

Assignment 2, Q8 : CS 663, Autumn 2023

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1 Introduction

In this assignment, we explore the application of a bilateral filter on two images: 'barbara256.png' and 'kodak24.png.' We start by adding zero-mean Gaussian noise to both images with a standard deviation of $\sigma = 5$. We then implement a bilateral filter with various parameter configurations and examine the results. Later, we repeat the process with increased noise ($\sigma = 10$) to observe the filter's performance under more challenging conditions.

2 Image Preparation

Before applying the bilateral filter, we prepare the images by adding Gaussian noise. For $\sigma = 5$, we obtain the following noisy images:



(a) Noisy Barbara Image ($\sigma = 5$)



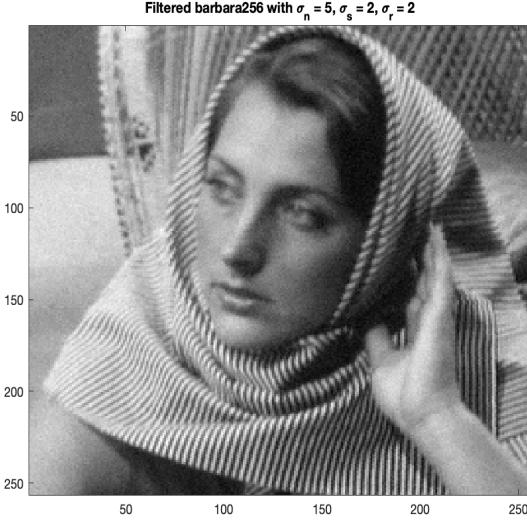
(b) Noisy Kodak Image ($\sigma = 5$)

3 Bilateral Filtering

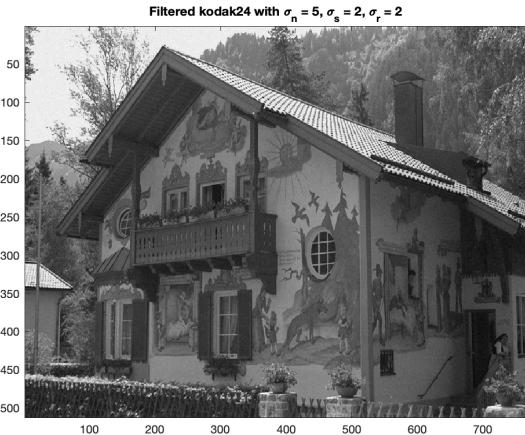
We implement a bilateral filter with various parameter configurations: $(\sigma_s = 2, \sigma_r = 2)$, $(\sigma_s = 0.1, \sigma_r = 0.1)$, and $(\sigma_s = 3, \sigma_r = 15)$. We apply the filter to both noisy images.

3.1 Parameter Configuration: $(\sigma_s = 2, \sigma_r = 2)$

For this configuration, we use a relatively small spatial and range window size.



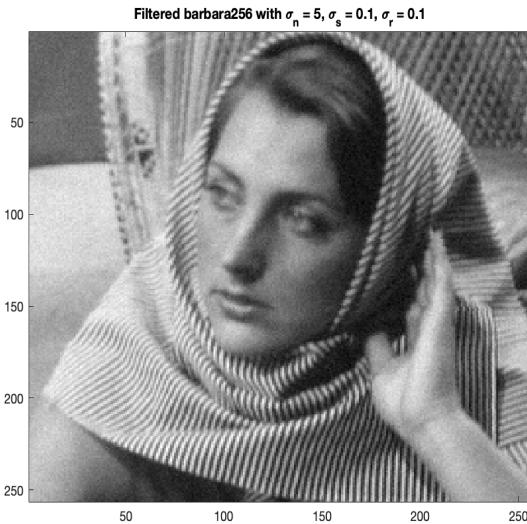
(a) Filtered Barbara Image (13×13 bin)



