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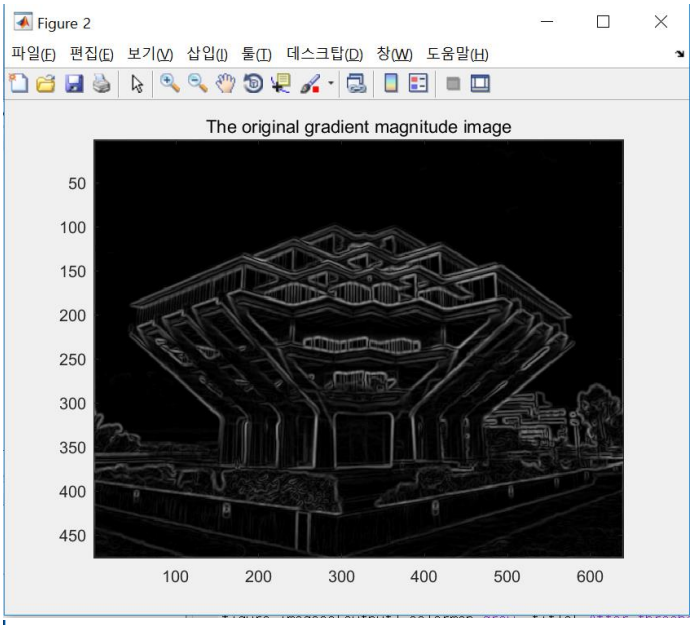
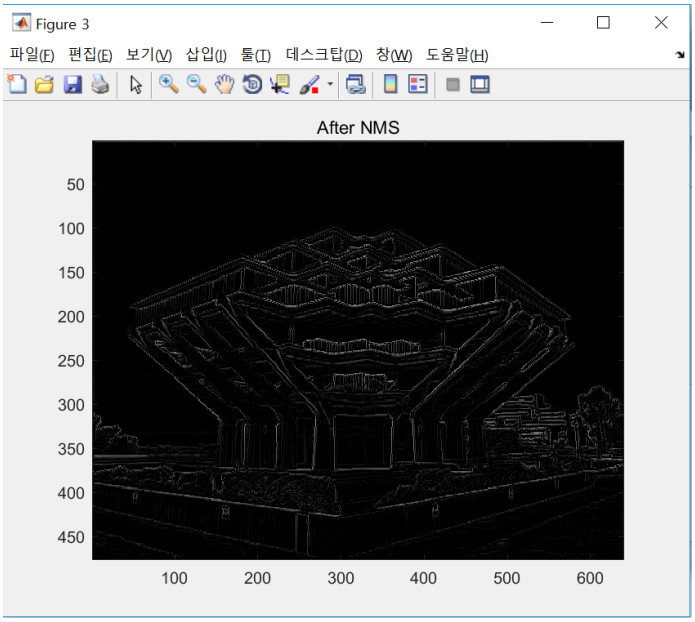
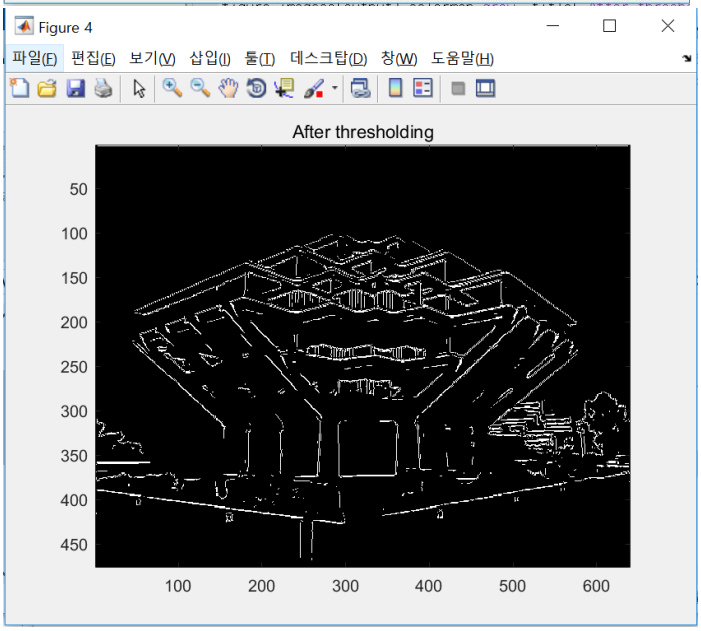
Homwork 4

