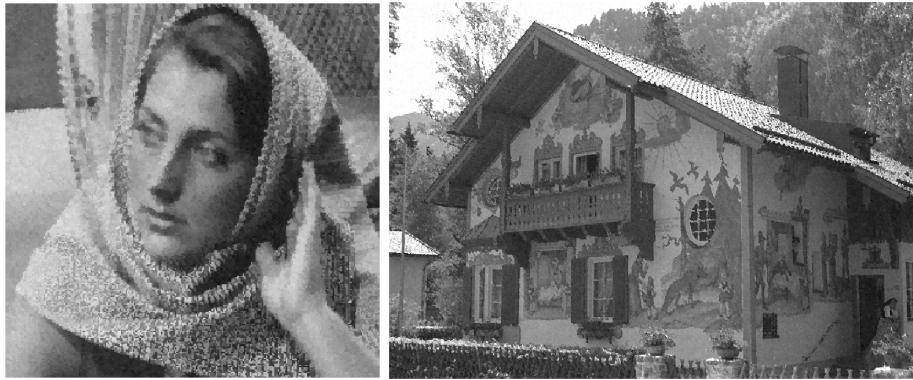


Figure 4: Mean-shift filtering of Barbara (*left*) and Kodak (*right*) images where zero mean Gaussian noise with  $\sigma = 5$  is added using  $\sigma_s = 2$  and  $\sigma_r = 2$ . The filtering effect is clearly visible in the images where segmentation has taken place.

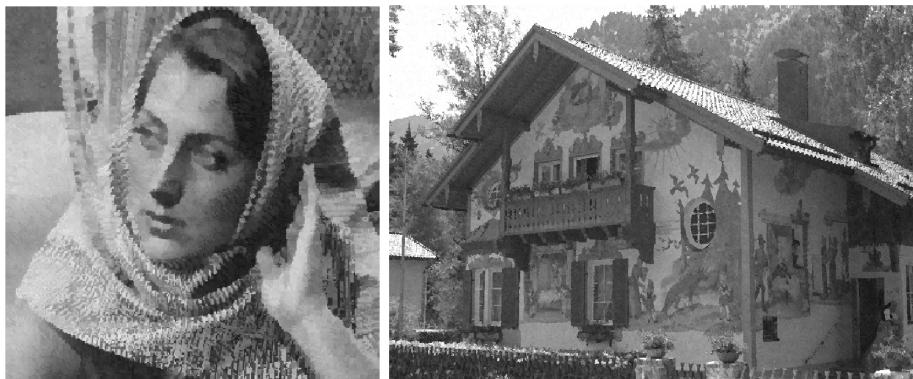


Figure 5: Mean-shift filtering of Barbara (*left*) and Kodak (*right*) images where zero mean Gaussian noise with  $\sigma = 5$  is added using  $\sigma_s = 3$  and  $\sigma_r = 15$ . The filtering effect is even more pronounced with larger sigma values as compared to the previous two figures. We can observe the segmentation effect.



Figure 6: Barbara (*left*) and Kodak (*right*) images where zero mean Gaussian noise with  $\sigma = 10$  is added.



Figure 7: Mean-shift filtering of Barbara (left) and Kodak (right) images where zero mean Gaussian noise with  $\sigma = 10$  is added using  $\sigma_s = 0.1$  and  $\sigma_r = 0.1$ . We observe that there is no significant filtering effect in the images due to low sigma value.

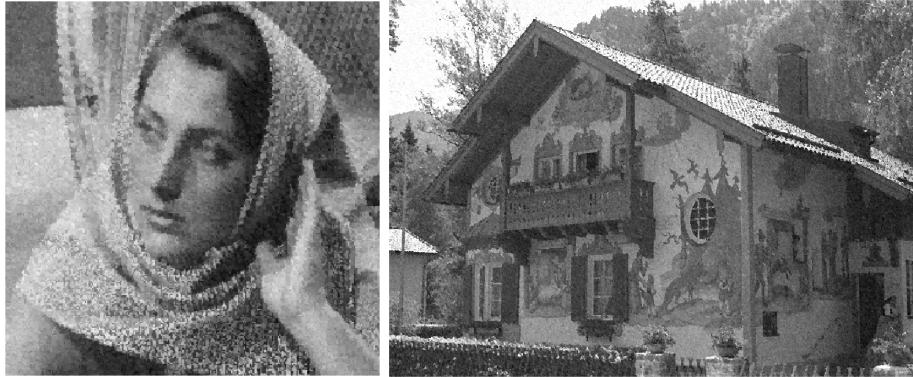


Figure 8: Mean-shift filtering of Barbara (left) and Kodak (right) images where zero mean Gaussian noise with  $\sigma = 10$  is added using  $\sigma_s = 2$  and  $\sigma_r = 2$ . We observe a considerable segmentation effect in the images, however, the image is still not visually very pleasing.

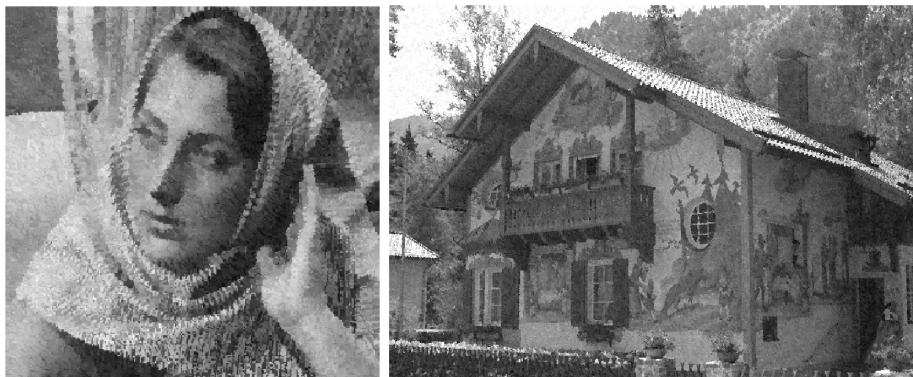


Figure 9: Mean-shift filtering of Barbara (left) and Kodak (right) images where zero mean Gaussian noise with  $\sigma = 10$  is added using  $\sigma_s = 3$  and  $\sigma_r = 15$ . The filtering effect is even more pronounced with larger sigma values as compared to the previous two figures. We can observe the segmentation effect in both the images. However, the filtering effect is not very pleasing here.