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PCA based image denoising

```
addpath('../../common/');
```

Initial Setup

```
image = imread('../data/barbara256.png');
image = double(image);
[rows, cols] = size(image);
standard_deviation = 20;
noisy_image = standard_deviation*randn(size(image)) + image;

rmsd_of_noisy_image = myRMSDofImage(image, noisy_image);
fprintf('RMSD of Noisy Image is: %.6f\n', rmsd_of_noisy_image);
```

```
RMSD of Noisy Image is: 19.898817
```

Simple PCA Denoising

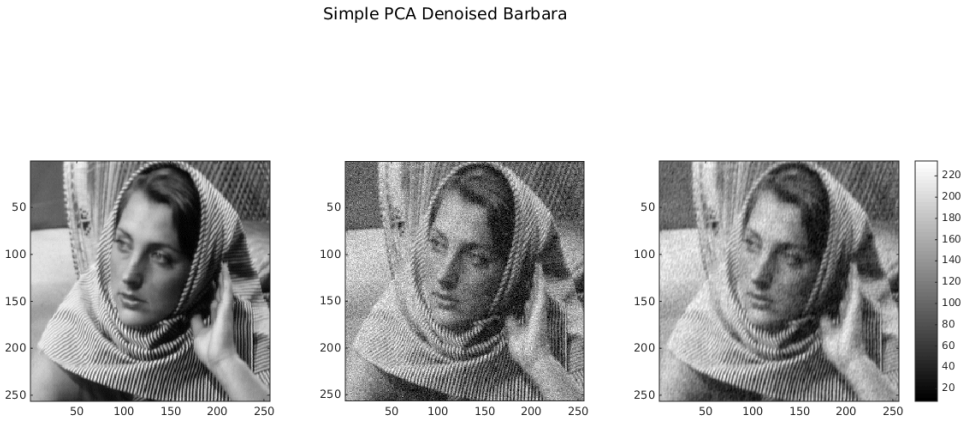
```
tic;
denoised_image = myPCADenoising1(noisy_image, [7, 7], standard_deviation);
denoised_image = reshape(denoised_image, rows, cols);
elapsed_time = toc;
if elapsed_time > 300
    save('../images/barbara_simple_pca.mat', 'denoised_image')
end

images = zeros(rows, cols, 3);
images(:, :, 1) = image;
images(:, :, 2) = noisy_image;
images(:, :, 3) = denoised_image;

myShowImages(images, 'Simple PCA Denoised Barbara');

fprintf('Time taken: %.3f\n', elapsed_time);
rmsd_of_denoised_image = myRMSDofImage(image, denoised_image);
fprintf('RMSD of Simple PCA denoised Image is: %.6f\n',...
    rmsd_of_denoised_image);
```

```
Time taken: 4.943
RMSD of Simple PCA denoised Image is: 9.827643
```



