Image and Video Processing Lab

Mini Project - JPEG Compression

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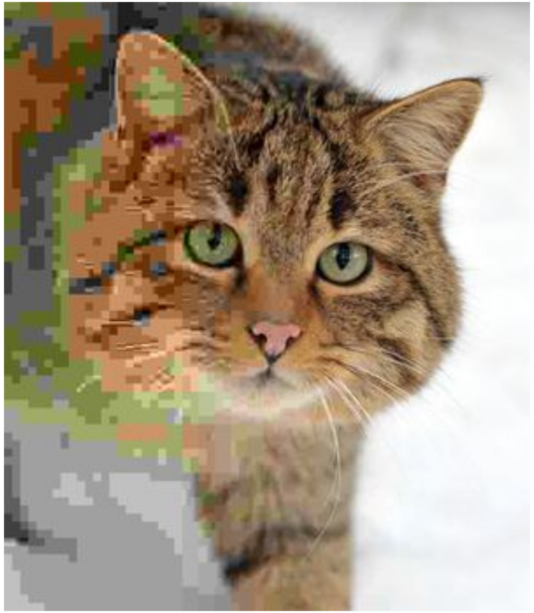
JPEG

JPEG (Joint Photographic Experts Group) is a widely used compression standard, especially for photographic images, developed in the late 1980s.

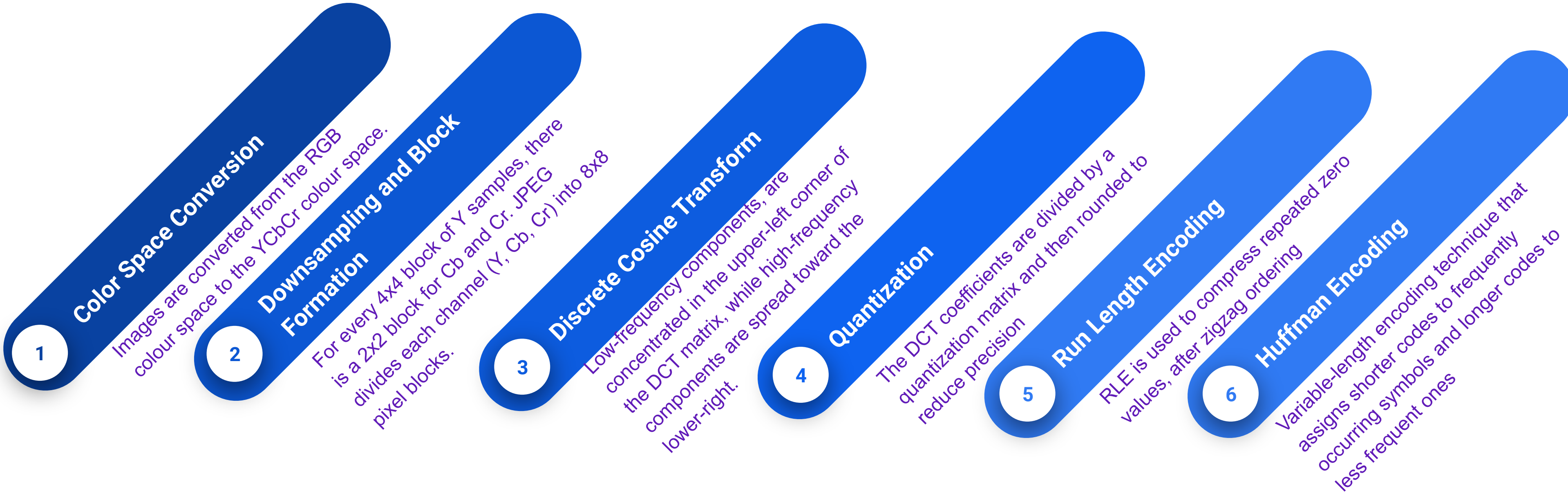
It's optimized for compressing images with complex color gradients and high detail, where preserving visual quality is essential.

JPEG uses lossy compression to reduce file sizes, making it easier to store and share images without significantly compromising visual quality.



