ΨΗΦΙΑΚΗ ΕΠΕΞΕΡΓΑΣΙΑ ΚΑΙ ΑΝΑΛΥΣΗ ΕΙΚΟΝΑΣ

ΕΡΓΑΣΤΗΡΙΑΚΗ ΑΣΚΗΣΗ

ΜΕΡΟΣ Α'

SCRIPTS

ΟΝ/ΜΟ: ΤΡΙΑΝΤΗΣ ΠΑΝΑΓΙΩΤΗΣ
ΕΤΟΣ : 5⁰
Α.Μ. : 5442

Η συνάρτηση που χρησιμοποιήθηκε για να επιτευχθεί το padding εικόνων με τη μέθοδο καθρέφτη :

padding_mirror.m

```matlab
%% synarthsh pou kanei ena epi8ymhto padding sthn eikona (gray scale)
% h synarthsh kanei padding tis idies sthles kai grammes giati auto
% xreiazotan sta plaisia ths askhshs
% input : img (eikona gia padding), lines2pad (grammes pou 8a
proste8oun
% perimetrika sthn eikona)
% output : padded_img (eikona e3odou)
function [padded_img] = padding_mirror(img,lines2pad)
% elegxos gia th "trith" diastash ths eikonas
% an einai to d megalytero apo 1 tote th kanoume rgb2gray
[x,y,d] = size(img);
if d~=1
    img = rgb2gray(img);
end
% epilogh grammwn me bash to padding pou 8eloume gia padding se
sthles
x_dim_start = img(:,1:lines2pad);
x_dim_end = img(:,y-(lines2pad-1):y);

% concatenating me thn eikona afou antistrafoun oi sthles (mirror)
padded_img_x = [fliplr(x_dim_start) img fliplr(x_dim_end)];
% arxikopoihsh endiameswn mege8wn gia na ginei padd kai stis grammes
[x_p,y_p] = size(padded_img_x);
% xrhsh idias me8odou me parapanw
y_dim_start = padded_img_x(1:lines2pad,:);
y_dim_end = padded_img_x(x_p-(lines2pad-1):x_p,:);

padded_img = [flipud(y_dim_start); padded_img_x; flipud(y_dim_end)];
end
```

erotima_1o_fft.m

```matlab
%% 1o_erotima (grammes - sthles)

close all; clear all; clc

clock = rgb2gray(im2double(imread('clock.jpg')));

[x,y] = size(clock);

% fft kata grammes(arxika) kai fft kata sthles se auto to apotelesma
me
% me xrhsh for
for i = 1:x
    fft_grammes(i,:) = fft(clock(i,:));
end
for j = 1:y
    fft_sthles(:,j) = fft(fft_grammes(:,j));
end

clock_new = fft_sthles ;
```

```matlab
% shift sta epimerous kommatia ths eikonas opws ypodeiknyetai (ta
floor kai
% ceil xrhsimopoih8hkan giati den eixame tetragwnisei thn eikona
fst_q = clock_new(1:floor(x/2),1:floor(y/2));
scd_q = clock_new(1:floor(x/2),ceil(y/2):y);
thd_q = clock_new(ceil(x/2):x,1:floor(y/2));
fth_q = clock_new(ceil(x/2):x,ceil(y/2):y);


% synenwsh twn epimerous kommatiwn
clock_new = [fth_q thd_q; scd_q fst_q];
% parousiash (edw xrhsimopoih8hkan kapoies metablhtes gia na
emfanistei to
% apotelesma, p.x sth grammikh apeikonish /100, sth logari8mikh log2
kai
% log10 plhn mia mikrh sta8era)
figure,subplot(1,3,1),imshow(clock),title('clock')
subplot(1,3,2),imshow(abs(clock_new)/100),title('FFT - linear')
subplot(1,3,3),imshow(log2(log10(abs(clock_new))-0.1)),title('FFT -
logarithmic')
```

erotima_1o_pinakasDFT.m

```matlab
%% 1o_erotima (pinakas DFT)

close all; clear all; clc

clock = rgb2gray(im2double(imread('clock.jpg')));


[x,y] = size(clock);

% checking dimensions
if x == y
    W = zeros(x);
    glo_var = x;
elseif x > y
    clock = imresize(clock,[x,x]);
    W = zeros(x);
    glo_var = x;
elseif y > x
    clock = imresize(clock,[y,y]);
    W = zeros(y);
    glo_var = y;
end


% ypologismos ths arxikhs grammhs omega
for i = 1:glo_var
    omega(1,i) = exp((-2*pi*1i/glo_var)*(i-1));
end


% ypswnontas to omega sthn i-1 epitygxanetai h morfh toy mhtrwou pou
% zhteitai
for i = 1:glo_var
    W(i,:) = omega.^(i-1);
end


% kanonikopoihsh tou W diairontas me to sqrt(N)
W = (1/sqrt(glo_var))*W;
```

```matlab
clock_new = W*clock*W';

% shift sta epimerous kommatia ths eikonas opws ypodeiknyetai
fst_q = clock_new(1:floor(glo_var/2),1:floor(glo_var/2));
scd_q = clock_new(1:floor(glo_var/2),ceil(glo_var/2):glo_var);
thd_q = clock_new(ceil(glo_var/2):glo_var,1:floor(glo_var/2));
fth_q = clock_new(ceil(glo_var/2):glo_var,ceil(glo_var/2):glo_var);

% synenwsh twn kommatiwn
clock_new = [fth_q thd_q; scd_q fst_q];

% emfanish apotelesmatwn
figure,subplot(1,3,1),subimage(abs(clock)),title('clock')
subplot(1,3,2),subimage(abs(clock_new)),title('DFT - linear')
subplot(1,3,3),subimage(log10(10*abs(clock_new))),title('DFT -
logarithmic')
```

