EECS225B–Spring 2020 — PROBLEM SET 08

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1 part 1

```
function y = ddwt(j, x)


x = double(x);
order_max = log(length(x))/log(2);

low = [1/sqrt(2) 1/sqrt(2)];
high = [1/sqrt(2) -1/sqrt(2)];

y = zeros(1,length(x));  % final result
app = zeros(1,length(x)/2);   % approximate
det = zeros(1,length(x)/2);   % detail


m = 1;
xtmp = x;
for norder = 1:j
    for n = 1:2:length(xtmp)
        app(m) = sum(xtmp(n:n+1).*low);
        det(m) = sum(xtmp(n:n+1).*high);
        m = m + 1;
    end
    % from back to front
    y( length(xtmp)/2+1:length(xtmp) ) = det( 1:2^(order_max-norder) );
    y( 1:length(xtmp)/2 ) = app( 1:2^(order_max-norder) );
    xtmp = app( 1:2^(order_max-norder) );
    m = 1;
end
```

```
function y = idwt(cA, cD, lpr, hpr)

na=length(cA);
nd=length(cD);

while (nd)>=(na)

    na=length(cA);
    for i=1:2 * na - 1
        if mod(i, 2)
            up1(i)=cA((i+1)/2);
        else
            up1(i)=0;
        end
    end
    cv1=conv(up1, lpr);

    cD_up=cD(nd-na+1:nd);
    ndup = length(cD_up);
    for i=1:2 * ndup - 1
        if mod(i, 2)
            uph(i)=cD_up((i+1)/2);
        else
            uph(i)=0;
        end
    end
    cvh=conv(uph, hpr);

    cA=cv1+cvh;
    cD=cD(1:nd-na);
    na=length(cA);
    nd=length(cD);
end
y=cA;
```

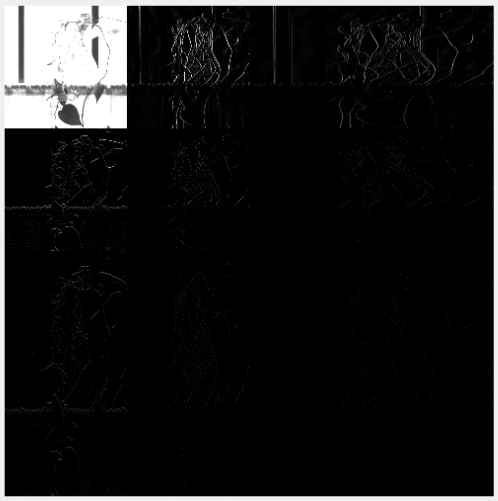
2 part 2

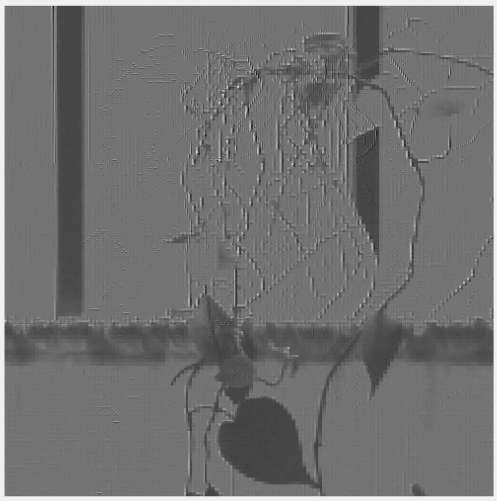
```
img = imread('Fig2.2.jpg');
j = 2;
[LL, LH, HL, HH, img_r]=haar_dwt2D(j,img);
subplot(1, 2, 1); imshow(img_r, []);
img_i = ihaar_dwt2D(j,img_r);
subplot(1, 2, 2);imshow(img_i, []);
```

```
function [LL, LH, HL, HH, img]=haar_dwt2D(j,img)
    [m, n]=size(img);
%     cnt = 0;
    for i=1:m       %transform horizon
        x=ddwt(j,img(i,:));
%         cnt = cnt + 1
        img(i,:)=x;
    end

    for t=1:n       %transform vertical
       x=ddwt(j,img(:,t).');
%        cnt = cnt + 1
       img(:,t)=x;
    end
    LL=img(1:m/2,1:n/2);
    LH=img(1:m/2,n/2+1:n);
    HL=img(m/2+1:m,1:n/2);
    HH=img(m/2+1:m,n/2+1:n);
end
```

```
function y=idwt2_one(LL,HL,LH,HH)

low = [1/sqrt(2) 1/sqrt(2)];
high = [1/sqrt(2) -1/sqrt(2)];

tmp_mat=[LL,HL;LH,HH];
[m,n]=size(tmp_mat);

for k=1:n
    ca1=tmp_mat(1:m/2,k);
    cd1=tmp_mat(m/2+1:m,k);
    tmp1=idwt(ca1,cd1,low,high);
    yt(:,k)=tmp1;
end

for j=1:m
    ca2=yt(j,1:n/2);
    cd2=yt(j,n/2+1:n);
    tmp2=idwt(ca2,cd2,low,high);
    yt(j,:)=tmp2;
end
y=yt;
```