Academic Integrity Policy: Integrity of scholarship is essential for an academic community. The University expects that both faculty and students will honor this principle and in so doing protect the validity of University intellectual work. For students, this means that all academic work will be done by the individual to whom it is assigned, without unauthorized aid of any kind. By including this in my report, I agree to abide by the Academic Integrity Policy mentioned above.

Problem 1







t_e = 160

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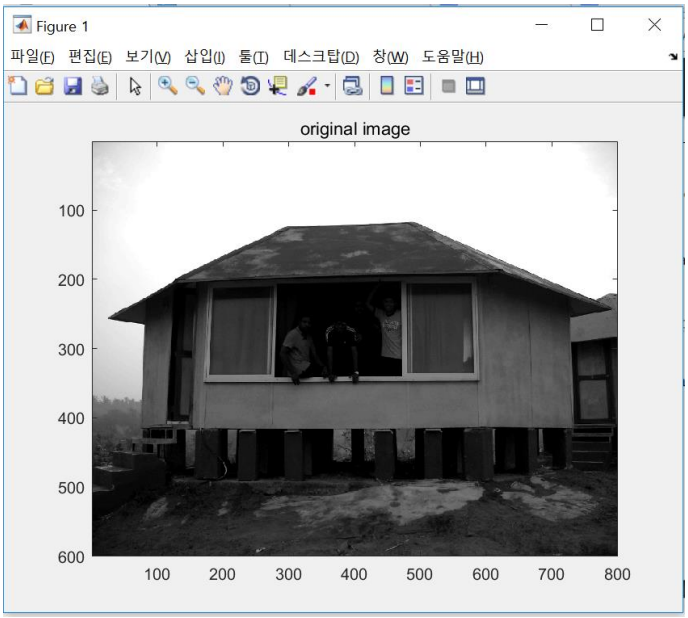
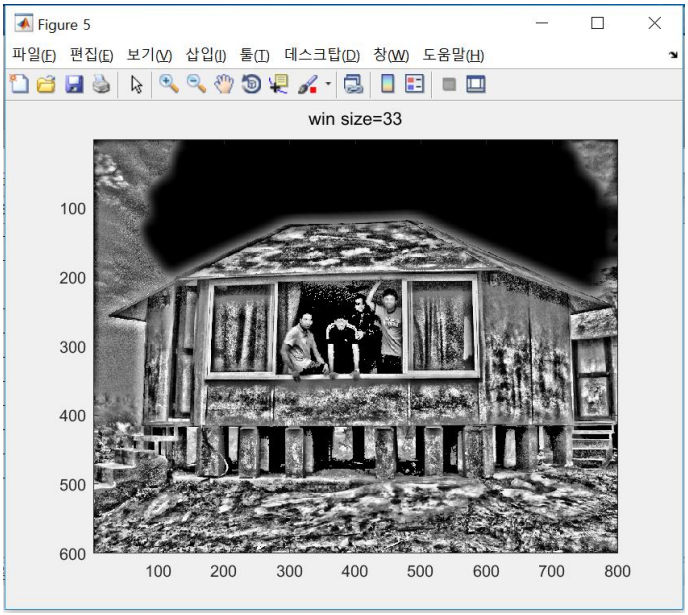
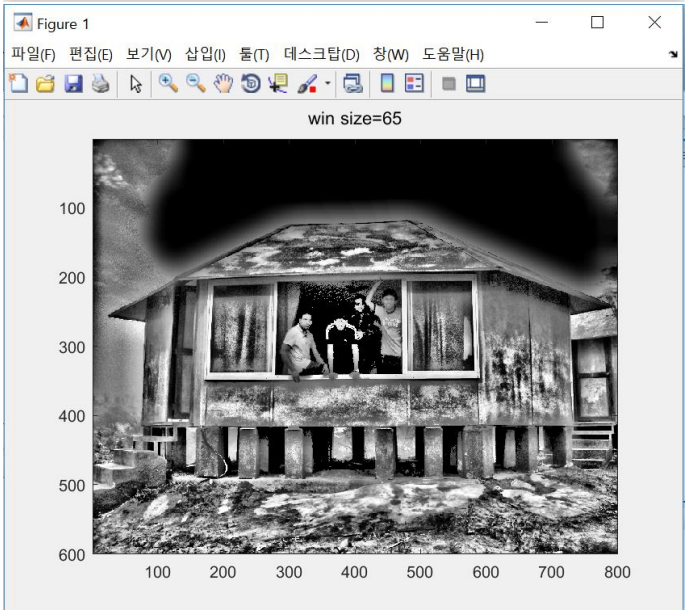
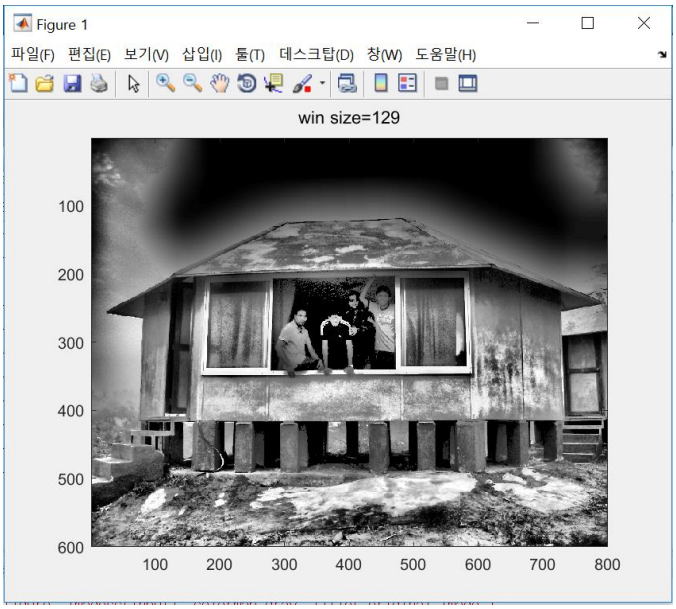
Problem 2