A photo of a European wildcat with the compression rate, and associated losses, decreasing from left to right

JPEG Compression Pipeline



1 **Color Space Conversion**

Images are converted from the RGB colour space to the YCbCr colour space.

2 **Downsampling and Block Formation**

For every 4x4 block of Y samples, there is a 2x2 block for Cb and Cr. JPEG divides each channel (Y, Cb, Cr) into 8x8 pixel blocks.

3 **Discrete Cosine Transform**

Low-frequency components, are concentrated in the upper-left corner of the DCT matrix, while high-frequency components are spread toward the lower-right.

4 **Quantization**

The DCT coefficients are divided by a quantization matrix and then rounded to reduce precision

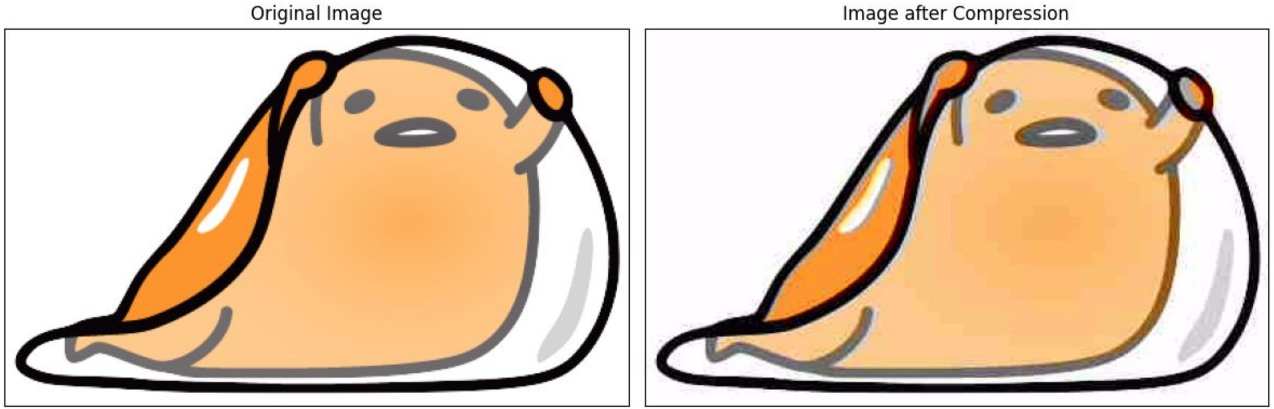
5 **Run Length Encoding**

RLE is used to compress repeated zero values, after zigzag ordering

6 **Huffman Encoding**

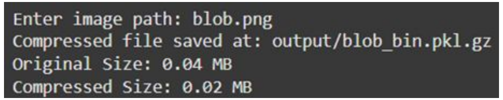
Variable-length encoding technique that assigns shorter codes to frequently occurring symbols and longer codes to less frequent ones

Results

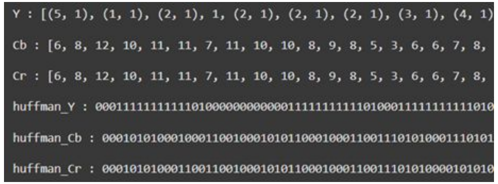


Original Image

Image after Compression



```
Enter image path: blob.png
Compressed file saved at: output/blob_bin.pkl.gz
Original Size: 0.04 MB
Compressed Size: 0.02 MB
```



```
Y : [(5, 1), (1, 1), (2, 1), 1, (2, 1), (2, 1), (2, 1), (3, 1), (4, 1)

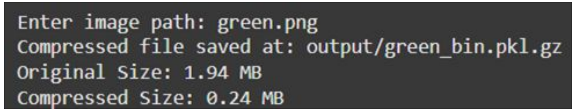
Cb : [6, 8, 12, 10, 11, 11, 7, 11, 10, 10, 8, 9, 8, 5, 3, 6, 6, 7, 8,

Cr : [6, 8, 12, 10, 11, 11, 7, 11, 10, 10, 8, 9, 8, 5, 3, 6, 6, 7, 8,

huffman_Y : 000111111111110100000000000001111111111101000111111111111010

huffman_Cb : 000101010001000110010001010110001000110011101010001110101

huffman_Cr : 000101010001100110010001010110001000110011101010000101010
```



```
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Compressed Size: 0.24 MB
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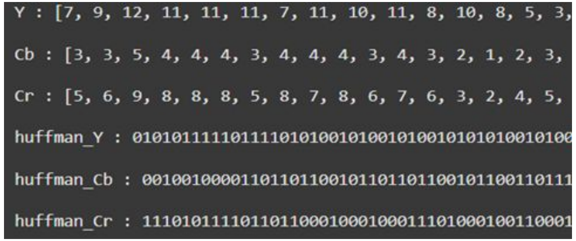


