ΨΗΦΙΑΚΗ ΕΠΕΞΕΡΓΑΣΙΑ ΚΑΙ ΑΝΑΛΥΣΗ ΕΙΚΟΝΑΣ

ΕΡΓΑΣΤΗΡΙΑΚΗ ΑΣΚΗΣΗ

ΜΕΡΟΣ Β’

SCRIPTS

ΟΝ/ΜΟ: ΤΡΙΑΝΤΗΣ ΠΑΝΑΓΙΩΤΗΣ
ΕΤΟΣ : 5ο
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Στα πλαίσια της άσκησης δημιουργήθηκαν συναρτήσεις που κάνουν τα εξής :

- (Shift & Inverse_shift) – μετατόπιση ώστε το χωρικό σημείο (0,0) του Fourier να βρεθεί στο κέντρο και η αντίστροφη συνάρτηση για τη shift (inverse_shift) που επαναφέρει τα χωρικά σημεία στις αρχικές θέσεις μετά την εφαρμογή της shift ώστε να γίνει ο αντίστροφος μετασχηματισμός Fourier σωστά. Στα script **shift.m** και **inverse_shift.m** είναι υλοποιημένες οι συναρτήσεις αυτές.
- (fft_pad & inverse_pad) – για να συνελίξουμε στη συχνότητα δισδιάστατα σήματα αυτό το κάνουμε με κυκλική συνέλιξη. Για να γίνει αυτό πρέπει να γίνουν οι διαστάσεις της εικόνας ,αν αρχικά η εικόνα x(n1,n2) και το φίλτρο που θέλουμε να κάνουμε είναι h(n1,n2) τότε θα πρέπει να επεκταθούν με μηδενικά και τα 2 σε διαστάσεις N1 κ N2 με N1 = n1+n1 -1 & N2 = n2+n2-1. Στα script **fft_pad.m** και **inverse_pad.m** είναι υλοποιημένες οι συναρτήσεις αυτές.

Εδώ παρατίθενται τα scripts :

```
%% function shift
% analoga me to mege8os ths eikonas kanoume shift sto metasxhmatismo
% fourier ths gia na feroume tis epi8ymhtes syxnothtes sto (0,0)
function [new_img] = shift(img)

[x,y,d] = size(img);
if d>1
    error('only m (x) n (x) 1 images');
    return;
end
if rem(x,2)==0 && rem(y,2)==0
    % diairesh eikonas se 4 kommatia
    fst_q = img(1:(x/2),1:(y/2));
    scd_q = img(1:(x/2),(y/2)+1:y);
    thd_q = img((x/2)+1:x,1:(y/2));
    fth_q = img((x/2)+1:x,(y/2)+1:y);
elseif rem(x,2)~=0 && rem(y,2)~=0
    fst_q = img(1:floor(x/2),1:floor(y/2));
    scd_q = img(1:floor(x/2),ceil(y/2):y);
    thd_q = img(ceil(x/2):x,1:floor(y/2));
    fth_q = img(ceil(x/2):x,ceil(y/2):y);
elseif rem(x,2)~=0 && rem(y,2)==0
    fst_q = img(1:floor(x/2),1:(y/2));
    scd_q = img(1:floor(x/2),(y/2)+1:y);
    thd_q = img(ceil(x/2):x,1:(y/2));
    fth_q = img(ceil(x/2):x,(y/2)+1:y);
elseif rem(x,2)==0 && rem(y,2)~=0
    fst_q = img(1:(x/2),1:floor(y/2));
    scd_q = img(1:(x/2),ceil(y/2):y);
    thd_q = img((x/2)+1:x,1:floor(y/2));
    fth_q = img((x/2)+1:x,ceil(y/2):y);
end
% synenwsh twn kommatiwn
new_img = [fth_q thd_q;
    scd_q fst_q];

end
```

```
%% function inverse_shift
% synarthsh pou xrhsimopoieitai gia antistrofh ths shift synartshs
gia na
% ginei o antistrofos fourier swsta
function [new_img] = inverse_shift(img)

[x,y,d] = size(img);
if d>1
    error('only m (x) n (x) 1 images');
    return;
end
if rem(x,2)==0 && rem(y,2)==0
    % diairesh eikonas se 4 kommatia
    fst_q = img(1:(x/2),1:(y/2));
    scd_q = img(1:(x/2),(y/2)+1:y);
    thd_q = img((x/2)+1:x,1:(y/2));
    fth_q = img((x/2)+1:x,(y/2)+1:y);
elseif rem(x,2)~=0 && rem(y,2)~=0
    fst_q = img(1:ceil(x/2),1:ceil(y/2));
    scd_q = img(1:ceil(x/2),ceil(y/2)+1:y);
    thd_q = img(ceil(x/2)+1:x,1:ceil(y/2));
    fth_q = img(ceil(x/2)+1:x,ceil(y/2)+1:y);
elseif rem(x,2)~=0 && rem(y,2)==0
    fst_q = img(1:ceil(x/2),1:(y/2));
    scd_q = img(1:ceil(x/2),(y/2)+1:y);