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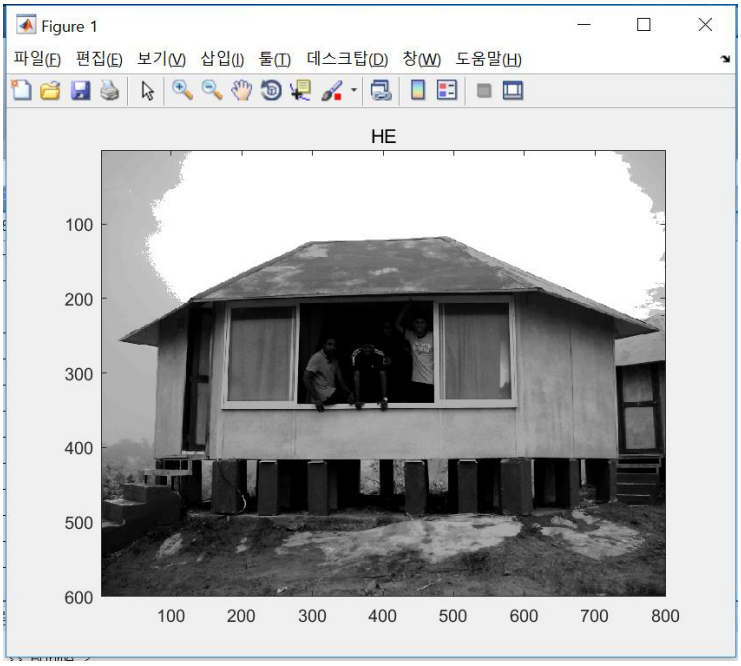

How does the original image qualitatively compare to the images after AHE and HE respectively?

