Edge-preserving Smoothing using Bilateral Filtering

Table of Contents

Objective

- Adding gaussian noise in the image
- Applying bilateral filter to smoothen out image
- Minimize Root Mean Square Distance

Original Image and parameter

```
% Image is loaded in variable imageOrig
load '../data/barbara.mat'
imageOrig = myLinearContrastStretching(imageOrig);
[rows, cols] = size(imageOrig);
window_size = 8;
sigmaD = 2.187;
sigmaR = 22.5;
noisy_image = myGaussianNoiser(imageOrig);
gaussian_mask = noisy_image - imageOrig;
```

Generating noise and smoothening image

Window size: 9, sigmaD: 3, sigmaR: 9

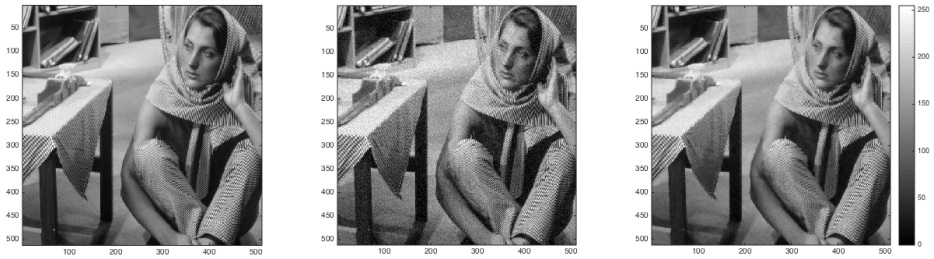
```
tic;
bilateral_filtered_image = myBilateralFiltering(noisy_image,...
    window_size, sigmaD, sigmaR);
elapsed_time = toc;
if elapsed_time > 300
    save('../images/barbara_smooth.mat', 'bilateral_filtered_image');
end
```

Smoothen Image

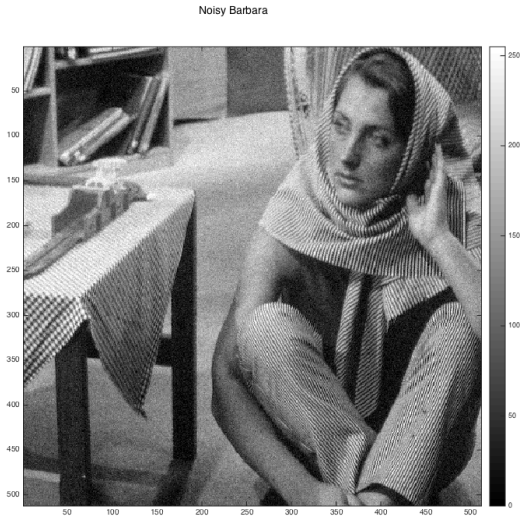
```
show_images = zeros(rows, cols, 3);
show_images(:, :, 1) = imageOrig;
show_images(:, :, 2) = noisy_image;
show_images(:, :, 3) = bilateral_filtered_image;
```

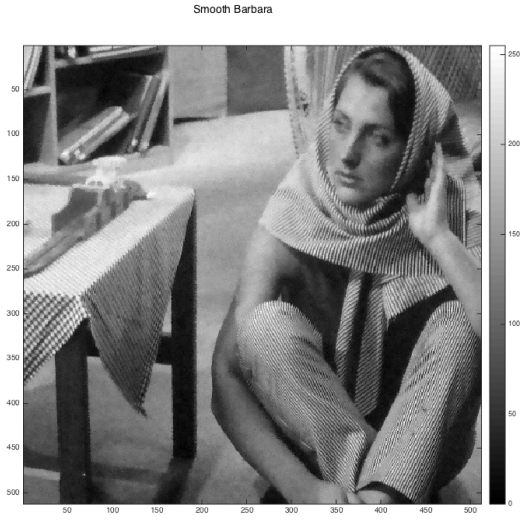
```
myShowImages(show_images,...
    'Side by Side comparison of imageOrig, noisy image and smooth image');

show_images = zeros(rows, cols, 1);
show_images(:, :, 1) = imageOrig;
myShowImages(show_images, 'Original Barbara');

show_images = zeros(rows, cols, 1);
show_images(:, :, 1) = noisy_image;
myShowImages(show_images, 'Noisy Barbara');

show_images = zeros(rows, cols, 1);
show_images(:, :, 1) = bilateral_filtered_image;
myShowImages(show_images, 'Smooth Barbara');
```