erotima_2o.m

```matlab
%% 2o_erotima apotelesmata gia 4 & 6 epipeda kvantishs se ka8e xrwma

close all; clear all; clc

peppers = imread('pepper.jpg');

L_4 = 4;
L_6 = 6;

peppers_4_lvls = img_quant(peppers,L_4,L_4,L_4);

peppers_6_lvls = img_quant(peppers,L_6,L_6,L_6);

%% SNR
% afairontas apo thn arxikh eikona th kvantismenh briskoume to 8orybo
noise_4_lvls = peppers - peppers_4_lvls;

noise_6_lvls = peppers - peppers_6_lvls;

% briskoume thn isxy tou shmatos (eikonas) kai twn 8oryvwn
power_pepp = sum(abs(peppers(:).^2))/length(peppers(:));

power_n_4 = sum(abs(noise_4_lvls(:).^2))/length(noise_4_lvls(:));

power_n_6 = sum(abs(noise_6_lvls(:).^2))/length(noise_6_lvls(:));

% ypologismos tou SNR kvantismenwn eikonwn
SNR_4 = 10*log10(power_pepp/power_n_4);

SNR_6 = 10*log10(power_pepp/power_n_6);

%% figures
% panw sth kvantimsenh eikona anagrafetai kai to SNR me akriveia 3
pshfiwn
str_4 = sprintf('4 level, SNR: %.3f',SNR_4);
str_6 = sprintf('6 level, SNR: %.3f',SNR_6);
subplot(1,3,1),subimage(peppers),title('arxikh')
```

```matlab
    subplot(1,3,2),subimage(peppers_4_lvls),title(str_4)
    subplot(1,3,3),subimage(peppers_6_lvls),title(str_6)
```

img_quant.m

```matlab
%% synarthsh kvantismou egxrwmhs (rgb) eikonas
% output: quantized_img(kvantismenh eikona)
% input: rgb_img(eikona pros kvantish)
% L1 -> epipeda kvantishs sto red
% L2 -> epipeda kvantishs sto green
% L3 -> epipeda kvantishs sto blue

function [quantized_img] = img_quant(rgb_img,L1,L2,L3)
% arxikopoihsh mege8wn
[x,y,f] = size(rgb_img);

for i = 1:f
    if i == 1
        epipeda = L1;
        fprintf('quantization on red scale');
    elseif i == 2
        epipeda = L2;
        fprintf('quantization on green scale');
    elseif i == 3
        epipeda = L3;
        fprintf('quantization on blue scale');
    end
    % dhmiourgia cell pou exei to red, green, blue se 3exwristous
pinakes
    im{i} = rgb_img(:,:,i);
    % metatroph se dianysma
    im2 = im{i}(:);
    % metatroph tou megistou se double gia na mporesoume na
epe3ergastoume
    % kai na kanoume pra3eis
    x_max = double(max(im{i}(:)));
    % to idio kai gia to min
    x_min = double(min(im{i}(:)));
    % briskoume to bhma kvantishs
    D = ((x_max-x_min)/(epipeda));
    % loop gia ypologismo twn akrwn sth kvantish to prwto einai iso
me to
    % min
    a(1) = x_min;
    for j = 1:epipeda+1
        a(j) = uint8((j-1)*D);
    end
    % provolh dianysmatos akrwn sto workspace
    display(a)
    % euresh kentrwn
    for m = 1:epipeda
        centers(m)=(a(m)+a(m+1))/2;
    end
    % provolh kentrwn sto ws
    display(centers)
    % edw ginetai h kvantish trexontas to pinaka san dianysma pou to
    % metatrepsame parapanw
    xlen = length(im2);
    for n = 1:xlen
```

```matlab
        % dhmiourgia flag gia thn while kai enos metrhth kl pou
kineitai
        % mesa sto dianysma pou periexei ta akra gia th kvantish kai
meta
        % epe3ergazomaste to ka8e stoixeio
        flag = true;
        kl = 1;
        while(flag)
            % kvantish twn stoixeiwn analogws me th timh ths
syxnothtas
            % tous
            if(im2(n) <= a(kl+1))&& (im2(n) <= centers(kl))
                quantized{i}(n) = uint8(a(kl));
                flag = false;
            elseif (im2(n) <= a(kl+1))&& (im2(n) >= centers(kl))
                quantized{i}(n) = uint8(a(kl+1));
                flag = false;
            else
                kl = kl+1;
            end
        end
    end
end
% enwsh twn rgb se mia eikona kai metasxhmatismos stis diastaseis ths
% arxikhs eikonas
quantized_img = [quantized{1} quantized{2} quantized{3}];
quantized_img = reshape(quantized_img,x,y,f);
end
```