In the original image, we barely see the guys and it is still hard to see them while the images after AHE show us them clearly with high contrast. But, in these images from AHE, we can also find a lot of edges and overamplified noises.

Which strategy (AHE or HE) works best for beach.png and why? Is this true for any image in general?

AHE looks more adequate for the image because in order to see people in the house we need to improve contrast by considering relative brightness of pixels within the neighborhood regions. Normal HE cannot guarantee the improvement at every part in an image.

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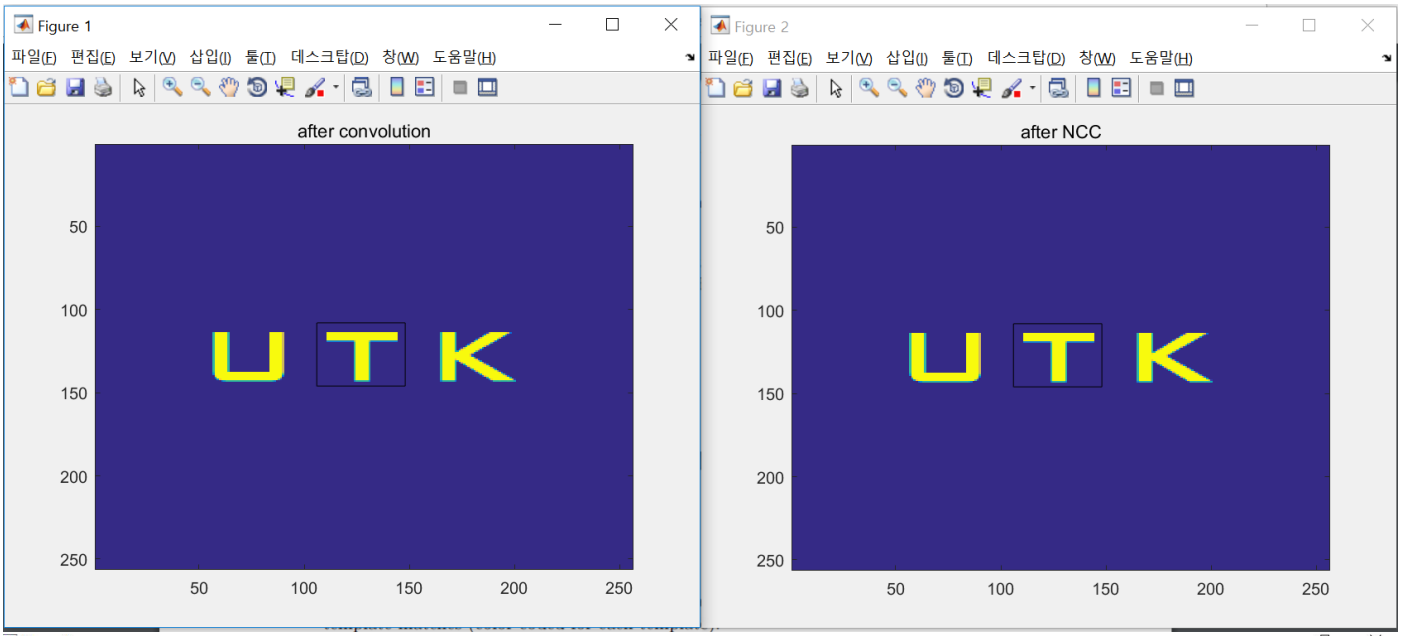
Problem 3



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**You can see the threshold that I used on the title of each figure.*

