CS663 - Assignment 3 - Question 3

Kavan Vavadiya
Roll No: 210100166

Kushal Agarwal
Roll No: 210100087

Anshika Raman
Roll No: 210050014

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- For $\boldsymbol{\sigma = 5}$

  Barbara256:

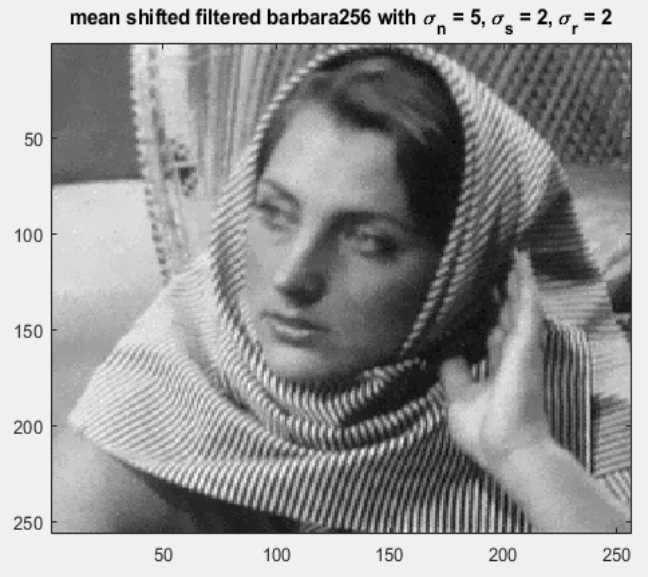
Barbara original image

Barbara noisy image for $\sigma = 5$

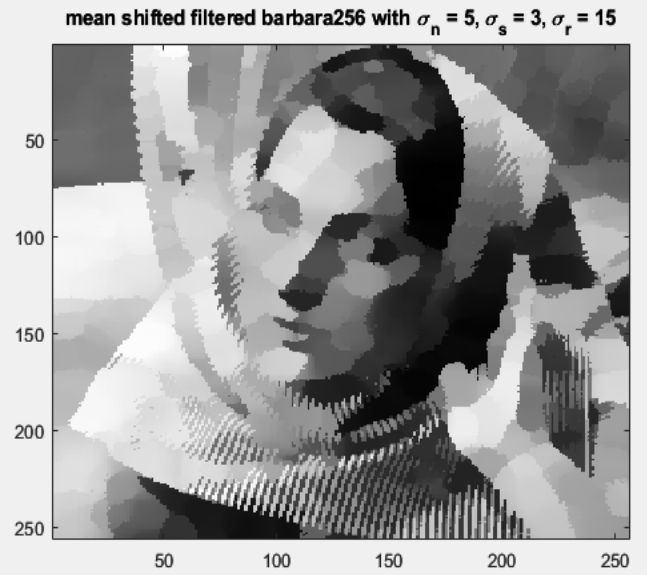
Above noisy image is getting from adding noise of mean 0 and standard deviation(σ) = 5

Mean shift Filtering:

Filtered barbara image with $\sigma_s = 0.1,\ \sigma_r = 0.1$



Filtered barbara image with $\sigma_s = 2,\ \sigma_r = 2$



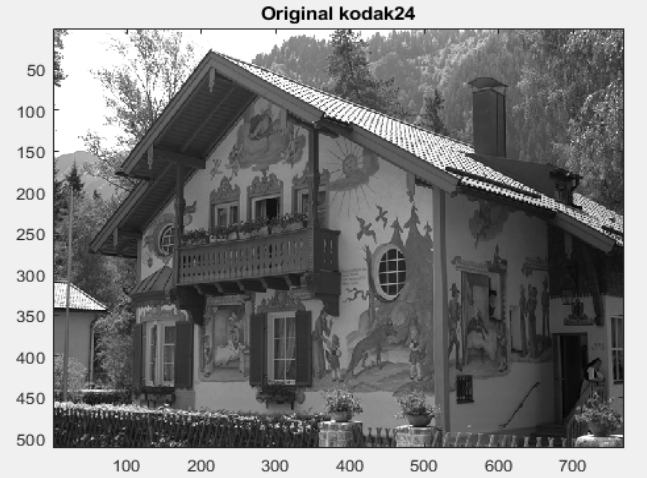
Filtered barbara image with $\sigma_s = 3,\ \sigma_r = 15$

We used $\epsilon = 0.01$ as the threshold for the maximum change in a feature vector to halt the convergence process. In comparison, we observed that for $s = 0.1$ and $r = 0.1$, the filtered image showed almost no change. For $s = 2$ and $r = 2$, a few small regions were smoothed, while the third case exhibited more extensive filtering.