erotima_3o.m

```matlab
%% 3o_erotima - anixneush akmwn

close all; clear all; clc

factory = rgb2gray(im2double(imread('factory.jpg')));
% mirror padding gia efarmogh tou para8yrou se ola ta pixel
factory = padding_mirror(factory,1);
% arxikopoihsh mege8wn
[x,y,~] = size(factory);

% dhmiourgia maskwn pou exoun didax8ei sto ma8hma
Sobel_G_x = [-1 0 1; -2 0 2; -1 0 1];
Sobel_G_y = Sobel_G_x';
Sobel_diag_1 = [0 1 2; -1 0 1; -2 -1 0];
Sobel_diag_2 = Sobel_diag_1';
Prewitt_G_x = [-1 0 1; -1 0 1; -1 0 1];
Prewitt_G_y = Prewitt_G_x';
Prewitt_diag_1 = [0 1 1; -1 0 1; -1 -1 0];
Prewitt_diag_2 = Prewitt_diag_1';

% euresh 2 katwfliwn gia thn apeikonish twn akmwn me bash th mesh
timh twn
% syxnothtwn ths eikonas (ena katwfli gia iso me th mesh timh kai ena
iso
% me th 3/2 ths meshs timhs)
T = mean(factory(:));
oliko = T;
oliko1 = 3*T/2;
```

```matlab
% efarmozetai didiastath syneli3h toy para8yrou pou kineitai mesa
sthn
% eikona me tis maskes kai meta ginetai epilogh ths megalyterhs
e3odou
% autwn twn maskwn
for i = 2:x-1
    fprintf('eimaste sth grammh: %d\n',i);
    for i1 = 2:y-1
        A = factory(i-1:i+1,i1-1:i1+1);
%         t = mean(A(:));
%         topiko = 5*t/4;
        sobel_x = conv2(A,Sobel_G_x,'same');
        sobel_y = conv2(A,Sobel_G_y,'same');
        sobel_diag_1 = conv2(A,Sobel_diag_1,'same');
        sobel_diag_2 = conv2(A,Sobel_diag_2,'same');
        prewitt_x = conv2(A,Prewitt_G_x,'same');
        prewitt_y = conv2(A,Prewitt_G_y,'same');
        prewitt_diag_1 = conv2(A,Prewitt_diag_1,'same');
        prewitt_diag_2 = conv2(A,Prewitt_diag_2,'same');
        sobel(i-1,i1-1) =
max([(abs(sobel_x(2,2))),(abs(sobel_y(2,2))),...
            abs(sobel_diag_1(2,2)),abs(sobel_diag_2(2,2))]);
        prewitt(i-1,i1-1) = max([(abs(prewitt_x(2,2))),...
            (abs(prewitt_y(2,2))),abs(prewitt_diag_1(2,2)),...
            abs(prewitt_diag_2(2,2))]);
        % dhmiourgia twn katwfliomenwn eikonwn
        if sobel(i-1,i1-1) >= oliko
            sobel_katwfli_oliko(i-1,i1-1) = 1;
        else sobel_katwfli_oliko(i-1,i1-1) = 0;
        end
        if prewitt(i-1,i1-1) >= oliko
            prewitt_katwfli_oliko(i-1,i1-1) = 1;
        else prewitt_katwfli_oliko(i-1,i1-1) = 0;
        end
        if sobel(i-1,i1-1) >= oliko1
            sobel_katwfli_oliko1(i-1,i1-1) = 1;
        else sobel_katwfli_oliko1(i-1,i1-1) = 0;
        end
        if prewitt(i-1,i1-1) >= oliko1
            prewitt_katwfli_oliko1(i-1,i1-1) = 1;
        else prewitt_katwfli_oliko1(i-1,i1-1) = 0;
        end
    end
end


%% parousiash twn eikonwn

figure
subplot(2,2,1),subimage(factory),title('arxikh')
subplot(2,2,2),subimage((sobel)),title('sobel')
subplot(2,2,3),subimage((sobel_katwfli_oliko)),title('sobel oliko 1')
subplot(2,2,4),subimage((sobel_katwfli_oliko1)),title('sobel oliko
2')
figure
subplot(2,2,1),subimage(factory),title('arxikh')
subplot(2,2,2),subimage((prewitt)),title('prewitt')
subplot(2,2,3),subimage((prewitt_katwfli_oliko)),title('prewitt oliko
1')
subplot(2,2,4),subimage((prewitt_katwfli_oliko1)),title('prewitt
oliko 2')
```