    thd_q = img(ceil(x/2)+1:x,1:(y/2));
    fth_q = img(ceil(x/2)+1:x,(y/2)+1:y);
elseif rem(x,2)==0 && rem(y,2)~=0
    fst_q = img(1:(x/2),1:ceil(y/2));
    scd_q = img(1:(x/2),ceil(y/2)+1:y);
    thd_q = img((x/2)+1:x,1:ceil(y/2));
    fth_q = img((x/2)+1:x,ceil(y/2)+1:y);
end

% synenwsh twn kommatiwn
new_img = [fth_q thd_q;
    scd_q fst_q];
end
```

```
%% function fft_pad
% kanei pad thn eikona me mhdenika gia na efarmostei fourier
% metasxhmatismos kai syneli3h sth syxnothta me vash oti to filtro 8a
einai
% to idio mege8os me thn eikona opote 8a kanoume pad thn eikona se
mege8os
% (2*x - 1) kai (2*y - 1)
% gia eikones me diastaseis-dimensions  m x n x 1 (grayscale)

function [padded] = fft_pad(img)

[x,y,d] = size(img);
if d>1
    fprintf('warning : you chose a non grayscale image. we will
convert it\n');
    img = rgb2gray(img);
end
padded = zeros((2*x)-1,(2*y)-1);
padded(1:x,1:y) = img(1:x,1:y);
end
```

```
%% function inverse_pad
% epanaferei th padded eikona sto arxiko ths mege8os afou exei
% xrhsimopoih8ei sthn eikona h synarthsh fft_pad

function [original] = inverse_pad(padded)

[x,y,d] = size(padded);
x = x + 1;
y = y + 1;
original = padded(1:(x/2),1:(y/2));
end
```

```
%% meros_A_B (apeikonish 2D Fourier & filtra Butterworth)
% script pou ginetai o 2D metasxhmatismos Fourier kai
% dhmiourgountai ta filtra butterworth (ypsiperata kai xamhloperata)
% gia na antimetwpistei o 8oryvos twn aktinografiwn sth syxnothta
close all; clear all; clc

%% radiograph_1
% prwth aktinografia
% diplasiasmos twn diastasewn ths eikonas gia na ginei o fourier kai
na
% syneli3oume sth syxnothta kai meta epanafora sta arxika mege8h sto
telos
radio_1 = fft_pad(im2double(imread('radiograph_1.jpg')));

[xr1,yr1] = size(radio_1);
% didiastatos fft me th me9odo grammwn sthlwn
for i = 1:xr1
    fft_grammes_r1(i,:) = fft(radio_1(i,:));
end

for i = 1:yr1
    fft_sthles_r1(:,i) = fft(fft_grammes_r1(:,i));
end
% shift sta epimerous kommatia gia na feroume sto (0,0) tis
syxnothtes
radio_1_fft2 = shift(fft_sthles_r1);

figure
subplot(1,2,1),imshow(inverse_pad(radio_1)),title('arxikh kranio')
subplot(1,2,2),imshow((log10(abs(radio_1_fft2))-1.35)),title('DFT')

% epilogh twn omega kai rank gia toys typous twn filtrwn
omega_l_r1 = 65.5;
omega_h_r1 = 199.5;
for repeat = 0:7
    ran_f = 1+repeat;

    for i = 1:xr1
        for j = 1:yr1
            % xamhloperato filtro
            Low_H_r1(i,j) = 1/(1+(sqrt(((i-((xr1+1)/2)).^2)+((j-
((yr1+1)/2)).^2))/omega_l_r1).^(2*ran_f));
            % ypsiperato filtro
            High_H_r1(i,j) = 1/(1+(omega_h_r1./sqrt(((i-
((xr1+1)/2)).^2)+((j-((yr1+1)/2)).^2))).^(2*ran_f));
```

```
        end
    end
    % syneli3h sth syxnnothta pol/zontas stoixeio epi stoixeio
    new_radio_1 = (Low_H_r1+High_H_r1).*radio_1_fft2;
    figure
    subplot(1,2,1),imshow(log10(abs(radio_1_fft2))-
1.35),title('arxiko fasmatiko periexomeno')
    subplot(1,2,2),imshow(log10(abs(new_radio_1))-
1.35),title(sprintf('periexomeno meta apo filtro ta3hs: %d',ran_f))
    new_radio_1 = inverse_shift(new_radio_1);
    % antistrofos fft kata grammes kai kata sthles gia na paroume thn