Side by Side comparison of imageOrig, noisy image and smooth image



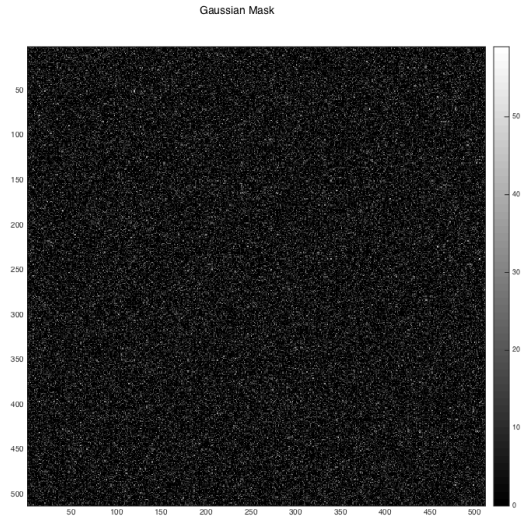
Original Barbara





Gaussian Mask

```
show_images = zeros(rows, cols, 1);
show_images(:,:,1) = gaussian_mask;
myShowImages(show_images, 'Gaussian Mask');
```



Optimal Parameters

```
rmsd_with_noised_image = myRMSDofImage(imageOrig, noisy_image);
Optimal_RMSD = myRMSDofImage(imageOrig, bilateral_filtered_image);
disp(['RMSD with noised image = ' num2str(rmsd_with_noised_image)]);
disp(['Optimal RMSD with smoothen image = ' num2str(Optimal_RMSD)]);
disp(['Optimal sigmaD = ' num2str(sigmaD)]);
disp(['Optimal sigmaR = ' num2str(sigmaR)]);
```

```
RMSD with noised image = 12.7592
Optimal RMSD with smoothen image = 8.4469
Optimal sigmaD = 2.187
Optimal sigmaR = 22.5
```

Tweaked Parameters

- 0.9 * sigmaD and sigmaR *

```
sigmaDNew = 0.9 * sigmaD;
tic;
bilateral_filtered_image_1 = myBilateralFiltering(noisy_image, window_size, sigmaD
elapsed_time = toc;
if elapsed_time > 300
    save('../images/barbara_1.mat', 'bilateral_filtered_image_1')
end
new_rmsd = myRMSDofImage(imageOrig, bilateral_filtered_image_1);
disp(['RMSD with 0.9sigmaD and sigmaR = ' num2str(new_rmsd)]);
```

```
RMSD with 0.9sigmaD and sigmaR = 8.4279
```

- 1.1 * sigmaD and sigmaR *

```
sigmaDNew = 1.1 * sigmaD;
tic;
bilateral_filtered_image_2 = myBilateralFiltering(noisy_image, window_size, sigmaD
```

```
elapsed_time = toc;
if elapsed_time > 300
    save('../images/barbara_2.mat', 'bilateral_filtered_image_2')
end
new_rmsd = myRMSDofImage(imageOrig, bilateral_filtered_image_2);
disp(['RMSD with 1.1sigmaD and sigmaR = ' num2str(new_rmsd)]);
```

```
RMSD with 1.1sigmaD and sigmaR = 8.4692
```

- sigmaD and 0.9 * sigmaR *

```
sigmaRNew = 0.9 * sigmaR;
tic;
bilateral_filtered_image_3 = myBilateralFiltering(noisy_image, window_size, sigmaD
elapsed_time = toc;
if elapsed_time > 300
    save('../images/barbara_3.mat', 'bilateral_filtered_image_3')
end
new_rmsd = myRMSDofImage(imageOrig, bilateral_filtered_image_3);
disp(['RMSD with sigmaD and 0.9sigmaR = ' num2str(new_rmsd)]);
```

```
RMSD with sigmaD and 0.9sigmaR = 8.5421
```

- sigmaD and 1.1 * sigmaR *

```
sigmaRNew = 1.1 * sigmaR;
tic;
bilateral_filtered_image_4 = myBilateralFiltering(noisy_image, window_size, sigmaD
elapsed_time = toc;
if elapsed_time > 300
    save('../images/barbara_4.mat', 'bilateral_filtered_image_4')
end
new_rmsd = myRMSDofImage(imageOrig, bilateral_filtered_image_4);
disp(['RMSD with sigmaD and 1.1sigmaR = ' num2str(new_rmsd)]);
```

```
RMSD with sigmaD and 1.1sigmaR = 8.4483
```

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