erotima_4o_A.m

```matlab
%% 4o_erotima_A
% dhmioyrgoyntai oi eikones me padding antikatoptrismou twn akrwn
tous
% me para8yra efarmoghs tou median 3x3 kai 5x5

close all; clear all; clc

% building
building = im2double(imread('building.jpg'));
building_3x3 = padding_mirror(building,1);
building_5x5 = padding_mirror(building,2);

% train
train = im2double(imread('train.jpg'));
train_3x3 = padding_mirror(train,1);
train_5x5 = padding_mirror(train,2);

% arxikopoihsh twn mege8wn twn (padded) eikonwn
[x_b3,y_b3] = size(building_3x3);
[x_t3,y_t3] = size(train_3x3);

[x_b5,y_b5] = size(building_5x5);
[x_t5,y_t5] = size(train_5x5);

% pragmatopoihsh tou kwdika gia to median

% building me window 3x3
for i = 2:x_b3-1
    fprintf('building - eimaste sth grammh: %d\n',i);
    for i1 = 2:y_b3-1
        A3 = building_3x3(i-1:i+1,i1-1:i1+1);
        filt_A3 = reshape(sort(A3(:)),3,3);
        building_3x3_n(i-1,i1-1) = filt_A3(2,2);
    end
end
building_n3 = building_3x3_n;

% train me window 3x3
for i = 2:x_t3-1
    fprintf('train - eimaste sth grammh: %d\n',i);
    for i1 = 2:y_t3-1
        B3 = train_3x3(i-1:i+1,i1-1:i1+1);
        filt_B3 = reshape(sort(B3(:)),3,3);
        train_3x3_n(i-1,i1-1) = filt_B3(2,2);
    end
end
train_n3 = train_3x3_n;

% building me window 5x5
for i = 3:x_b5-2
    fprintf('building - eimaste sth grammh: %d\n',i);
    for i1 = 3:y_b5-2
        A5 = building_5x5(i-2:i+2,i1-2:i1+2);
        filt_A5 = reshape(sort(A5(:)),5,5);
        building_5x5_n(i-2,i1-2) = filt_A5(3,3);
    end
end
```

```matlab
building_n5 = building_5x5_n;

% train me window 5x5
for i = 3:x_t5-2
    fprintf('train - eimaste sth grammh: %d\n',i);
    for i1 = 3:y_t5-2
        B5 = train_5x5(i-2:i+2,i1-2:i1+2);
        filt_B5 = reshape(sort(B5(:)),5,5);
        train_5x5_n(i-2,i1-2) = filt_B5(3,3);
    end
end
train_n5 = train_5x5_n;

figure,subplot(1,3,1),imshow(building),title('arxikh')
subplot(1,3,2),imshow(building_n3),title('3x3')
subplot(1,3,3),imshow(building_n5),title('5x5')
%figure, imshow(building_n5)
figure,subplot(1,3,1),imshow(train),title('arxikh')
subplot(1,3,2),imshow(train_n3),title('3x3')
subplot(1,3,3),imshow(train_n5),title('5x5')
%figure, imshow(train_n5)
```

erotima_4o_B.m

```matlab
%% 4o_erotima B
% padding twn eikonwn me th me8odo antikatoptrismou twn akrwn tous

close all; clear all; clc
building = im2double(imread('building.jpg'));
building_5x5 = padding_mirror(building,2);

train = im2double(imread('train.jpg'));
train_5x5 = padding_mirror(train,2);

% arxikopoihsh mege8wn
[x_b5,y_b5] = size(building_5x5);
[x_t5,y_t5] = size(train_5x5);

% dhmiourgia tou pinaka pou mas dothike
filt = [0 1 1 1 0];
filt = [filt; filt+1; filt+1; filt+1; filt];
filt(3,3) = 2*filt(3,3);
% metatroph tou se dianysma gia na efarmostei sth synexeia me vash th
% me8odo pou akolou8oume
filt = filt(:);

for i = 3:x_b5-2
    fprintf('building - eimaste sth grammh: %d\n',i);
    for i1 = 3:y_b5-2
        % dialegoume apo thn eikona ena para8yro 5x5
        A5 = building_5x5(i-2:i+2,i1-2:i1+2);
        % to kanoume dianysma
        A5 = A5(:);
        % arxikopoioume ena dianysma gia na apo8hkeusoume ta stoixeia
meta
        % thn efarmogh ths me8odou wste na diale3oume to katallhlo
        n = [];
        % ousiastika epanalamvanoyme ta stoixeia tou 5x5 para8yrou
gia oses
```

```matlab
        % 8eseis ypodeikyei to filtro mas
        for j = 1:length(A5)
            rep(j,1) = A5(j);
            num = numel(n);
            n(num+1:num+filt(j)) = rep(j,1);
        end
        % sort tou dianysmatos
        n = sort(n);
        % epilogh tou mesaiou stoixeiou tou dianysmatos, sth
periptwsh mas
        % h if xreiazetai mono to prwto meros afou to sum tou filtrou
einai
        % iso me 32 ara epilegoume to (16o+17o)/2 alliws an to sum
htan
        % monos ari8mos 8a epilegotan to (((sum-1)/2) + 1)
        if rem(length(n),2) == 0
            building_5x5_n(i-2,i1-2) =
(n(floor(length(n)/2))+n(ceil(length(n)/2)))/2;
        elseif rem(length(n),2)~=0
            building_5x5_n(i-2,i1-2) = n(ceil(length(n)/2));
        end
    end
end

% akolou8eitai h idia diadikasia me parapanw
for i = 3:x_t5-2
    fprintf('train - eimaste sth grammh: %d\n',i);
    for i1 = 3:y_t5-2
        B5 = train_5x5(i-2:i+2,i1-2:i1+2);
        B5 = B5(:);
        n = [];
        for j = 1:length(B5)
            rep(j,1) = B5(j);
            num = numel(n);
            n(num+1:num+filt(j)) = rep(j,1);
        end
        n = sort(n);
        if rem(length(n),2) == 0
            train_5x5_n(i-2,i1-2) =
(n(floor(length(n)/2))+n(ceil(length(n)/2)))/2;
        elseif rem(length(n),2)~=0
            train_5x5_n(i-2,i1-2) = n(ceil(length(n)/2));
        end
    end
end

figure,subplot(1,2,1),imshow(building),title('arxikh')
subplot(1,2,2),imshow(building_5x5_n),title('5x5 me varh')
figure,subplot(1,2,1),imshow(train),title('arxikh')
subplot(1,2,2),imshow(train_5x5_n),title('5x5 me varh')
```