arxikh
    % eikona mas
    for i = 1:xr1
       ifft_grammes_r1(i,:) = ifft(new_radio_1(i,:));
    end

    for i = 1:yr1
        ifft_sthles_r1(:,i) = ifft(ifft_grammes_r1(:,i));
    end
    teliko_r1 = inverse_pad(ifft_sthles_r1);

    figure
    subplot(1,2,1),imshow(inverse_pad(radio_1)),title('arxikh')
    subplot(1,2,2),imshow(teliko_r1),title(sprintf('filtrarismenh me
filtro ta3hs: %d',ran_f))
end

%% radiograph_2
% deuterh aktinografia - kai edw akolou8eitai h idia me8odos me
parapanw
radio_2 = fft_pad(im2double(imread('radiograph_2.jpg')));

[xr2,yr2] = size(radio_2);

for i = 1:xr2
    fft_grammes_r2(i,:) = fft(radio_2(i,:));
end

for i = 1:yr2
    fft_sthles_r2(:,i) = fft(fft_grammes_r2(:,i));
end

radio_2_fft2 = shift(fft_sthles_r2);

figure
subplot(1,2,1),imshow(inverse_pad(radio_2)),title('arxikh gonato')
subplot(1,2,2),imshow((log10(abs(radio_2_fft2))-1.35)),title('DFT')

omega_l_r2 = 52.5;
omega_h_r2 = 112;
for repeat = 0:4
    ran_f = 1+repeat;

    for i = 1:xr2
        for j = 1:yr2
            % xamhloperato filtro
            Low_H_r2(i,j) = 1/(1+(sqrt(((i-((xr2+1)/2)).^2)+((j-
((yr2+1)/2)).^2))/omega_l_r2).^(2*ran_f));
```

```
            % ypsiperato filtro
            High_H_r2(i,j) = 1/(1+(omega_h_r2./sqrt(((i-
((xr2+1)/2)).^2)+((j-((yr2+1)/2)).^2))).^(2*ran_f));
        end
    end

    new_radio_2 = (Low_H_r2+High_H_r2).*radio_2_fft2;

    figure
    subplot(1,2,1),imshow(log10(abs(radio_2_fft2))-
1.35),title('arxiko fasmatiko periexomeno')
    subplot(1,2,2),imshow(log10(abs(new_radio_2))-
1.35),title(sprintf('periexomeno meta apo filtro ta3hs: %d',ran_f))
    new_radio_2 = inverse_shift(new_radio_2);

    for i = 1:xr2
        ifft_grammes_r2(i,:) = ifft(new_radio_2(i,:));
    end

    for i = 1:yr2
        ifft_sthles_r2(:,i) = ifft(ifft_grammes_r2(:,i));
    end
    teliko_r2 = inverse_pad(ifft_sthles_r2);
    figure
    subplot(1,2,1),imshow(inverse_pad(radio_2)),title('arxikh')
    subplot(1,2,2),imshow(teliko_r2),title(sprintf('filtrarismenh me
filtro ta3hs: %d',ran_f))
end
```

```
%% meros_C (filtra Notch)
% script pou dhmiourgeitai to filtro notch na antimetwpistei o
8oryvos twn
% aktinografiwn sth syxnothta sta shmeia opou parousiazetai akrivws

close all; clear all; clc

%% radiograph_1
% akolou8eitai h idia diadikasia gia to metasxhmatismo Fourier kai
ton
% antistrofo metasxhmatismo sth synexeia
% padding ths eikonas me mhdenika
radio_1 = fft_pad(im2double(imread('radiograph_1.jpg')));
[xr1,yr1] = size(radio_1);
% fft kata grammes - sthles
for i = 1:xr1
    fft_grammes_r1(i,:) = fft(radio_1(i,:));
end

for i = 1:yr1
    fft_sthles_r1(:,i) = fft(fft_grammes_r1(:,i));
end

radio_1_fft2 = shift(fft_sthles_r1);

sigma = 2*25.6;
posit_r1_x = 2*[-95 -45 45 95];
posit_r2_y = 2*[10 5 -5 -10];
```

```
for metav = 1:4
    omega_x_r1 = (xr1+1)/2;
    omega_y_r1 = (yr1+1)/2;
    omega_x_r1 = omega_x_r1 + posit_r1_x(metav);
    omega_y_r1 = omega_y_r1 + posit_r2_y(metav);
    for i = 1:xr1
        for j = 1:yr1
            H_r1{metav}(i,j) = (1-exp(-((omega_x_r1 - i)^2 +...