```
Y : [7, 9, 12, 11, 11, 11, 7, 11, 10, 11, 8, 10, 8, 5, 3,

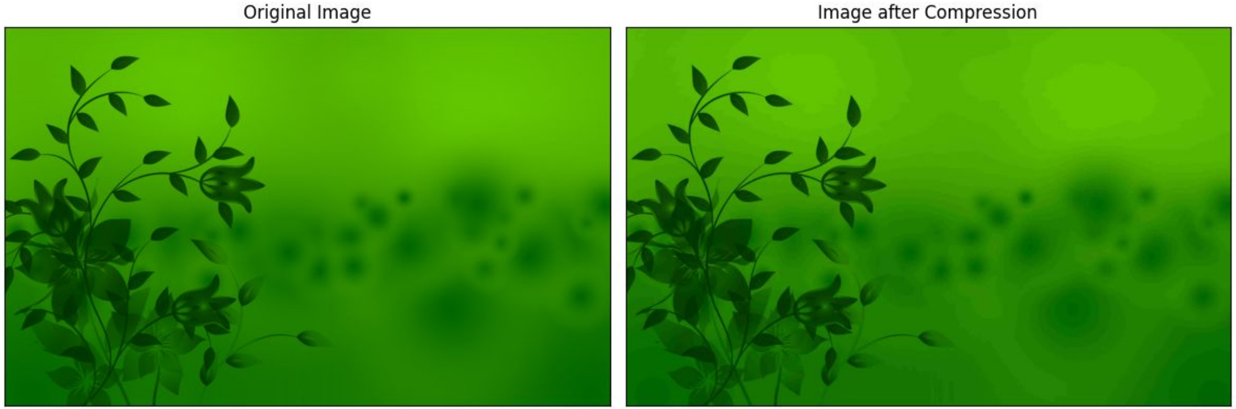
Cb : [3, 3, 5, 4, 4, 4, 3, 4, 4, 4, 3, 4, 3, 2, 1, 2, 3,