erotima_5o_A.m

```matlab
%% 5o_erotima A meros - emfanish istogrammatwn twn eikonwn

close all; clear all; clc

d_road_1 = ((imread('dark_road_1.jpg')));
d_road_2 = ((imread('dark_road_2.jpg')));
```

```matlab
d_road_3 = ((imread('dark_road_3.jpg')));
% dhmiourgia enos hist matrix to opoio periexei tis times 0...255 sth
prwth
% sthlh kai stis ypoloipes 8a periexei poses fores yparxei ka8e
syxnothta
% apo 0...255 se ka8e mia apo tis treis eikones
hist_mat = zeros(256,4);
hist_mat(:,1) = (0:1:255)';
% metatroph twn eikonwn se dianysmata
dr1_vec = d_road_1(:);
dr2_vec = d_road_2(:);
dr3_vec = d_road_3(:);
% metrhsh emfanishs syxnothtwn twn eikonwn
for i = 1:1:length(dr1_vec)
    timh = double(dr1_vec(i,1));
    timh1 = double(dr2_vec(i,1));
    hist_mat(timh+1,2) = hist_mat(timh+1,2) + 1;
    hist_mat(timh1+1,3) = hist_mat(timh1+1,3) +1;
end
% gia th trith eikona
for i = 1:1:length(dr3_vec)
    timh = double(dr3_vec(i,1));
    hist_mat(timh+1,4) = hist_mat(timh+1,4)+1;
end
% emfanish istogrammatwn me xrhsh bar
figure,bar(hist_mat(:,1),hist_mat(:,2)),title('dark road 1')
figure,bar(hist_mat(:,1),hist_mat(:,3)),title('dark road 2')
figure,bar(hist_mat(:,1),hist_mat(:,4)),title('dark road 3')
```