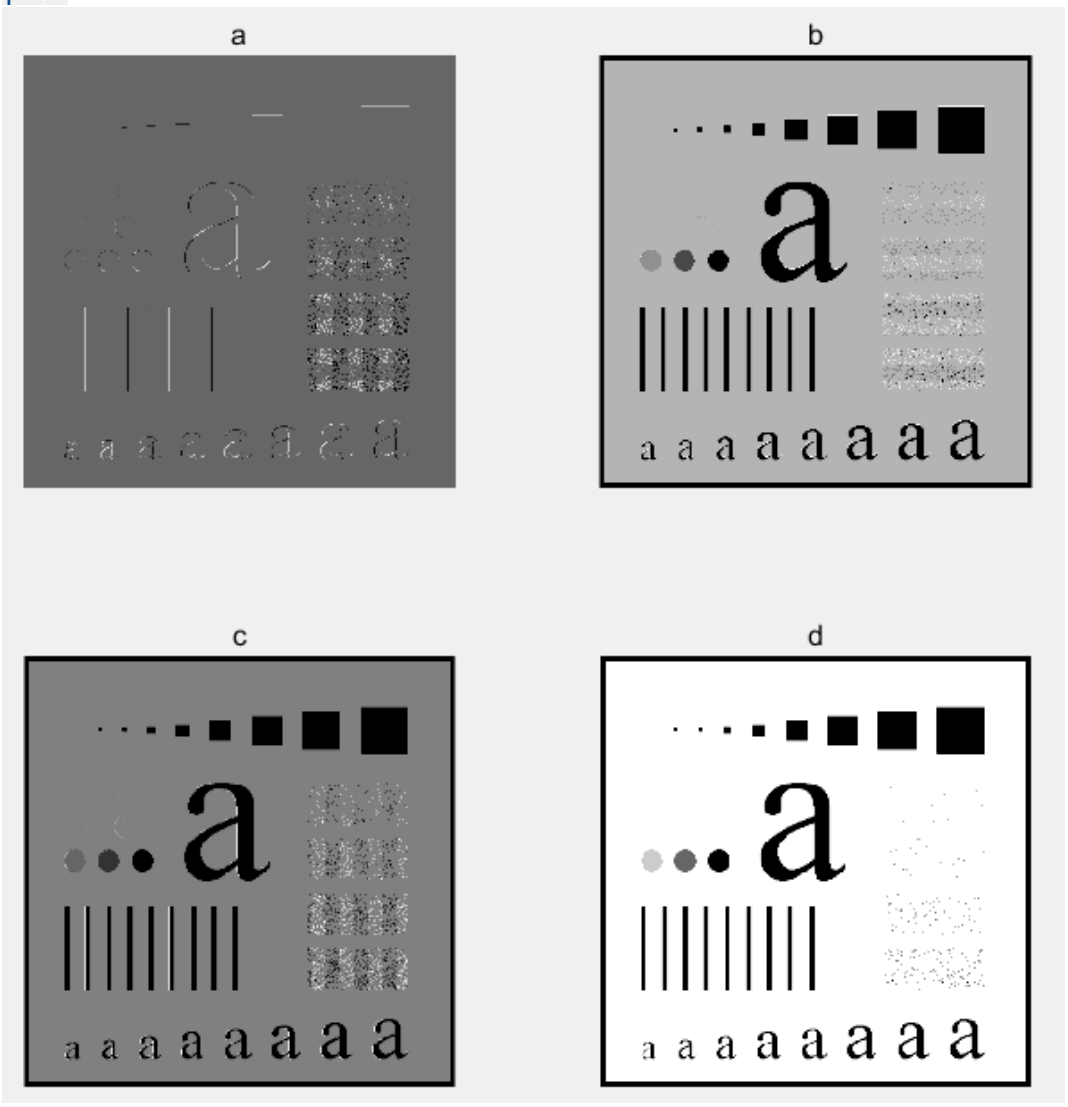
```
function y = ihaar_dwt2D(j,x)

xr=double(x);
[m,n]=size(xr);
for i=j:-1:1
    tmp=xr(1:floor(m/2^(i-1)),1:floor(n/2^(i-1)));

    [rt1,ct1]=size(tmp);
    rt=rt1-mod(rt1,2);ct=ct1-mod(ct1,2);
    rLL=tmp(1:rt/2,1:ct/2);
    rHL=tmp(1:rt/2,ct/2+1:ct);
    rLH=tmp(rt/2+1:rt,1:ct/2);
    rHH=tmp(rt/2+1:rt,ct/2+1:ct);
    tmp(1:rt,1:ct)=idwt2_one(rLL,rHL,rLH,rHH);

    xr(1:rt1,1:ct1)=tmp;
end
y = xr;
```