Better PCA Denoising

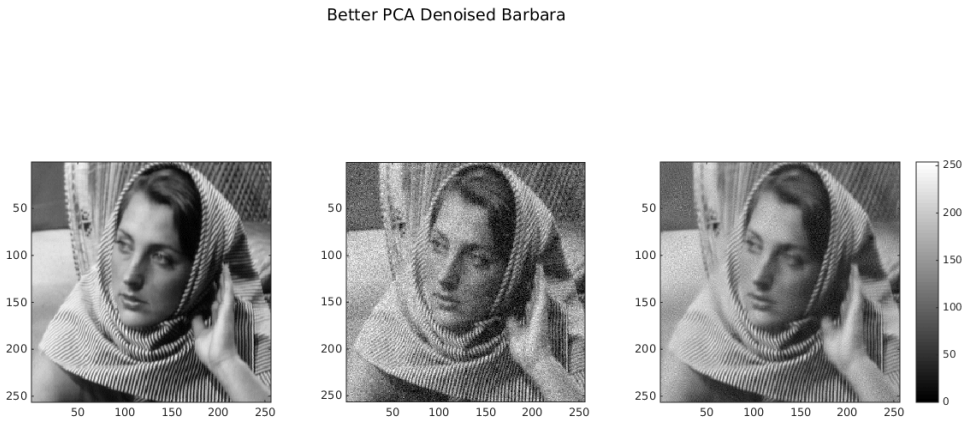
```
tic;
denoised_image = myPCADenoising2(noisy_image, [7, 7], [31, 31], 200,...
    standard_deviation);
denoised_image = reshape(denoised_image, rows, cols);
elapsed_time = toc;
if elapsed_time > 300
    save('../images/barbara_better_pca.mat', 'denoised_image')
end

images = zeros(rows, cols, 3);
images(:, :, 1) = image;
images(:, :, 2) = noisy_image;
images(:, :, 3) = denoised_image;

myShowImages(images, 'Better PCA Denoised Barbara');

fprintf('Time taken: %.3f\n', elapsed_time);
rmsd_of_denoised_image = myRMSDofImage(image, denoised_image);
fprintf('RMSD of Better PCA denoised Image is: %.6f\n',...
    rmsd_of_denoised_image);
```

```
Time taken: 1335.188
RMSD of Better PCA denoised Image is: 9.850672
```



Bilateral Filtering

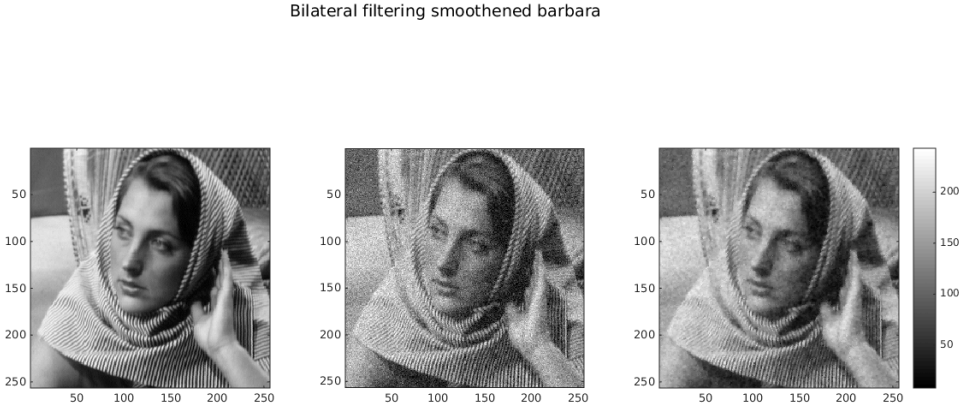
```
tic;
denoised_image = myBilateralFiltering(noisy_image, [15, 15], 1, 51.25);
elapsed_time = toc;
if elapsed_time > 300
    save('../images/barbara_bilateral.mat', 'denoised_image')
end

images = zeros(rows, cols, 3);
images(:, :, 1) = image;
images(:, :, 2) = noisy_image;
images(:, :, 3) = denoised_image;

myShowImages(images, 'Bilateral filtering smoothened barbara');

fprintf('Time taken: %.3f\n', elapsed_time);
rmsd_of_denoised_image = myRMSDofImage(image, denoised_image);
fprintf('RMSD of bilateral filtered smoothened Image is: %.6f\n',...
    rmsd_of_denoised_image);
```

```
Time taken: 9.930
RMSD of bilateral filtered smoothened Image is: 11.297491
```



Observations

- In PCA based denoising, edges are intact while in bilateral filtering edges have been smoothened
- PCA based denoised images looks more closer to original image than bilateral filtered images. This is confirmed by RMSD values as well

Difference In PCA based denoising and bilateral filtering

- While PCA based denoising tries to reconstruct image on the basis of noise type, origin and mathematical modelling of noise, bilateral filter just average out pixel values. Different noise types will require different PCAs but bilateral filter can be applied on any image
- PCA based denoising are automatic and they don't require any manual tuning unlike bilateral filtering where manual tuning is required to get best result

Published with MATLAB® R2014b