                (omega_y_r1 - j)^2)/sigma^2));
        end
    end
end
% ypologismos tou telikou filtrou gia ka8e shmeio opou parousiazetai
% paramorfwsh sto fasma twn syxnothtwn
h_r1 = H_r1{1}.*H_r1{2}.*H_r1{3}.*H_r1{4};
new_radio_1 = (h_r1).*radio_1_fft2;

figure
subplot(1,3,1),imshow(log10(abs(radio_1_fft2))-1.35),title('arxiko
fasmatiko periexomeno')
subplot(1,3,2),imshow(h_r1),title('filtro Notch')
subplot(1,3,3),imshow(log10(abs(new_radio_1))-
1.35),title('periexomeno meta to filtro')

new_radio_1 = inverse_shift(new_radio_1);
% ifft kata grammes - sthles
for i = 1:xr1
    ifft_grammes_r1(i,:) = ifft(new_radio_1(i,:));
end

for i = 1:yr1
    ifft_sthles_r1(:,i) = ifft(ifft_grammes_r1(:,i));
end
% epanafora ths eikonas sto arxiko ths mege9os
teliko_r1 = inverse_pad(ifft_sthles_r1);

figure
subplot(1,2,1),imshow(inverse_pad(radio_1)),title('arxikh')
subplot(1,2,2),imshow(teliko_r1),title('filtrarismenh eikona')


%% radiograph_2
% akolou8eitai h idia diadikasia me thn 1h aktinografia mono pou edw
% dhmiourgountai 2 filtra mono giati ta shmeia pou 8eloume na
e3aleipsoume
% einai 2
radio_2 = fft_pad(im2double(imread('radiograph_2.jpg')));

[xr2,yr2] = size(radio_2);
% fft
for i = 1:xr2
    fft_grammes_r2(i,:) = fft(radio_2(i,:));
end

for i = 1:yr2
    fft_sthles_r2(:,i) = fft(fft_grammes_r2(:,i));
end

radio_2_fft2 = shift(fft_sthles_r2);
```

```
sigma_r2 = 2*17.6;
posit_r2_x = 2*[9 -9];
posit_r2_y = 2*[-35 35];

for metav = 1:length(posit_r2_x)
    omega_x_r2 = (xr2+1)/2;
    omega_y_r2 = (yr2+1)/2;
    omega_x_r2 = omega_x_r2 + posit_r2_x(metav);
    omega_y_r2 = omega_y_r2 + posit_r2_y(metav);
    for i = 1:xr2
        for j = 1:yr2
            H_r2{metav}(i,j) = (1-exp(-((omega_x_r2 - i)^2 +...
                (omega_y_r2 - j)^2)/sigma_r2^2));
        end
    end
end

h_r2 = H_r2{1}.*H_r2{2};
new_radio_2 = (h_r2).*radio_2_fft2;

figure
subplot(1,3,1),imshow((log10(abs(radio_2_fft2))-1.35)),title('arxiko
fasmatiko periexomeno')
subplot(1,3,2),imshow(h_r2),title('filtro Notch')
subplot(1,3,3),imshow(abs((new_radio_2))/100),title('periexomeno meta
to filtro')

new_radio_2 = inverse_shift(new_radio_2);
% ifft
for i = 1:xr2
    ifft_grammes_r2(i,:) = ifft(new_radio_2(i,:));
end

for i = 1:yr2
    ifft_sthles_r2(:,i) = ifft(ifft_grammes_r2(:,i));
end
teliko_r2 = inverse_pad(ifft_sthles_r2);

figure
subplot(1,2,1),imshow(inverse_pad(radio_2)),title('arxikh')
subplot(1,2,2),imshow(teliko_r2),title('filtrarismenh eikona')
```

```
%% ellipsoid_filter
% xamhloperata kai ypsiperata filtra alla me elleipsoeides sxhma
% einai ta idia filtra me ta butterworth apla anti gia kyklo
dhmiourgh8hke
% elleipsh panw stous a3ones logw ths katanomhs tou 8oryvou etsi wste
na
% epiteux8ei ligoterh apwleia plhroforias kata thn efarmogh toy
filtrou.