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APPENDIX

Problem 1

```
close all;
clear;
%%Run me

input = imread('geisel.jpg');
input = rgb2gray(input);
figure,imshow(input),colormap gray, title('input image')
output = cannyedge(input,160);
figure,imagesc(output),colormap gray, title('After thresholding')
```

```
function [output] = cannyedge(input, t)
%% Smoothing
input = double(input);
k=(1/159)*[2 4 5 4 2 ; 4 9 12 9 4; 5 12 15 12 5; 4 9 12 9 4; 2 4 5 4 2];
S = conv2(input,k,'same');

%% Finding gradients
k_x = [-1 0 1 ; -2 0 2 ; -1 0 1];
k_y = [-1 -2 -1 ; 0 0 0 ; 1 2 1];
G_x = conv2(S,k_x,'same');
G_y = conv2(S,k_y,'same');

G_mag = sqrt(G_x.^2 + G_y.^2);
G_theta = atan(G_y./G_x);

figure, imagesc(G_mag),colormap gray, title('The original gradient magnitude image')

%% NMS
G_theta = round(G_theta.*(180/45))*45; %round values to nearest 45 degrees

size_G = size(G_theta);
for i=1 :    size_G(1)
      for j=1 : size_G(2)
          if G_theta(i,j) == 45 || G_theta(i,j) == 225 || G_theta(i,j) == -135 || G_theta(i,j) == -215

                    if (i+1)>size_G(1) || (j-1)<1
                    A = [G_mag(i,j),G_mag(i-1,j+1)];
                    elseif (i-1)<1 || (j+1)>size_G(2)
                    A = [G_mag(i+1,j-1),G_mag(i,j)];
                    else
                    A = [G_mag(i+1,j-1),G_mag(i,j),G_mag(i-1,j+1)];
                    end

               if G_mag(i,j) ~= max(A)
                    G_mag(i,j) = 0;
               end

          elseif G_theta(i,j) == 90 || G_theta(i,j) == -90 || G_theta(i,j) == -270 || G_theta(i,j) == 270
```

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```
                    if (i-1)<1
                      A = [G_mag(i,j),G_mag(i+1,j)];
                      elseif (i+1)>size_G(1)
                      A = [G_mag(i-1,j),G_mag(i-1,j)];
                      else
                      A = [G_mag(i+1,j),G_mag(i,j),G_mag(i+1,j)];
                      end

                if G_mag(i,j) ~= max(A)
                      G_mag(i,j) = 0;
                end

          elseif G_theta(i,j) == 135 || G_theta(i,j) == -45 || G_theta(i,j) == -225 || G_theta(i,j) == 315

                    if (i-1)<1 || (j-1)<1
                      A = [G_mag(i,j),G_mag(i+1,j+1)];
                      elseif (i+1)>size_G(1) || (j+1)>size_G(2)
                      A = [G_mag(i-1,j-1),G_mag(i,j)];
                      else
                      A = [G_mag(i-1,j-1),G_mag(i,j),G_mag(i+1,j+1)];
                      end

                if G_mag(i,j) ~= max(A)
                      G_mag(i,j) = 0;
                end
          else
                      if (j-1)<1
                      A = [G_mag(i,j+1),G_mag(i,j)];
                      elseif (j+1)>size_G(2)
                      A = [G_mag(i,j),G_mag(i,j-1)];
                      else
                      A = [G_mag(i,j-1),G_mag(i,j),G_mag(i,j+1)];
                      end

                if G_mag(i,j) ~= max(A)
                      G_mag(i,j) = 0;
                end
          end
      end
end
figure, imagesc(G_mag),colormap gray, title('After NMS')

%% Thresholding
G_mag = (G_mag >= t);

%% output
output = G_mag;
end
```

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Problem 2

```
close
clear all;
%%runme
input = imread('beach.png');
figure, imagesc(input), colormap gray, title('original image')
output1 = AHE(input,33);
figure, imagesc(output1), colormap gray, title('win_ size=33')
output2 = AHE(input,65);
figure, imagesc(output2), colormap gray, title('win_ size=65')
output3 = AHE(input,129);
figure, imagesc(output3), colormap gray, title('win_ size=129')
output4 = histeq(input);
figure, imagesc(output4), colormap gray, title('HE')
```

