%cover image- ‘lena.jpg’ size=512x512

%watermark- ‘moon.jpg’ size=128x128

%main

x=im2double(imread('lena.jpg')); %cover image

a=im2double(imread('moon.jpg')); %watermark image

figure, imshow(x), title('ORIGINAL IMAGE');

k=0.05;

y = embed(x,a,k);  %watermarked image

figure, imshow(y), title('WATERMARKED IMAGE');

%these are for creating attacked images

%att = median\_filter(y);  %attacked image

%att = imnoise(y,'salt & pepper',0.02);

%att = imgaussfilt(y,0.5);

%att = imnoise(y,'speckle',0.2);

%figure, imshow(att), title('ATTACKED IMAGE');

w = extract(y,x,k);

figure, imshow(w), title('EXTRACTED WATERMARK');

display(psnr\_def(x,y));

nc\_def(w,a);

%embedding function

function [output] = embed(cover, a, k)  %a is the watermark

    lshaar = liftwave('haar');

    els = {'p',[-0.125 0.125],0};

    lsnew = addlift(lshaar,els);

    [LL1,LH1,HL1,HH1] = lwt2(cover,lsnew);  %lwt on cover image

    [LL2,LH2,HL2,HH2] = lwt2(LH1,lsnew);  %lwt on LH1 subband

    %p = size(cH)

    %a = imresize(a,[p(1) p(2)]);

    a = ar\_enc(a);  %encrypt the watermark

    %figure, imshow(a\_enc);

    %apply dct on LH2

    x=LH2;

    x1 = x(:,:,1);

    x2 = x(:,:,2);

    x3 = x(:,:,3);

    dx1=dct2(x1);

    dx2=dct2(x2);

    dx3=dct2(x3);

    %apply DCT on a

    a1 = a(:,:,1);

    a2 = a(:,:,2);

    a3 = a(:,:,3);

    da1=dct2(a1);

    da2=dct2(a2);

    da3=dct2(a3);

    dx1 = dx1 + k \* da1;

    dx2 = dx2 + k \* da2;

    dx3 = dx3 + k \* da3;

    LH2new1 = idct2(dx1);   %inverse DCT to get new LH2

    LH2new2 = idct2(dx2);

    LH2new3 = idct2(dx3);

    LH2new(:,:,1) = LH2new1;

    LH2new(:,:,2) = LH2new2;

    LH2new(:,:,3) = LH2new3;

    LH1new = ilwt2(LL2,LH2new,HL2,HH2,lsnew);  %inverse DCT to get new LH1

    output = ilwt2(LL1,LH1new,HL1,HH1,lsnew);  %inverse DCT to get watermarked image

end

%extraction algorithm

function [wm] = extract(input, cover, k)

    %input is the watermarked image

    lshaar = liftwave('haar');

    els = {'p',[-0.125 0.125],0};

    lsnew = addlift(lshaar,els);

    [LLw1,LHw1,HLw1,HHw1] = lwt2(input,lsnew); %LWT on watermarked image(input)

    [LLw2,LHw2,HLw2,HHw2] = lwt2(LHw1,lsnew);

    [LLc1,LHc1,HLc1,HHc1] = lwt2(cover,lsnew); %LWT on cover image

    [LLc2,LHc2,HLc2,HHc2] = lwt2(LHc1,lsnew);

    %dct on LHw2 band of input image(watermarked image)

    y=LHw2;

    y1 = y(:,:,1);

    y2 = y(:,:,2);

    y3 = y(:,:,3);

    dy1 = dct2(y1);

    dy2 = dct2(y2);

    dy3 = dct2(y3);

    %dct on LHc2 band of cover image

    x=LHc2;

    x1 = x(:,:,1);

    x2 = x(:,:,2);

    x3 = x(:,:,3);

    dx1 = dct2(x1);

    dx2 = dct2(x2);

    dx3 = dct2(x3);

    %extraction

    wm1 = (dy1 - dx1)/k;

    wm2 = (dy2 - dx2)/k;

    wm3 = (dy3 - dx3)/k;

    wm1 = idct2(wm1);

    wm2 = idct2(wm2);

    wm3 = idct2(wm3);

    wm(:,:,1) = wm1;

    wm(:,:,2) = wm2;

    wm(:,:,3) = wm3;

    wm = ar\_dec(wm);  %decrypting the extracted watermark

end

%calculate nc value

function [NC] = nc\_def(exwat1,wat1)

    %calculation of NC value

    % m no of rows, n no of columns and k no of bands

    [m,n,k] = size(exwat1);

    wat1 = imresize(wat1,[m n]);

    for a=1:k   % for bands (1,2,3)

        dm=0;

        nm=0;

         for c=1:m    %for rows

             for b=1:n   %for columns

                 nm = nm + exwat1(c,b,a)\*wat1(c,b,a);

                 dm = dm + wat1(c,b,a)\*wat1(c,b,a);

             end

         end

        nc(a)=nm/dm;  % NC for different k values(bands)

    end

    avgnc=mean(nc);

    display(avgnc);

    %calculation of NC value

    wat2 = wat1;

    exwat2 = exwat1;

    %figure, imshow(exwat2(:,:,1));

    NM\_R=sum(sum(wat2(:,:,1).\*exwat2(:,:,1)));

    NM\_G=sum(sum(wat2(:,:,2).\*exwat2(:,:,2)));

    NM\_B=sum(sum(wat2(:,:,3).\*exwat2(:,:,3)));

    DM\_R=sum(sum(wat2(:,:,1).\*wat2(:,:,1)));

    DM\_G=sum(sum(wat2(:,:,2).\*wat2(:,:,2)));

    DM\_B=sum(sum(wat2(:,:,3).\*wat2(:,:,3)));

    NC\_R=NM\_R/DM\_R;

    NC\_G=NM\_G/DM\_G;

    NC\_B=NM\_B/DM\_B;

    NC=(NC\_R + NC\_G + NC\_B)/3;

    display(NC);

end