erotima_5o_B.m

```matlab
%% 5o_erotima B meros - olikh e3iswsh istogrammatos

close all; clear all; clc

d_road_1 = ((imread('dark_road_1.jpg')));
d_road_2 = ((imread('dark_road_2.jpg')));
d_road_3 = ((imread('dark_road_3.jpg')));
% dhmiourgia enos hist matrix to opoio periexei tis times 0...255 sth
prwth
% sthlh kai stis ypoloipes 8a periexei poses fores yparxei ka8e
syxnothta
% apo 0...255 se ka8e mia apo tis treis eikones
hist_mat = zeros(256,4);
hist_mat(:,1) = (0:1:255)';
% metatroph ywn eikonwn se dianysmata
dr1_vec = d_road_1(:);
dr2_vec = d_road_2(:);
dr3_vec = d_road_3(:);
% gia tis 2 prwtes xrhsimopoieitai ena loop, gia na metrhsoume thn
emfanish
% kaue syxnothtas, giati exoun to idio mege9os
for i = 1:1:length(dr1_vec)
    timh = double(dr1_vec(i,1));
    timh1 = double(dr2_vec(i,1));
    hist_mat(timh+1,2) = hist_mat(timh+1,2) + 1;
    hist_mat(timh1+1,3) = hist_mat(timh1+1,3) +1;
end
% h trith eikona
```

```matlab
for i = 1:1:length(dr3_vec)
    timh = double(dr3_vec(i,1));
    hist_mat(timh+1,4) = hist_mat(timh+1,4)+1;
end
% edw ypologizontai oi pi8anothtes emfanishs
dr1 = hist_mat(:,2)./length(dr1_vec);
dr2 = hist_mat(:,3)./length(dr2_vec);
dr3 = hist_mat(:,4)./length(dr3_vec);
% edw ypologizetai to cumsum gia tis pi8anothtes emfanishs syxnothtas
kai
% gia tis 3 eikones
for i = 1:256
    cs1(i,1) = sum(dr1(1:i));
    cs2(i,1) = sum(dr2(1:i));
    cs3(i,1) = sum(dr3(1:i));
end
% edw ypologizontai oi nees syxnothtes me vash to cumsum ths
% ka8e eikonas kai ginetai metatroph pali se uint8
for i = 1:length(dr1_vec)
    timh = double(dr1_vec(i,1));
    timh1 = double(dr2_vec(i,1));
    dr1_vec_n(i,1) = uint8(floor(255*cs1(timh+1,1)));
    dr2_vec_n(i,1) = uint8(floor(255*cs2(timh1+1,1)));
end
dr1_vec_n = reshape(dr1_vec_n,450,800);
dr2_vec_n = reshape(dr2_vec_n,450,800);
% to idio me th for panw (edw ginetai gia th trith eikona)
for i = 1:length(dr3_vec)
    timh = double(dr3_vec(i,1));
    dr3_vec_n(i,1) = uint8(floor(255*cs3(timh+1,1)));
end
dr3_vec_n = reshape(dr3_vec_n,480,640);
%% ta figure mas gia ta apotelesmata me emfanish twn istogrammatwn
figure
subplot(2,2,1),subimage(d_road_1),title('arxikh')
subplot(2,2,2),subimage(dr1_vec_n),title('meta thn e3iswsh')
subplot(2,2,3),imhist(d_road_1(:)),title('arxiko hist')
subplot(2,2,4),imhist(dr1_vec_n(:)),title('teliko hist')
figure
subplot(2,2,1),subimage(d_road_2),title('arxikh')
subplot(2,2,2),subimage(dr2_vec_n),title('meta thn e3iswsh')
subplot(2,2,3),imhist(d_road_2(:)),title('arxiko hist')
subplot(2,2,4),imhist(dr2_vec_n(:)),title('teliko hist')
figure
subplot(2,2,1),subimage(d_road_3),title('arxikh')
subplot(2,2,2),subimage(dr3_vec_n),title('meta thn e3iswsh')
subplot(2,2,3),imhist(d_road_3(:)),title('arxiko hist')
subplot(2,2,4),imhist(dr3_vec_n(:)),title('teliko hist')
```

erotima_5o_C.m

```matlab
%% 5o_erotima_C

% efarmogh ths e3iswshs istogrammatos topika sthn eikona
close all; clear all; clc
% metablhtes pou ry8mizoun to para8yro kai to padding pou 8a
xreiastei gia
% to para8yro pou 8a xrhsimopoih8ei wste na automatopoieitai h
diadikasia
```

```matlab
para8yro = 71;
orio = floor(para8yro/2);

d_road_1 = (im2double(imread('dark_road_1.jpg')));
d_road_2 = (im2double(imread('dark_road_2.jpg')));
d_road_3 = (im2double(imread('dark_road_3.jpg')));

% padding me th synarthsh mas gia reflection-mirror padding
d_road_1 = padding_mirror(d_road_1,orio);
d_road_2 = padding_mirror(d_road_2,orio);
d_road_3 = padding_mirror(d_road_3,orio);

% arxikopoihsh mege8wn
[x1,y1] = size(d_road_1);
[x3,y3] = size(d_road_3);

% meros opou pragmatopoieitai o kwdikas gia thn e3iswsh istogrammatos
% oi 2 eikones exoun to idio mege8os opote exoun mpei sto idio loop
for x = (orio+1):x1-orio
    fprintf('eimaste sth grammh : %d\n',x);
    for y = (orio+1):y1-orio
        % epilogh tou para8yrou ka8e eikonas pou 8eloume na kanoyme
e3iswsh
        % istogrammatos
        A = d_road_1(x-orio:x+orio,y-orio:y+orio);
        B = d_road_2(x-orio:x+orio,y-orio:y+orio);
        % sto j kai j1 apo8hkeuontai ta kentrika shmeia tou
        % para8yrou(ennoeitai to para8yro einai perittos 3,5,7)
        j = A(orio+1,orio+1);
        j1 = B(orio+1,orio+1);
        % arxikopoihsh dianysmatwn pou periexoun th timh, th
pi8anothta
        % emfanishs ka8e timhs sto sygkekrimeno para8yro
        a = [];
        b = [];
        % briskoume tis monadikes times pou yparxoun sto para8yro kai
        % metrame poses fores emfanizontai me th xrhsh twn for
        a(:,1) = unique(A);
        b(:,1) = unique(B);
        for i = 1:length(a(:))
            t = a(i,1);
            a(i,2) = numel(find(A==t));
            a(i,2) = (a(i,2)./length(A(:)));
            % elegxoume an h timh(syxnothta) pou briskoume th
pi8anothta
            % einai idia me th timh(syxnothta) tou kentrikou shmeiou
tou
            % para8yrou. an einai idia tote briskoume to cumulative
sum
            % dhladh th swreumenh pi8anothta se ekeino to shmeio kai
            % pol/zoume me to 255 gia na vroume th nea syxnothta tou
shmeiou
            if t == j
                % edw yparxei kai h dynatothta na ginei se uint8 h
eikona
                % alla den exei diafora apo th double ta apotelesmata
einai
                % idia
                % d_road_n1(x-orio,y-orio) =
floor(255*sum(a(1:i,2)));
```

```matlab
                d_road_n1(x-orio,y-orio) = sum(a(1:i,2));
                break
            end
        end
        % ginetai h idia diadikasia me parapanw
        for i = 1:length(b(:))
            t1 = b(i,1);
            b(i,2) = numel(find(B==t1));
            b(i,2) = (b(i,2)./length(B(:)));
            if t1 == j1
                d_road_n2(x-orio,y-orio) = sum(b(1:i,2));
                % edw yparxei kai h dynatothta na ginei se uint8 h
eikona
                % alla den exei diafora apo th double ta apotelesmata
einai
                % idia
                % d_road_n2(x-orio,y-orio) =
floor(255*sum(b(1:i,2)));
                break
            end
        end
    end
end
% ginetai h idia diadikasia pou perigrafhke gia tis prohgoumenes dyo
% eikones
for x = (orio+1):x3-orio
    fprintf('eimaste sth grammh : %d\n',x);
    for y = (orio+1):y3-orio
        A = d_road_3(x-orio:x+orio,y-orio:y+orio);
        j = A(orio+1,orio+1);
        a = [];
        a(:,1) = unique(A);
        for i = 1:length(a(:))
            t = a(i,1);
            a(i,2) = numel(find(A==t));
            a(i,2) = (a(i,2)./length(A(:)));
            if t == j
                % d_road_n3(x-orio,y-orio) =
floor(255*sum(a(1:i,2)));
                d_road_n3(x-orio,y-orio) = sum(a(1:i,2));
                break
            end
        end
    end
end
%% ta imshow gia ta apotelesmata mas

figure,imshow((d_road_n1)),figure,imshow((d_road_n2)),figure,imshow((
d_road_n3))
figure,subplot(1,2,1),imshow(d_road_n1),subplot(1,2,2),imhist(d_road_
n1)
figure,subplot(1,2,1),imshow(d_road_n2),subplot(1,2,2),imhist(d_road_
n2)
figure,subplot(1,2,1),imshow(d_road_n3),subplot(1,2,2),imhist(d_road_
n3)
```

