

JPEG2000 Style Compression - DWT Based

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Input : RAW Image Output : Reconstructed Image using DWT (JPEG2000 concept)

Notes: - Haar Wavelet - 2-level DWT on Y channel - Chroma subsampling (4:2:0) - Threshold-based coefficient suppression - No blocking artifacts

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Defaults

```
clear all;  
clc;  
close all;
```

1. Inputs, Variables, Constants

```
I = imread("cat.png");  
  
figure("Name","Original Image");  
imshow(I);  
title("Original RGB Image");
```

Original RGB Image



2. RGB -> YCbCr

```
Iycbcr = rgb2ycbcr(I);  
  
Y = Iycbcr(:,:,1);  
Cb = Iycbcr(:,:,2);  
Cr = Iycbcr(:,:,3);  
  
figure("Name","Color Space Conversion");  
subplot(1,2,1), imshow(I), title("RGB Color Space");  
subplot(1,2,2), imshow(Iycbcr), title("YCbCr Color Space");
```



3. Image Size Adjustment (Even dimensions for DWT)

```
[H,W] = size(Y);  
  
H2 = floor(H/2)*2;  
W2 = floor(W/2)*2;  
  
Y = Y(1:H2, 1:W2);  
Cb = Cb(1:H2, 1:W2);  
Cr = Cr(1:H2, 1:W2);
```

4. Chroma Subsampling (4:2:0)

```
Cb_ds = Cb(1:2:end, 1:2:end);  
Cr_ds = Cr(1:2:end, 1:2:end);  
  
figure("Name","Chroma Subsampling");  
subplot(1,3,1), imshow(Y), title("Y - Luminance");  
subplot(1,3,2), imshow(Cb_ds), title("Cb - Subsampled");  
subplot(1,3,3), imshow(Cr_ds), title("Cr - Subsampled");
```

