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CS 754 : Advanced Image Processing - Assignment 1

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```
clear;  
clc;
```

2 (a) Preparing Image

```
sigma = sqrt(4);  
image = double(imread('barbara256.png'));  
noise = randn(size(image))*sigma;  
image = image + noise;  
[height, width] = size(image);  
  
imshow(image/max(image, [], 'all'));  
title("Noisy image")  
hold off
```

Noisy image



2 (b) ISTA on barbara256: parameters, matrices

```
sensing_matrix = randn(32, 64);
dct_matrix = kron(dctmtx(8), dctmtx(8));
A_matrix = sensing_matrix * dct_matrix';

patch_size = 8; patch_stride = patch_size/2;
padded_height = height+2*patch_stride;
padded_width = width+2*patch_stride;
alpha = eigs(A_matrix' * A_matrix, 1) * 1.05;
lambda = 1;
epsilon = 1e-3;

padded_image = zeros(padded_height, padded_width);
padded_image(patch_stride+1:end-patch_stride, ...
    patch_stride+1:end-patch_stride) = image;
```

2 (b) ISTA on barbara256: loop over patches

```
padded_image_recon = zeros(padded_height, padded_width);

tic
for phid = 1:patch_stride:padded_height-patch_stride
    for pwid = 1:patch_stride:padded_width-patch_stride
        fprintf("x = %d, y = %d \n", phid, pwid)
        current_xi = padded_image(phid:phid+patch_size-1, ...
            pwid:pwid+patch_size-1);
        current_xi = current_xi(:);
        current_yi = sensing_matrix * current_xi;

        current_theta_i_recon = ista_reconstruction(current_yi, ...
            A_matrix, alpha, lambda, epsilon);
        current_xi_recon = dct_matrix' * current_theta_i_recon;
        current_xi_recon = reshape(current_xi_recon, patch_size, ...
            patch_size);
        curr_rrmse = norm(current_xi(:)-current_xi_recon(:)) / ...
            norm(current_xi(:))
        padded_image_recon(phid:phid+patch_size-1, ...
            pwid:pwid+patch_size-1) = padded_image_recon(phid: ...
            phid+patch_size-1, pwid:pwid+patch_size-1) + current_xi_recon;
        fid = fopen('log.txt', 'a+');
        fprintf(fid, 'x = %d y = %d \n', phid, pwid);
        fclose(fid);
    end
end
toc
```

Elapsed time is 2955.161043 seconds.

Noisy image



2 (b) ISTA on barbara256: reconstruction results

```
padded_image_recon = padded_image_recon ./ 4;  
image_recon = padded_image_recon(patch_stride+1:end-patch_stride, ...  
    patch_stride+1:end-patch_stride);  
  
imshow(image_recon/max(image_recon, [], 'all'));  
title("Reconstructed Image")  
hold off  
  
rrmse = norm(image(:)-image_recon(:)) / norm(image(:));  
rrmse
```

rrmse =

0.0732

Reconstructed Image



2 (b) ISTA on goldhill: preparation

```
clear;
clc;

sigma = sqrt(4);
image = double(imread('goldhill.png'));
image = image(1:256,1:256);
noise = randn(size(image))*sigma;
image = image + noise;
[height, width] = size(image);

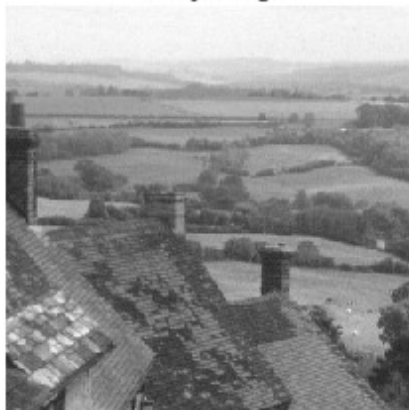
imshow(image/max(image, [], 'all'));
title("Noisy image")
hold off

sensing_matrix = randn(32, 64);
dct_matrix = kron(dctmtx(8), dctmtx(8));
A_matrix = sensing_matrix * dct_matrix';

patch_size = 8; patch_stride = patch_size/2;
padded_height = height+2*patch_stride;
padded_width = width+2*patch_stride;
alpha = eigs(A_matrix' * A_matrix, 1) * 1.05;
lambda = 1;
epsilon = 1e-3;

padded_image = zeros(padded_height, padded_width);
padded_image(patch_stride+1:end-patch_stride, ...
    patch_stride+1:end-patch_stride) = image;
padded_image_recon = zeros(padded_height, padded_width);
```

Noisy image



2 (b) ISTA on goldhill: loop over patches

```
tic
for phid = 1:patch_stride:padded_height-patch_stride
    for pwid = 1:patch_stride:padded_width-patch_stride
```

```

%       sprintf("x = %d, y = %d", phid, pwid)
current_xi = padded_image(phid:phid+patch_size-1, ...
    pwid:pwid+patch_size-1);
current_xi = current_xi(:);
current_yi = sensing_matrix * current_xi;

current_theta_i_recon = ista_reconstruction(current_yi, ...
    A_matrix, alpha, lambda, epsilon);
current_xi_recon = dct_matrix' * current_theta_i_recon;
current_xi_recon = reshape(current_xi_recon, patch_size, ...
    patch_size);
%       curr_rrmse = norm(current_xi(:)-current_xi_recon(:)) / ...
%       norm(current_xi(:))
padded_image_recon(phid:phid+patch_size-1, ...
    pwid:pwid+patch_size-1) = padded_image_recon(phid: ...
    phid+patch_size-1, pwid:pwid+patch_size-1) + current_xi_recon;
fid = fopen('log.txt', 'a+');
fprintf(fid, 'x = %d y = %d \n', phid, pwid);
fclose(fid);

end
end
toc

```

Elapsed time is 1883.123293 seconds.

2 (b) ISTA on goldhill: results

```

padded_image_recon = padded_image_recon ./ 4;
image_recon = padded_image_recon(patch_stride+1:end-patch_stride, ...
    patch_stride+1:end-patch_stride);

imshow(image_recon/max(image_recon, [], 'all'));
title("Reconstructed Image")
hold off

rrmse = norm(image(:)-image_recon(:)) / norm(image(:));
rrmse

```

rrmse =

0.0432

Reconstructed Image