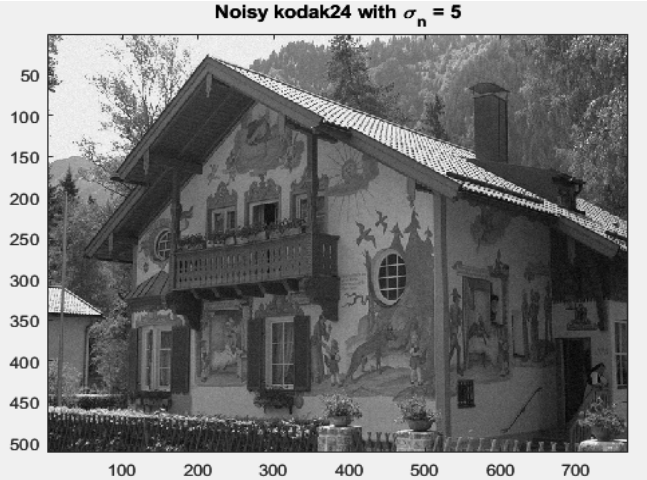
This occurs because, as the values of s and r increase, the number of local maxima in the kernel density estimate decreases, causing more pixels to converge to the same point. In the case of $s = 0.1$ and $r = 0.1$, each feature vector acts as a local maximum, so every pixel forms its own cluster point.

Additionally, we observed that convergence takes longer for higher s and r values. With fewer local maxima, pixels are farther from their destination and take longer to reach it via gradient ascent. This pattern is evident in the following Kodak images.

Kodak26:

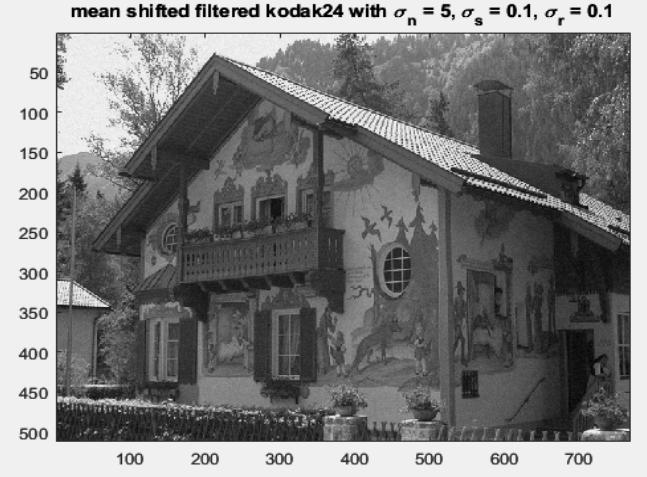


Kodak original image

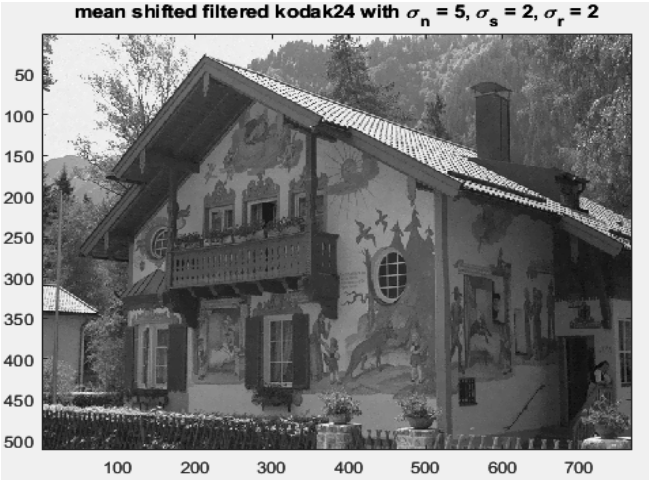


Kodak noisy image for $\sigma = 5$

Mean shift Filtering:



Filtered kodak image with $\sigma_s = 0.1,\ \sigma_r = 0.1$



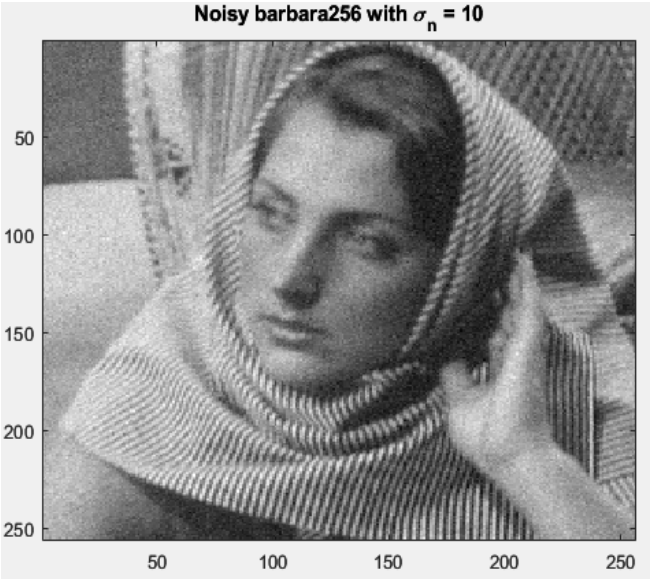
Filtered barbara image with $\sigma_s = 2,\ \sigma_r = 2$