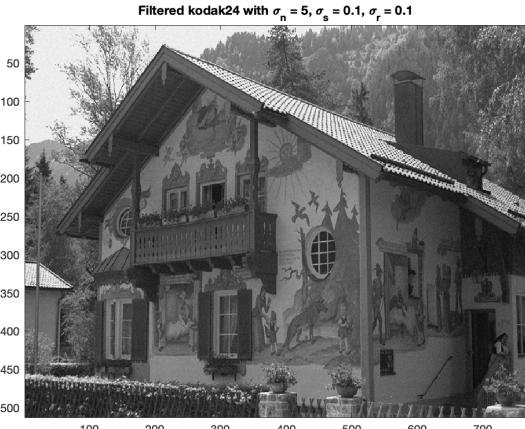
(b) Filtered Kodak Image (13×13 bin)

3.2 Parameter Configuration: $(\sigma_s = 0.1, \sigma_r = 0.1)$

Here, we use a small spatial and range window size, which may result in stronger smoothing.



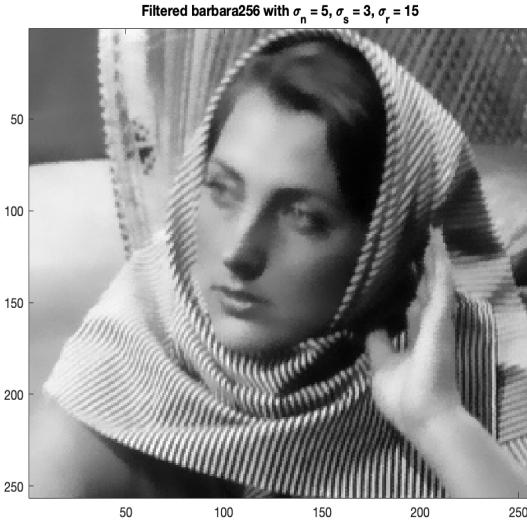
(a) Filtered Barbara Image (3×3 bin)



(b) Filtered Kodak Image (3×3 bin)

3.3 Parameter Configuration: $(\sigma_s = 3, \sigma_r = 15)$

In this case, we use a larger spatial and range window size, which can preserve more details.



(a) Filtered Barbara Image (19×19 bin)

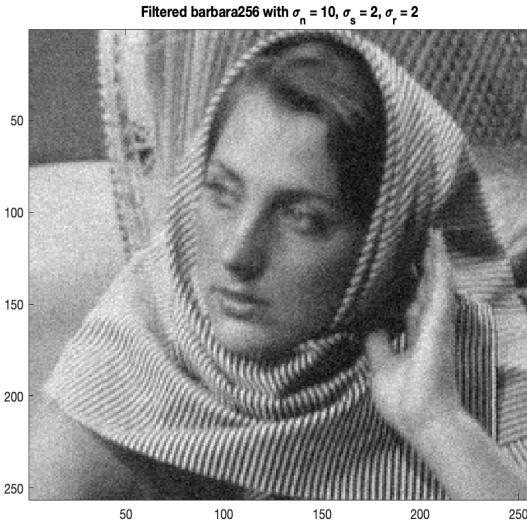


(b) Filtered Kodak Image (19×19 bin)

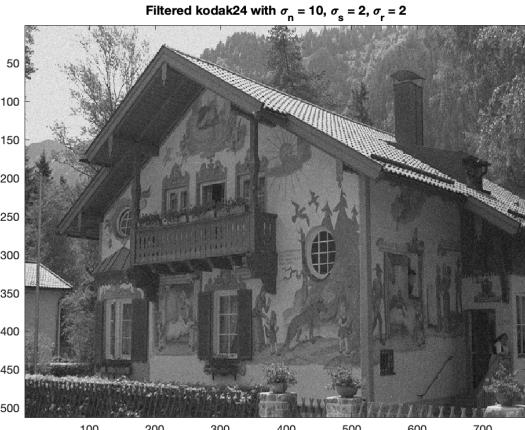
4 Increased Noise ($\sigma = 10$)

We repeat the entire process with increased noise levels ($\sigma = 10$) to assess the filter's performance under more challenging conditions.