Cr : [5, 6, 9, 8, 8, 8, 5, 8, 7, 8, 6, 7, 6, 3, 2, 4, 5,

huffman_Y : 010101111101111010100101001010010101010010100

huffman_Cb : 00100100001101101100101101101100101100110111

huffman_Cr : 11101011110110110001000100011101000100110001
```



Original Image

Image after Compression

Results

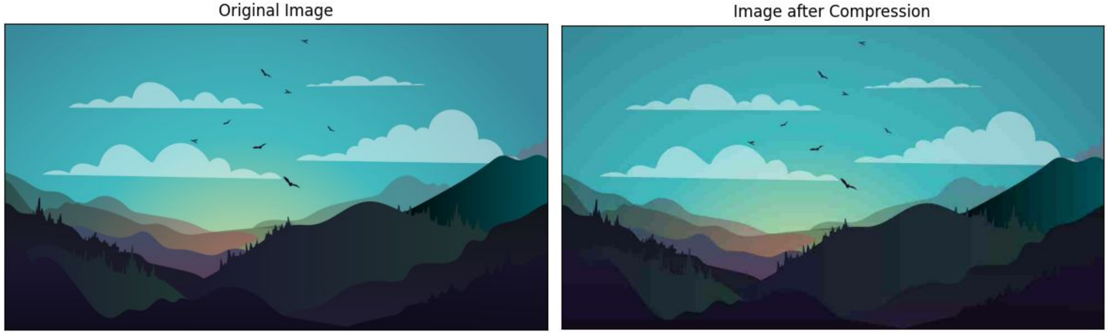
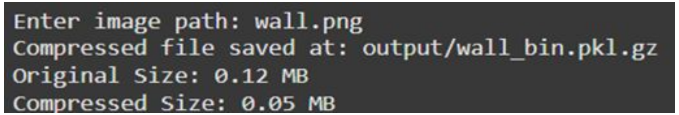
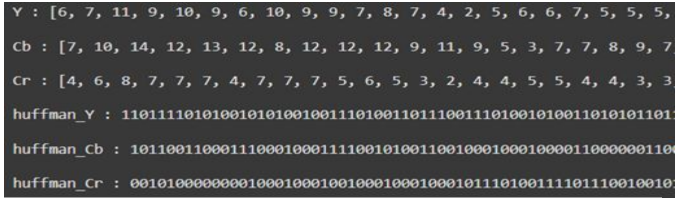

Original Image

Image after Compression


```
Enter image path: wall.png
Compressed file saved at: output/wall_bin.pkl.gz
Original Size: 0.12 MB
Compressed Size: 0.05 MB
```


```
Y : [6, 7, 11, 9, 10, 9, 6, 10, 9, 9, 7, 8, 7, 4, 2, 5, 6, 6, 7, 5, 5, 5,

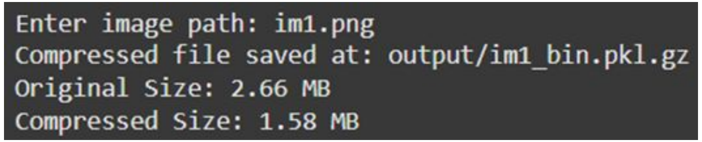
Cb : [7, 10, 14, 12, 13, 12, 8, 12, 12, 12, 9, 11, 9, 5, 3, 7, 7, 8, 9, 7

Cr : [4, 6, 8, 7, 7, 7, 4, 7, 7, 7, 5, 6, 5, 3, 2, 4, 4, 5, 5, 4, 4, 3, 3

huffman_Y : 1101111010100101010010011101001101110011101001010011010101101

huffman_Cb : 1011001100011100010001111001010011001000100010000110000001100

huffman_Cr : 0010100000000010001000100100010001000101110100111101110010010
```


```
Enter image path: im1.png
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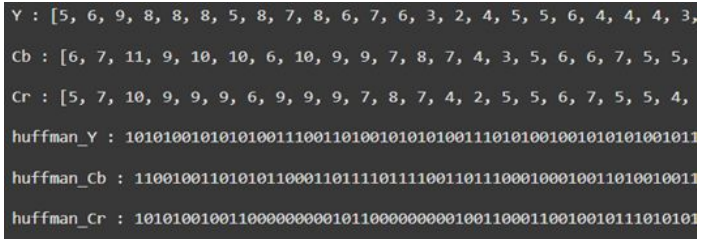
Compressed Size: 1.58 MB
```