```
function [output] = AHE(im, win_size)
pad_num = round(win_size/2)-1;
size_im = size(im);
im = padarray(im,[pad_num,pad_num],'symmetric');

for x = 1+pad_num : size_im(1)+pad_num
    for y = 1+pad_num : size_im(2)+pad_num
        rank = 0;
        contex = im(x-pad_num:x+pad_num,y-pad_num:y+pad_num);
        for i=1 : 2*pad_num+1
            for j=1 : 2*pad_num+1
                if im(x,y)>contex(i,j)
                    rank = rank + 1;
                end
            end
        end
        output(x-pad_num,y-pad_num) = rank*255/(win_size)^2;
    end
end
end
```

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Problem 3

```
%% correction by convolution
image = double(imread('Letters.jpg'));
template = double(imread('LettersTemplate.jpg'));
template = flip(flip(template),2);
result_conv = conv2(image,template);
[y, x] = find(result_conv==max(result_conv(:)));
size_tem = size(template);
figure, imagesc(image); title('after convolution');
rectangle('Position',[x-size_tem(2) y-size_tem(1) size_tem(2) size_tem(1)])

%% Normalized Cross Correlation
image = double(imread('Letters.jpg'));
template = double(imread('LettersTemplate.jpg'));
result_NCC = normxcorr2(template,image);
[y, x] = find(result_NCC==max(result_NCC(:)));
size_tem = size(template);
figure, imagesc(image); title('after NCC');
rectangle('Position',[x-size_tem(2) y-size_tem(1) size_tem(2) size_tem(1)])

%% Multiple Matches
image = imread('crowd.jpg');
image_g = double(rgb2gray(image));
template = imread('face1.jpeg');
template_g = double(rgb2gray(template));
result_NCC = normxcorr2(template_g,image_g);
[y, x] = find(result_NCC>0.60*max(result_NCC(:)));
size_tem = size(template_g);
figure, imagesc(image); title('threshold : 60% of the maximum');
for i=1 : length(x)
rectangle('Position',[x(i)-size_tem(2) y(i)-size_tem(1) size_tem(2) size_tem(1)],'EdgeColor','r',...
      'LineWidth',1);
end

%% Multiple Templates
image = imread('crowd.jpg');
image_g = double(rgb2gray(image));
template_1 = imread('face1.jpeg');
size_tem = size(template_1);
template_1 = double(rgb2gray(template_1));
result_NCC_1 = normxcorr2(template_1,image_g);
[y, x] = find(result_NCC_1>0.60*max(result_NCC_1(:)));
figure, imagesc(image); title('threshold : red(60%) blue(76%) green(80%) ');
for i=1 : length(x)
```

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```
rectangle('Position',[x(i)-size_tem(2) y(i)-size_tem(1) size_tem(2) size_tem(1)],'EdgeColor','r',...
      'LineWidth',1);
end

template_2 = imread('face2.jpeg');
template_2 = double(rgb2gray(template_2));
result_NCC_2 = normxcorr2(template_2,image_g);
[y, x] = find(result_NCC_2>0.76*max(result_NCC_2(:)));
for i=1 : length(x)
rectangle('Position',[x(i)-size_tem(2) y(i)-size_tem(1) size_tem(2) size_tem(1)],'EdgeColor','b',...
      'LineWidth',1);
end

template_3 = imread('face3.jpeg');
template_3 = double(rgb2gray(template_3));
result_NCC_3 = normxcorr2(template_3,image_g);
[y, x] = find(result_NCC_3>0.80*max(result_NCC_3(:)));
for i=1 : length(x)
rectangle('Position',[x(i)-size_tem(2) y(i)-size_tem(1) size_tem(2) size_tem(1)],'EdgeColor','g',...
      'LineWidth',1);
end
```