

Image Compression using Discrete Cosine Transform (DCT) in MATLAB

Objective:

To implement an efficient image compression algorithm using the Discrete Cosine Transform (DCT) and evaluate compression ratio and image quality.

Introduction:

Image compression reduces the size of image files without significantly degrading image quality, enabling efficient storage and transmission. The Discrete Cosine Transform (DCT) is widely used in JPEG compression as it transforms image data from the spatial domain into the frequency domain. In this domain, high-frequency components (which the human eye is less sensitive to) can be reduced or discarded, achieving compression with minimal quality loss.

Steps Involved:

1. Read the input image.
2. Convert the image to grayscale (if RGB).
3. Divide the image into blocks (e.g., 8×8).
4. Apply 2D-DCT to each block.
5. Quantize and retain only significant coefficients.
6. Store compressed data.
7. Apply inverse DCT (IDCT) to reconstruct the image.
8. Evaluate performance using Compression Ratio (CR) and PSNR.

MATLAB Code:

```
% Image Compression using DCT
clc; clear; close all;

% Step 1: Read Image
img = imread('peppers.png'); % example image
img_gray = rgb2gray(img);
figure, imshow(img_gray), title('Original Image');

% Step 2: Apply DCT
dct_img = dct2(img_gray);

% Step 3: Keep only top coefficients (Compression)
k = 50; % percentage of coefficients to keep
[m, n] = size(dct_img);
mask = zeros(m, n);
mask(1:round(m*k/100), 1:round(n*k/100)) = 1;
compressed_dct = dct_img .* mask;

% Step 4: Reconstruct image using IDCT
reconstructed_img = uint8(idct2(compressed_dct));

% Step 5: Display results
figure, imshow(reconstructed_img), title(['Reconstructed Image with ', num2str(k), '% coefficients'])
% Step 6: Performance Metrics
```

```
MSE = immse(reconstructed_img, img_gray);  
PSNR = 10 * log10(255^2 / MSE);  
disp(['MSE: ', num2str(MSE)]);  
disp(['PSNR: ', num2str(PSNR), ' dB']);
```

Applications:

- JPEG Image Compression
- Reducing image storage in databases
- Faster transmission of images over networks
- Multimedia and digital photography systems

Conclusion:

This project demonstrates image compression using DCT in MATLAB. The results show that a significant amount of image data can be discarded while retaining acceptable visual quality. This technique is widely used in JPEG compression, making it highly relevant in real-world applications such as multimedia storage and transmission.