% sto typo tou filtrou anti na mpei h synarthsh gia to kyklo (x^2 ,
y^2)
% diaire8hke me kapoies metavlhtes gia na dhmiourgh8oun oi elleipseis
close all; clear all; clc

%% radiograph_1
```

```
radio_1 = fft_pad(im2double(imread('radiograph_1.jpg')));

[xr1,yr1] = size(radio_1);

for i = 1:xr1
    fft_grammes_r1(i,:) = fft(radio_1(i,:));
end

for i = 1:yr1
    fft_sthles_r1(:,i) = fft(fft_grammes_r1(:,i));
end

radio_1_fft2 = shift(fft_sthles_r1);

omega_l_r1 = 47.5;
omega_h_r1 = 90;
ran_f = 5;

for i = 1:xr1
    for j = 1:yr1
        % xamhloperato me diairemeno to x^2 kai y^2 me mia sta8era
        Low_H_r1(i,j) = 1/(1+(sqrt(((i-(xr1/2)).^2)/2+((j-
(yr1/2)).^2)/6)/omega_l_r1).^(2*ran_f));
        % ypsiperato me diairemeno to x^2 kai y^2 me mia sta8era
        High_H_r1(i,j) = 1/(1+(omega_h_r1./sqrt(((i-
(xr1/2)).^2)/6+((j-(yr1/2)).^2)/.45)).^(2*ran_f));
    end
end

new_radio_1 = (Low_H_r1+High_H_r1).*radio_1_fft2;

figure
subplot(1,3,1),imshow(log10(abs(radio_1_fft2))-1.35),title('arxiko
fasmatiko periexomeno')
subplot(1,3,2),imshow(Low_H_r1+High_H_r1),title('filtro')
subplot(1,3,3),imshow(log10(abs(new_radio_1))-
1.35),title('periexomeno meta to filtro')

new_radio_1 = inverse_shift(new_radio_1);

for i = 1:xr1
    ifft_grammes_r1(i,:) = ifft(new_radio_1(i,:));
end

for i = 1:yr1
    ifft_sthles_r1(:,i) = ifft(ifft_grammes_r1(:,i));
end

teliko_r1 = inverse_pad(ifft_sthles_r1);

figure
subplot(1,2,1),imshow(inverse_pad(radio_1)),title('arxikh')
subplot(1,2,2),imshow(teliko_r1),title('filtrarismenh')


%% radiograph_2

% akolou8eitai h idia diadikasia kai edw
```

```
radio_2 = fft_pad(im2double(imread('radiograph_2.jpg')));

[xr2,yr2] = size(radio_2);

for i = 1:xr2
    fft_grammes_r2(i,:) = fft(radio_2(i,:));
end

for i = 1:yr2
    fft_sthles_r2(:,i) = fft(fft_grammes_r2(:,i));
end

radio_2_fft2 = shift(fft_sthles_r2);
ran_f = 5;
omega_l_r2 = 25;
omega_h_r2 = 80;
for i = 1:xr2
    for j = 1:yr2
        Low_H_r2(i,j) = 1/(1+(sqrt(((i-((xr2+1)/2)).^2)/2+((j-
((yr2+1)/2)).^2)/1.35)/omega_l_r2).^(2*ran_f));
        High_H_r2(i,j) = 1/(1+(omega_h_r2./sqrt(((i-
((xr2+1)/2)).^2)/0.2+((j-((yr2+1)/2)).^2)/1.2)).^(2*ran_f));
    end
end

new_radio_2 = (Low_H_r2+High_H_r2).*radio_2_fft2;

figure
subplot(1,3,1),imshow(log10(abs(radio_2_fft2))-1.35),title('arxiko
fasmatiko periexomeno')
subplot(1,3,2),imshow(Low_H_r2+High_H_r2),title('filtro')
subplot(1,3,3),imshow(log10(abs(new_radio_2))-
1.35),title('periexomeno meta to filtro')

new_radio_2 = inverse_shift(new_radio_2);

for i = 1:xr2
    ifft_grammes_r2(i,:) = ifft(new_radio_2(i,:));
end

for i = 1:yr2
    ifft_sthles_r2(:,i) = ifft(ifft_grammes_r2(:,i));
end
teliko_r2 = inverse_pad(ifft_sthles_r2);

figure
subplot(1,2,1),imshow(inverse_pad(radio_2)),title('arxikh')
subplot(1,2,2),imshow(teliko_r2),title('filtrarismenh')
```