Filtered kodak image with $\sigma_s = 3,\ \sigma_r = 15$

- For $\boldsymbol{\sigma = 10}$

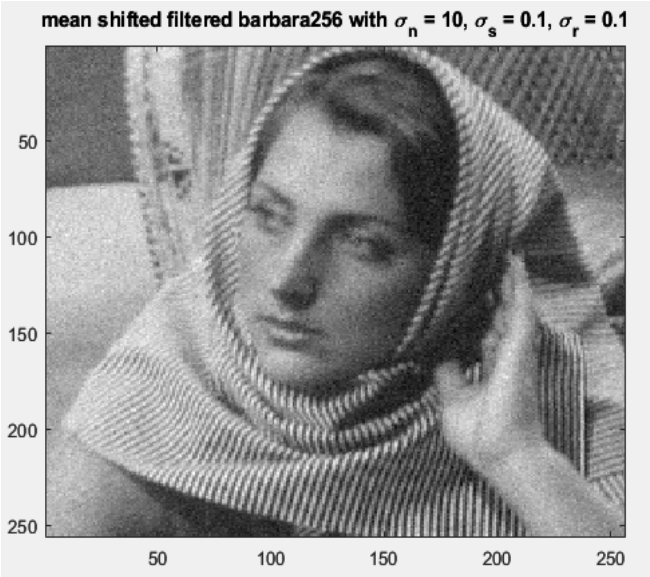
  Barbara256:

Barbara original image

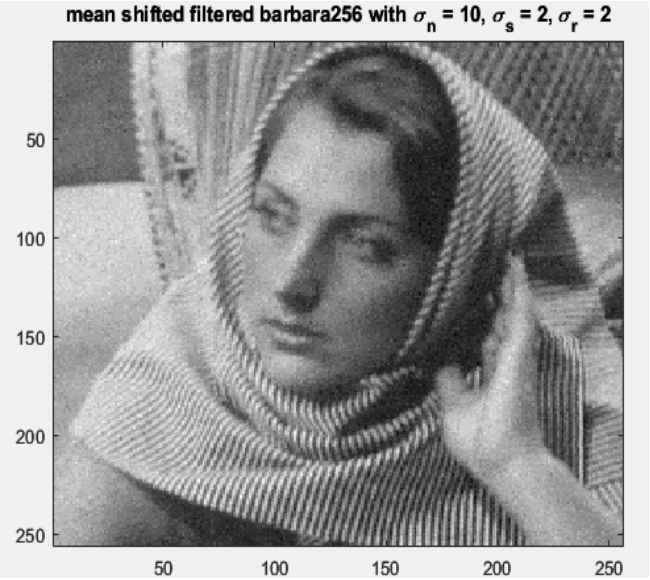


Barbara noisy image for $\sigma = 10$

Mean shift Filtering:



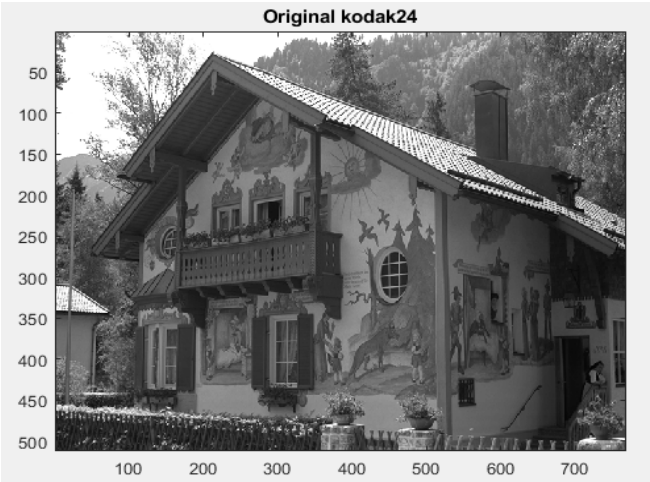
Filtered barbara image with $\sigma_s = 0.1,\ \sigma_r = 0.1$



