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

## Read the image

```
I = imread('cameraman.tif'); % Replace with your image

% Convert to grayscale if it is RGB
if size(I,3) == 3
    I = rgb2gray(I);
end

% Convert to double for processing
I = im2double(I);
```

## Ensure even dimensions

```
[M, N] = size(I);
I = I(1:floor(M/2)*2, 1:floor(N/2)*2);
```

## --- Manual 1-Level Haar DWT ---

Approximation (CA) and Detail coefficients (CH, CV, CD)

```
CA = (I(1:2:end,1:2:end) + I(1:2:end,2:2:end) + ...
      I(2:2:end,1:2:end) + I(2:2:end,2:2:end)) / 2;

CH = (I(1:2:end,1:2:end) - I(1:2:end,2:2:end) + ...
      I(2:2:end,1:2:end) - I(2:2:end,2:2:end)) / 2;

CV = (I(1:2:end,1:2:end) + I(1:2:end,2:2:end) - ...
      I(2:2:end,1:2:end) - I(2:2:end,2:2:end)) / 2;

CD = (I(1:2:end,1:2:end) - I(1:2:end,2:2:end) - ...
      I(2:2:end,1:2:end) + I(2:2:end,2:2:end)) / 2;
```

## --- Display results ---

```
figure('Name','Manual Haar DWT','NumberTitle','off');
```

---

```

subplot(2,3,1);
imshow(I, []);
title('Original Grayscale');

subplot(2,3,2);
imshow(CA, []);
title('Approximation (CA)');

subplot(2,3,3);
imshow(abs(CH), []);
title('Horizontal Detail (CH)');

subplot(2,3,5);
imshow(abs(CV), []);
title('Vertical Detail (CV)');

subplot(2,3,6);
imshow(abs(CD), []);
title('Diagonal Detail (CD)');

% Optional: Remove empty subplot (2,3,4) for cleaner layout

```

**Original Grayscale**



**Approximation (CA)**



**Horizontal Detail (CH)**



**Vertical Detail (CV)**



**Diagonal Detail (CD)**