erotima_6o_A.m

```matlab
%% 6o_erotima A meros
% adding noise
```

```matlab
close all; clear all; clc

clock = im2double(rgb2gray(imread('clock.jpg')));
clock = imresize(clock,[301 301]);
[x,y] = size(clock);

% mesh timh = 0
mean = 0;

% diaspora
sigma = 1;

% epi8ymhto snr
SNR = 10;

% dhmiourgia 8orybou
noise = sqrt(sigma)*randn(x,y) + mean;

% euresh meshs isxyos shmatos kai 8oryvou
Power_s = sum(abs(clock(:)).^2)/length(clock(:));
Power_n = sum(abs(noise(:)).^2)/length(noise(:));

% euresh klimakas ypoba8mishs vash tou epi8umhtou 8oryvou
scale_fact = (Power_s/Power_n)*10^(-SNR/10);

% telikos epi8ymhtos 9oryvos pou prosti8etai sthn eikona
noise_fin = sqrt(scale_fact)*noise;

% eikona me 8oryvo
white_clock = clock + noise_fin;

%% DFT noisy img and noise


% ypologismos ths arxikhs grammhs omega
for i = 1:x
    omega(1,i) = exp((-2*pi*1i/x)*(i-1));
end

% ypswnontas to omega sthn i-1 epitygxanetai h morfh toy mhtrwou pou
% zhteitai
for i = 1:x
    W(i,:) = omega.^(i-1);
end

% kanonikopoihsh tou W diairontas me to sqrt(N)
W = (1/sqrt(x))*W;

% DFT ths eikonas
clock_new = W*white_clock*W';

% DFT tou 8oryvou
pn1 = W*noise_fin*W';

%% efarmogh ths texnikhs gia wiener filtering
```

```matlab
% briskoume th pyknothta fasmatos tou noisy image
mpl = (abs(clock_new).^2)./y^2;


% =============================================================== %
% edw briskoume to Pn (pyknothta fasmatos tou 8oryvou) 8ewrontas ton
% agnwsto. briskoume th mesh timh apo ena para8yro pou scannarei thn
% pyknothta fasmatos isxyos ths eikonas (makrya apo tis gwnies kai
akres pou
% yparxoun oi xamhles syxnothtes kai thn apo8hkeuoume se ena
dianysma. meta
% apo auto to dianysma briskoume pali mia mesh timh gia na eimaste
oso pio
% konta mporoume se ena "kalo mean"
pn = [];
block = 40;
for i = block:y-block
    for j = block:y-block
        gia_pn = mpl(i:i+(block-1),j:j+(block-1));
        pn(numel(pn)+1,1) = sum(gia_pn(:))/length(gia_pn(:));
    end
end
pn = sum(pn)/length(pn);

% dhmiourgoume ena pinaka sto mege8os ths eikonas me ka8e timh tou
ish me
% to pn pou brhkame
pn = pn*ones(y);

% edw xrhsimopoioume kai to gnwsto 8orybo gia to 1o ypoerwthma tou A
merous
pn1 = abs(pn1).^2/y^2;

% pn1 = abs(pn1);
% briskoume ena pf gia ton agnwsto 8orybo
pf = abs(mpl-pn);

% ena pf gia to gnwsto 8oryvo
pf1 = abs(mpl-pn1);

% briskoume to H filtro gia ton agnwsto 8oryvo
H = pf./(pf+pn);

% to H1 gia ton gnwsto 8oryvo
H1 = pf1./(pf1+pn1);

% polzoume to DFT tou noisy image me to ena H kai sth synexeia me to
allo
wie = (clock_new).*(H);
wie1 = (clock_new).*(H1);

% sth synexeia sta figures kanoume th pra3h gia ton antistrofo DFT
wste na
% mporesoume na doume to apotelesma
figure,subplot(1,3,1),imshow(white_clock),title('noisy image')
subplot(1,3,2),imshow(real(inv(W)*wie1*inv(W'))),title('filtro me
gnwsto noise')
subplot(1,3,3),imshow(real(inv(W)*wie*inv(W'))),title('filtro me
noise para8yrou')
```