```
Y : [5, 6, 9, 8, 8, 8, 5, 8, 7, 8, 6, 7, 6, 3, 2, 4, 5, 5, 6, 4, 4, 4, 3,

Cb : [6, 7, 11, 9, 10, 10, 6, 10, 9, 9, 7, 8, 7, 4, 3, 5, 6, 6, 7, 5, 5,

Cr : [5, 7, 10, 9, 9, 9, 6, 9, 9, 9, 7, 8, 7, 4, 2, 5, 5, 6, 7, 5, 5, 4,

huffman_Y : 1010100101010100111001101001010101001110101001001010101001011

huffman_Cb : 1100100110101011000110111101111001101110001000100110100100 11

huffman_Cr : 1010100100110000000000101100000000001001100011001001011101010 1
```

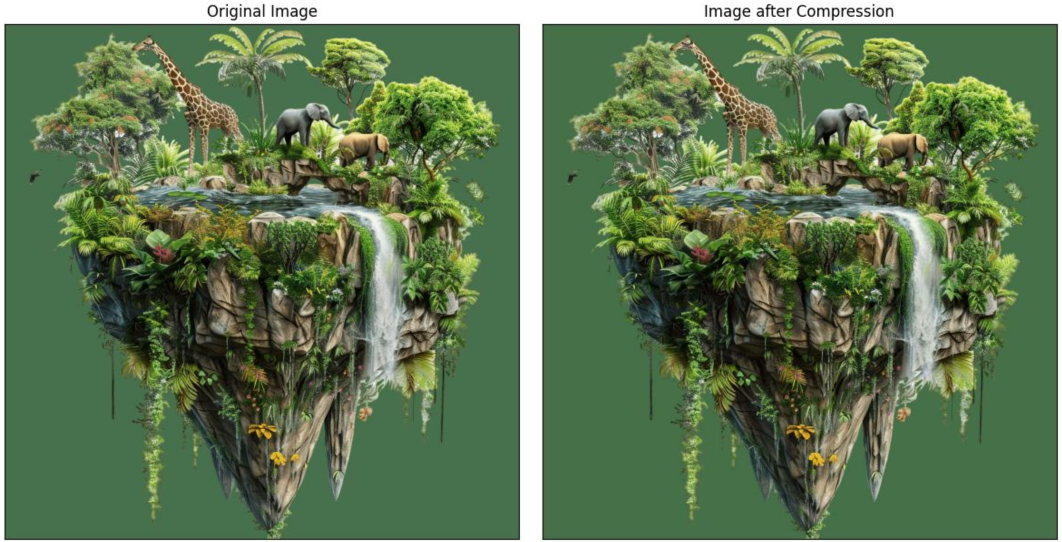
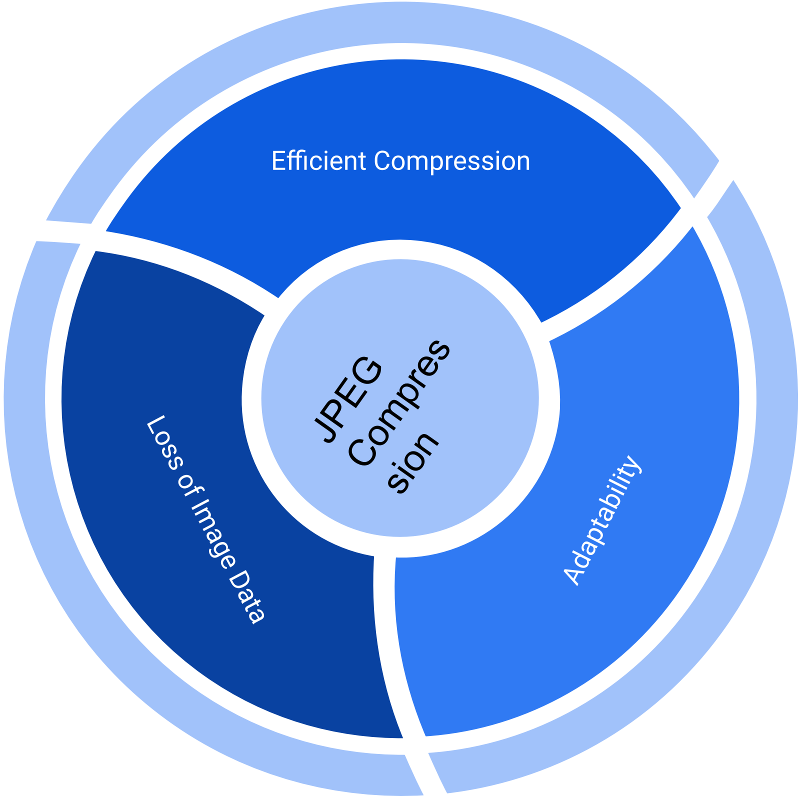

Original Image

Image after Compression

Conclusion


Efficient Compression
JPEG Compression
Loss of Image Data
Adaptability