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1 Meta images

1, 2 show the original and the noisy images that are to be fed to the bilateral filter.

As σ increases, the noise in both images increases. Since, the resolution of the Kodak image is much higher than the Barbara image, the effect of noise on the details is lesser. Hence, we expect more noise degradation in the Barbara image and this is also observed.

2 Bilateral filter on original images

3, 4 show the results of bilateral filter applied on the original Barbara and Kodak image.

As we go from left to right (increasing σ_s, σ_r), for both images, the image looks smoother but the textures get lost as is evident by focusing on the net in the background of the Barbara image, the text on the house in the Kodak image and the multi-layered window in the Kodak image. Also, some weird artifacts on the edges became more prominent like at the edges of facial features of Barbara.

3 Bilateral filter on noisy images

5, 6 show the results of bilateral filter applied on the noisy Barbara and Kodak image.

Bilateral filter of the biggest size ($\sigma_s = 3, \sigma_r = 15$) does a good job in noise removal from both the images corrupted by both kind of Gaussian noise.

We get similar results as in 2, from left to right (increasing σ_s, σ_r), for both images, smoothening increases, the textures get lost and some weird edge artifacts arise. The examples mentioned in 2 applies here too.

Note the size of the filter is such that it includes the points at most $\lceil 3\sigma_s \rceil$ away from the center point.

(a) Given image (b) Corrupted with Gaussian noise $\mu = 0, \sigma = 5$ (c) Corrupted with Gaussian noise $\mu = 0, \sigma = 10$

Figure 1: Barbara image

(a) Given image (b) Corrupted with Gaussian noise $\mu = 0, \sigma = 5$ (c) Corrupted with Gaussian noise $\mu = 0, \sigma = 10$

Figure 2: Kodak image

(a) $\sigma_s = 0.1, \sigma_r = 0.1$ (b) $\sigma_s = 2, \sigma_r = 2$ (c) $\sigma_s = 3, \sigma_r = 15$

Figure 3: Bilateral filter on original Barbara image

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(a) $\sigma_s = 0.1, \sigma_r = 0.1$ (b) $\sigma_s = 2, \sigma_r = 2$ (c) $\sigma_s = 3, \sigma_r = 15$

Figure 4: Bilateral filter on original Kodak image

(a) $\mu, \sigma = 0, 5, \sigma_s = 0.1, \sigma_r = 0.1$

(b) $\mu, \sigma = 0, 5, \sigma_s = 2, \sigma_r = 2$

(c) $\mu, \sigma = 0, 5, \sigma_s = 3, \sigma_r = 15$

(d) $\mu, \sigma = 0, 10, \sigma_s = 0.1, \sigma_r = 0.1$

(e) $\mu, \sigma = 0, 10, \sigma_s = 2, \sigma_r = 2$

(f) $\mu, \sigma = 0, 10, \sigma_s = 3, \sigma_r = 15$

Figure 5: Bilateral filter on noisy Barbara images

(a) $\mu, \sigma = 0, 5, \sigma_s = 0.1, \sigma_r = 0.1$

(b) $\mu, \sigma = 0, 5, \sigma_s = 2, \sigma_r = 2$

(c) $\mu, \sigma = 0, 5, \sigma_s = 3, \sigma_r = 15$

(d) $\mu, \sigma = 0, 10, \sigma_s = 0.1, \sigma_r = 0.1$

(e) $\mu, \sigma = 0, 10, \sigma_s = 2, \sigma_r = 2$

(f) $\mu, \sigma = 0, 10, \sigma_s = 3, \sigma_r = 15$

Figure 6: Bilateral filter on noisy Kodak images