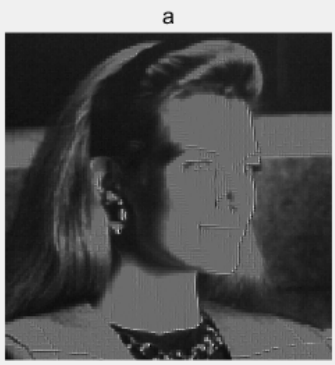
3 part 3

```
img = imread('Fig2.3.jpg');
img_p = padarray(img, [6, 6]);
% subplot(2, 2, 4);imshow(img_p, []);title('origin');
j = 1; %scale
[LL, LH, HL, HH, ~]= haar_dwt2D(j,img_p);
[m, n] = size(HH);
LLp = zeros(m, n);LHp = zeros(m, n);
HLp = zeros(m, n);HHp = zeros(m, n);
img_a = [LLp, LH; HL, HH];
img_ai = ihaar_dwt2D(j, img_a);
subplot(2, 2, 1);imshow(img_ai, []);title('a');
img_b = [LL, LHp; HL, HHp];
img_bi = ihaar_dwt2D(j, img_b);
subplot(2, 2, 2);imshow(img_bi, []);title('b');
img_c = [LL, LH; HLp, HHp];
img_ci = ihaar_dwt2D(j, img_c);
subplot(2, 2, 3);imshow(img_ci, []);title('c');
img_d = [LL, LHp; HLp, HHp];
img_di = ihaar_dwt2D(j, img_d);
subplot(2, 2, 4);imshow(img_di, []);title('d');
```



4 part 4

```
img = imread('Fig2.4.jpg');
subplot(1, 2, 1);imshow(img, []);title('origin');
j = 2; %scale
[LL, LH, HL, HH, ~]= haar_dwt2D(j,img);
[m, n] = size(HH);
LLp = zeros(m, n);
LHp = zeros(m, n);
HLp = zeros(m, n);
HHp = zeros(m, n);
img_a = [LL, LHp; HLp, HHp];
img_ai = ihaar_dwt2D(j, img_a);
subplot(1, 2, 2);imshow(img_ai, []);title('a');
e = e_RMS(img, img_ai)
snr = snr_ms(img, img_ai)
```




```
>> p4

e =

    1.6467


snr =

  680.0178

>>
```