4.1 Parameter Configuration: ($\sigma_s = 2$, $\sigma_r = 2$)

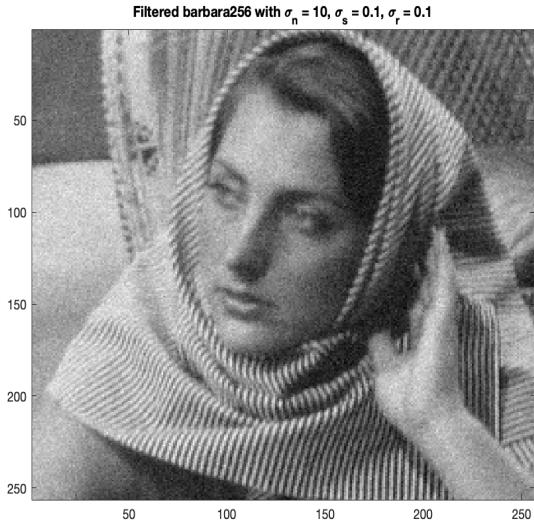


(a) Filtered Barbara Image (13×13 bin)

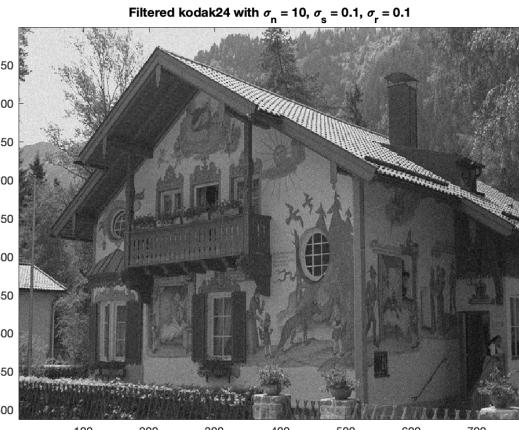


(b) Filtered Kodak Image (13×13 bin)

4.2 Parameter Configuration: ($\sigma_s = 0.1, \sigma_r = 0.1$)

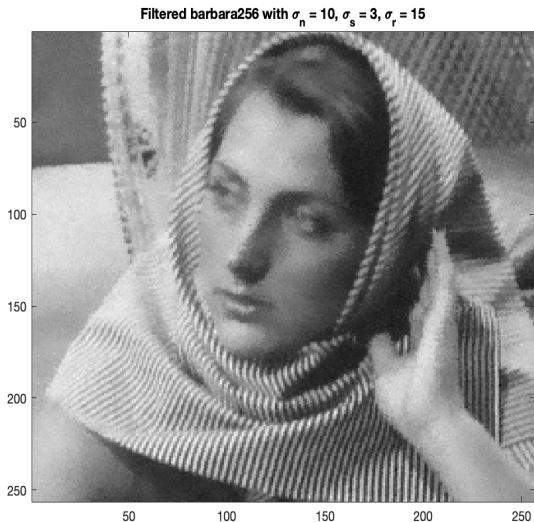


(a) Filtered Barbara Image (3×3 bin)

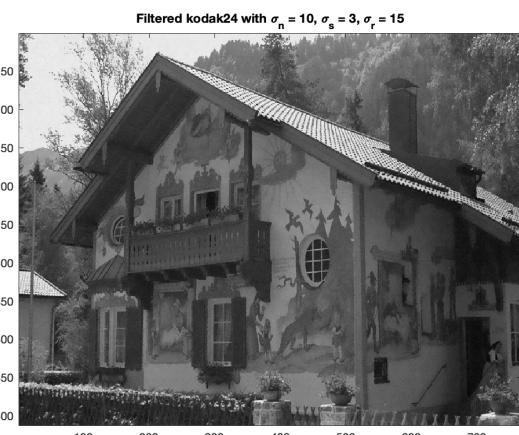


(b) Filtered Kodak Image (3×3 bin)

4.3 Parameter Configuration: ($\sigma_s = 3, \sigma_r = 15$)



(a) Filtered Barbara Image (19×19 bin)



(b) Filtered Kodak Image (19×19 bin)

5 Conclusion

In this assignment, we applied a bilateral filter to noisy images with various parameter configurations. The filter effectively reduced noise while preserving image details. We observed how changing the spatial and range window sizes affected the results. The filter performed well even with increased noise levels ($\sigma = 10$).