RGB Color Space



YCbCr Color Space



Y - Luminance



Cb - Subsampled



Cr - Subsampled

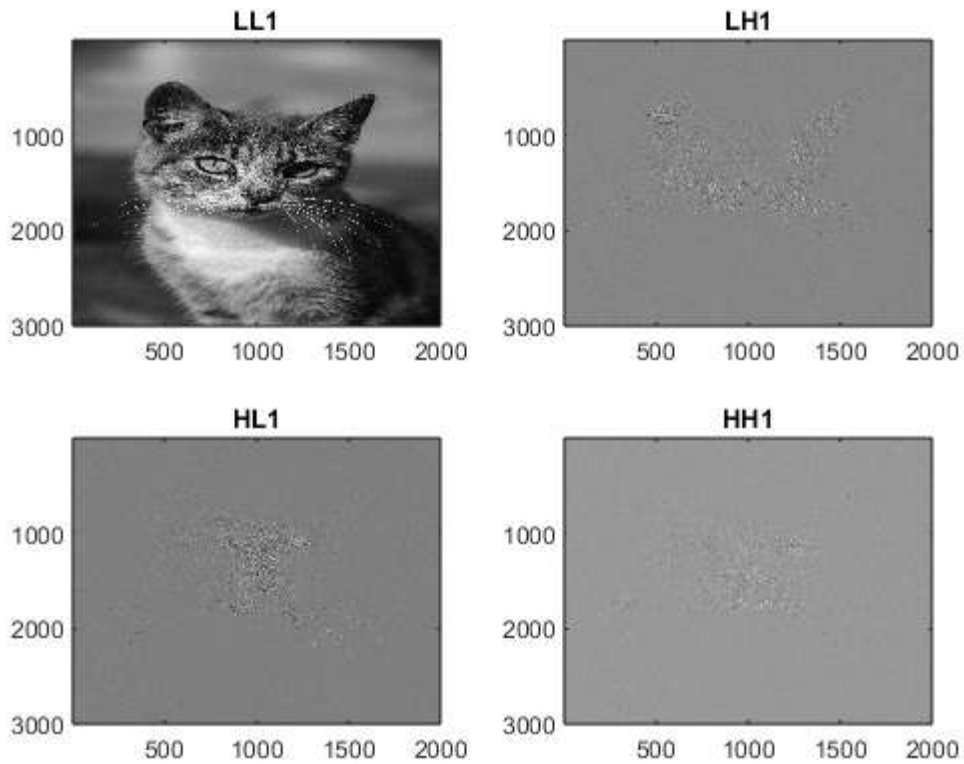


5. Convert Y to Double

```
Y = double(Y);
```

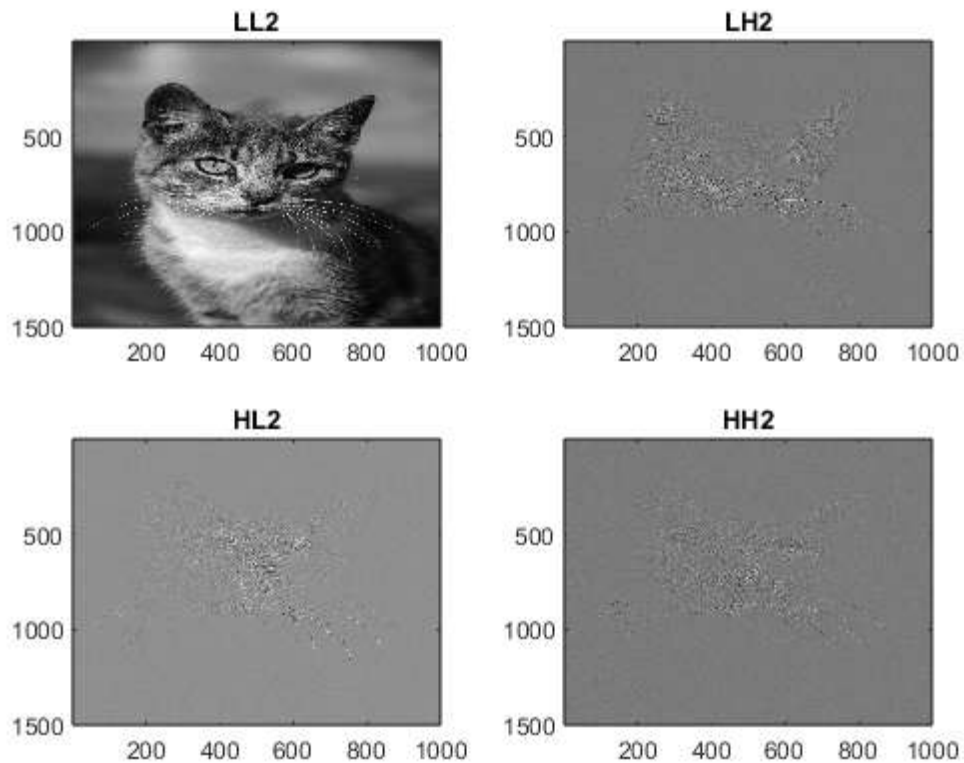
6. Level-1 2D HAAR DWT

```
[LL1, LH1, HL1, HH1] = dwt2(Y, 'haar');  
  
figure("Name","Level-1 DWT Subbands");  
subplot(2,2,1), imagesc(LL1), colormap gray, title("LL1");  
subplot(2,2,2), imagesc(LH1), colormap gray, title("LH1");  
subplot(2,2,3), imagesc(HL1), colormap gray, title("HL1");  
subplot(2,2,4), imagesc(HH1), colormap gray, title("HH1");
```



7. Level-2 DWT on LL1

```
[LL2, LH2, HL2, HH2] = dwt2(LL1, 'haar');  
  
figure("Name","Level-2 DWT Subbands");  
subplot(2,2,1), imagesc(LL2), colormap gray, title("LL2");  
subplot(2,2,2), imagesc(LH2), colormap gray, title("LH2");  
subplot(2,2,3), imagesc(HL2), colormap gray, title("HL2");  
subplot(2,2,4), imagesc(HH2), colormap gray, title("HH2");
```