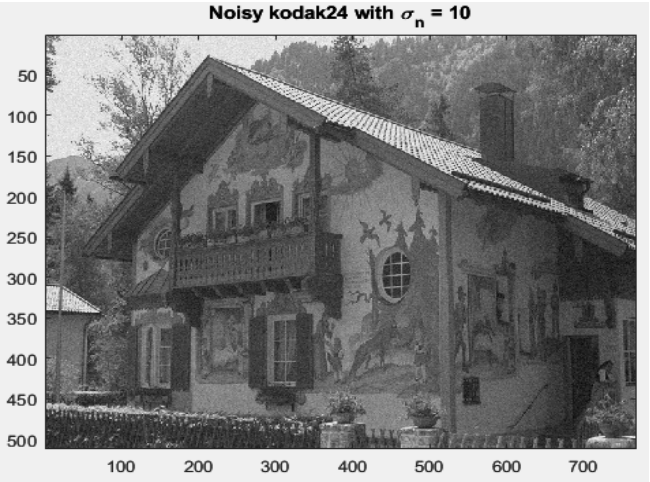
Filtered barbara image with $\sigma_s = 2,\ \sigma_r = 2$

Filtered barbara image with $\sigma_s = 3,\ \sigma_r = 15$

Kodak26:

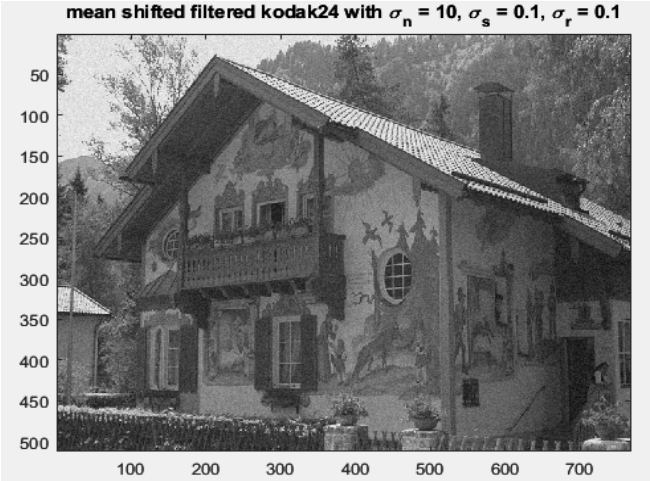


Kodak original image

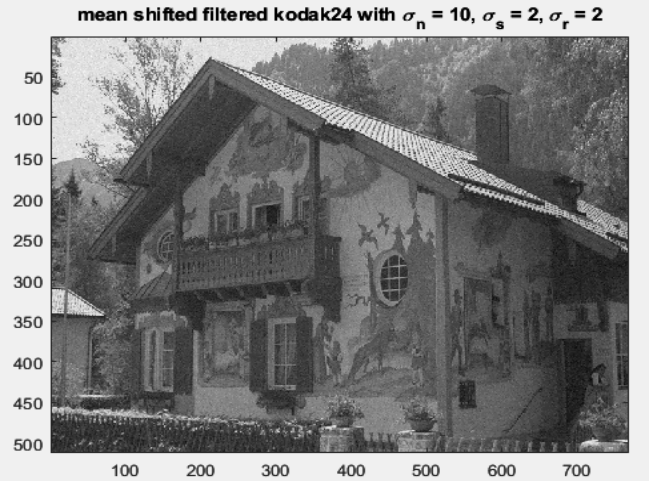


Kodak noisy image for $\sigma = 10$

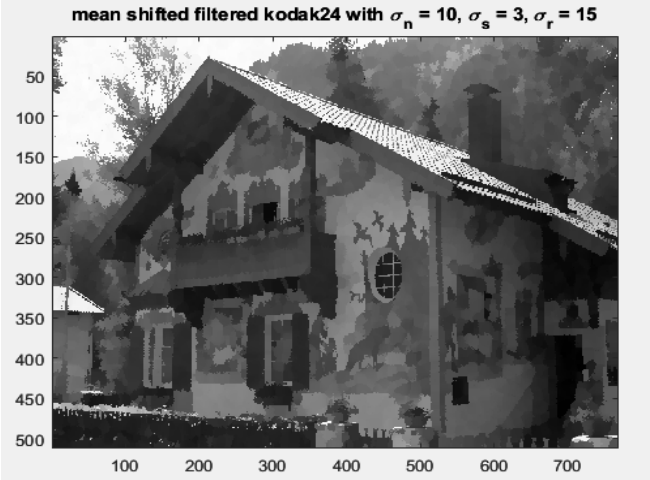
Mean shift Filtering:



Filtered kodak image with $\sigma_s = 0.1,\ \sigma_r = 0.1$



Filtered barbara image with $\sigma_s = 2,\ \sigma_r = 2$



Filtered kodak image with $\sigma_s = 3,\ \sigma_r = 15$

As the standard deviation of the Gaussian noise increases, the intensity values exhibit more error. We observed that the convergence time has decreased compared to the previous case, and the filtering effects are now more clearly noticeable.