erotima_6o_B.m

```matlab
%% 6o_erotima_B

close all; clear all; clc

clock = im2double(rgb2gray(imread('clock.jpg')));

% kanoume tetragwniko to clock
clock = imresize(clock,[301 301]);
[x,y] = size(clock);

% xrhsimopoioume to psf kai pairnoume thn e3odo
psf_clock = psf(clock);

%% DFT noisy img and noise


% ypologismos ths arxikhs grammhs omega
for i = 1:x
    omega(1,i) = exp((-2*pi*1i/x)*(i-1));
end

% ypswnontas to omega sthn i-1 epitygxanetai h morfh toy mhtrwou pou
% zhteitai
for i = 1:x
    W(i,:) = omega.^(i-1);
end

% kanonikopoihsh tou W diairontas me to sqrt(N)
W = (1/sqrt(x))*W;

% DFT ths eikonas e3odou tou psf
ft_psf_clock = W*psf_clock*W';

% DFT ths kanonikhs eikonas
ft_clock = W*clock*W';

% synarthsh metaforas brisketai sth syxnothta diairontas to fourirer
ths
% e3odou me to fourier ths eisodou
Hf = (ft_psf_clock)./(ft_clock);

% h kroustikh apokrish einai o antistrofos fourier ths synarthshs
metaforas
hf = inv(W)*(Hf)*inv(W');

% plot ths Hf kai hf
figure,subplot(2,1,1),plot(real(Hf(:))),title('synarthsh metaforas')
subplot(2,1,2),plot(real(hf(:))),title('kroustikh apokrish')

figure,imshow(Hf),title('apeikonish synarthshs metaforas')

% B iso me th synarthsh metaforas gia euresh tou antistrofou filtrou
B = Hf(:);

% ena gamma pou xrhsimopoioume gia th kawfliwsh
```

```matlab
gamma_vect = [0.8, 1.2, 4];
for repeat = 1: length(gamma_vect);
    gamma = gamma_vect(repeat);
    for i = 1:length(B)
        if gamma > 1/abs(B(i))
            H{repeat}(i,1) = 1/B(i);
        elseif gamma <= 1/abs(B(i))
            H{repeat}(i,1) = (gamma*abs(B(i)))/B(i);
        end
    end
end

for rep = 1:repeat
    % H to teliko antistrofo filtro mas
    H_loc = reshape(H{rep},size(Hf,1),size(Hf,2));

    % edw sth syxnothta efarmozetai to filtro sth
    wie = ft_psf_clock.*H_loc;

    teliko = inv(W)*(wie)*inv(W');

    % syneli3h - pol/mos sth syxnothta ths eikonas e3odou tou psf me
th 1 pros
    % ths synarthsh metaforas 1/Hf
    antistrofo_mono = real(inv(W)*((1./Hf).*ft_psf_clock)*inv(W'));

    mse(rep) = mean((clock(:) - real(teliko(:))).^2);

    str{rep} = sprintf('me katwfli: %.1f ,mse: %d', gamma_vect(rep),
mse(rep));
     %% figures gia ka8e timh katwfliou, nagrafetai panw sthn eikona
to
    % katwfli kai to mean square error
    figure(2+rep)
    subplot(2,2,1),imshow(clock),title('arxiko')
    subplot(2,2,2),imshow(psf_clock/5),title('clock meta apo psf')
    subplot(2,2,3),imshow(antistrofo_mono),title('aplh syneli3h me
antistrofo')
    subplot(2,2,4),imshow(real(teliko)),title(str{rep})
end
```