8. Thresholding (JPEG2000-style Quantization)

```
T1 = 20;    % Threshold for level-1 details
T2 = 30;    % Threshold for level-2 details
```

```
LH1(abs(LH1) < T1) = 0;
HL1(abs(HL1) < T1) = 0;
HH1(abs(HH1) < T1) = 0;
```

```
LH2(abs(LH2) < T2) = 0;
HL2(abs(HL2) < T2) = 0;
HH2(abs(HH2) < T2) = 0;
```

9. Inverse DWT for Reconstruction

```
LL1_rec = idwt2(LL2, LH2, HL2, HH2, 'haar');
Y_rec   = idwt2(LL1_rec, LH1, HL1, HH1, 'haar');

Y_rec = uint8(min(max(Y_rec,0),255));
```

10. Chroma Upsampling (4:2:0 -> 4:4:4)

```
Cb_rec = imresize(Cb_ds, 2, 'bilinear');
Cr_rec = imresize(Cr_ds, 2, 'bilinear');

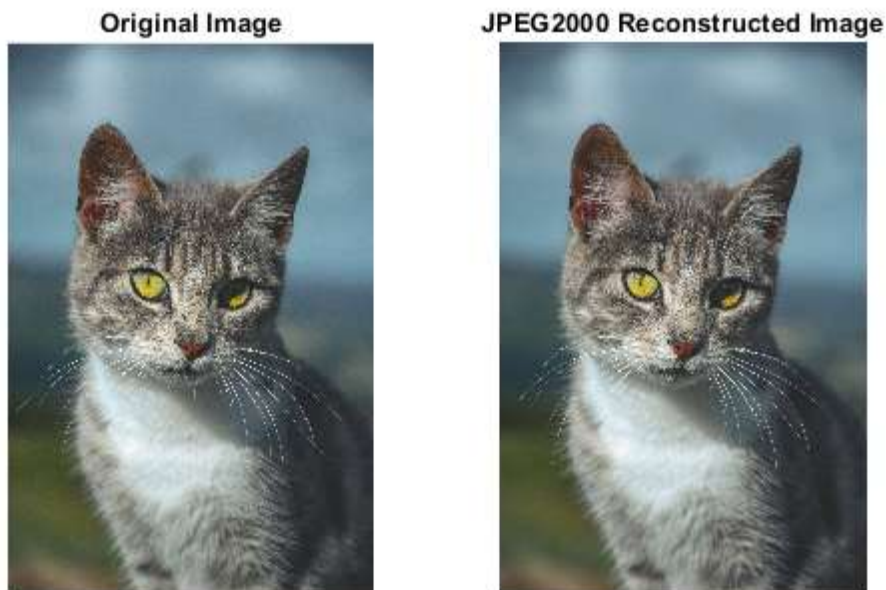
Cb_rec = uint8(Cb_rec(1:H2,1:W2));
Cr_rec = uint8(Cr_rec(1:H2,1:W2));
```

11. Recombine channels and YCbCr -> RGB

```
Iycbcr_rec = cat(3, Y_rec, Cb_rec, Cr_rec);  
I_rec = ycbcr2rgb(Iycbcr_rec);
```

12. Final Visual Comparison

```
figure("Name","JPEG2000 (DWT) Result");  
subplot(1,2,1), imshow(I(1:H2,1:W2,:)), title("Original Image");  
subplot(1,2,2), imshow(I_rec), title("JPEG2000 Reconstructed Image");
```



13. Quality Metrics

```
mse = mean((double(I(1:H2,1:W2,:)) - double(I_rec)).^2, 'all');  
psnr_val = 10*log10(255^2 / mse);  
  
fprintf("MSE = %.4f\n", mse);  
fprintf("PSNR = %.2f dB\n", psnr_val);
```

```
MSE = 16.8020  
PSNR = 35.88 dB
```