CS517

REPORT

JPEG COMPRESSION

Presented By: Sahil

Entry No: 2021CSB1128

Introduction

In the field of digital image processing, the need for image compression arises due to the ever-increasing amount of digital image data being generated and shared on various platforms. High-resolution images occupy a significant amount of storage space and makes it cumbersome to transmit data. Image compression techniques are used to reduce the size of digital images while preserving the visual quality and details of the image. This reduction in size results in improved storage and transmission efficiency, making it easier to store, share, and process large amounts of digital image data. Various algorithms are used for image compression. This report mainly focuses on **JPEG Compression**.

JPEG COMPRESSION

JPEG, short for Joint Photographic Experts Group, is a widely used image compression standard for digital images. It was developed by a group of experts from the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) in the late 1980s.

JPEG compression is a lossy compression technique, which means that it sacrifices some image quality to achieve a smaller file size. The compression process involves dividing the image into 8x8 pixel blocks and applying a Discrete Cosine Transform (DCT) to each block to convert it from the spatial domain to the frequency domain. The resulting frequency coefficients are then quantized, which means that some of the less significant coefficients are rounded off or set to zero. This quantization process introduces some loss of information and contributes to the compression.

INPUT AND OUTPUT

For the JPEG compression, I have made two functions- one for the encoding of image (JPEG_encoder()) and another for the decoding of encoded pattern (JPEG_decoder()). JPEG_encoder() takes 4 arguments - filename, blockSize, no. of coefficients and isColoured. The default value of the blockSize is 8 which corresponds to squares of 8 x 8 and encoding of each 8 x 8 block is written in text file namely jpeg_encoded.txt. We can change the value of blockSize as per our wish with -1 corresponding to the whole image.

The no. of coefficients here refer to the number of values we want in the zigzag pattern. The default value of no. of coefficients is -1 which corresponds to all the values in the smaller matrices. The isColoured parameter tells whether we want to perform the JPEG compression on coloured images or gray scale images.

The decoder function is used to decode the encoded pattern. The decoded output is shown and various parameters are calculated like rmse, compression ratio and psnr etc. which helps us to analyze various characteristics of the compression algorithms and it also shows the real importance of image compression in our daily life.

QUANTIZATION MATRICES USED

Quantization matrices are 8x8 matrices of integer values that are used to divide the frequency coefficients obtained from the DCT stage of JPEG compression. Each coefficient is divided by the corresponding value in the quantization matrix, and the result is rounded off to the nearest integer.

```
quantization_matrix = [[16, 11, 10, 16, 24, 40, 51, 61],
                       [12, 12, 14, 19, 26, 58, 60, 55],
                       [14, 13, 16, 24, 40, 57, 69, 56],
                       [14, 17, 22, 29, 51, 87, 80, 62],
                       [18, 22, 37, 56, 68, 109, 103, 77],
                       [24, 35, 55, 64, 81, 104, 113, 92],
                       [49, 64, 78, 87, 103, 121, 120, 101],
                       [72, 92, 95, 98, 112, 100, 103, 99]]
```

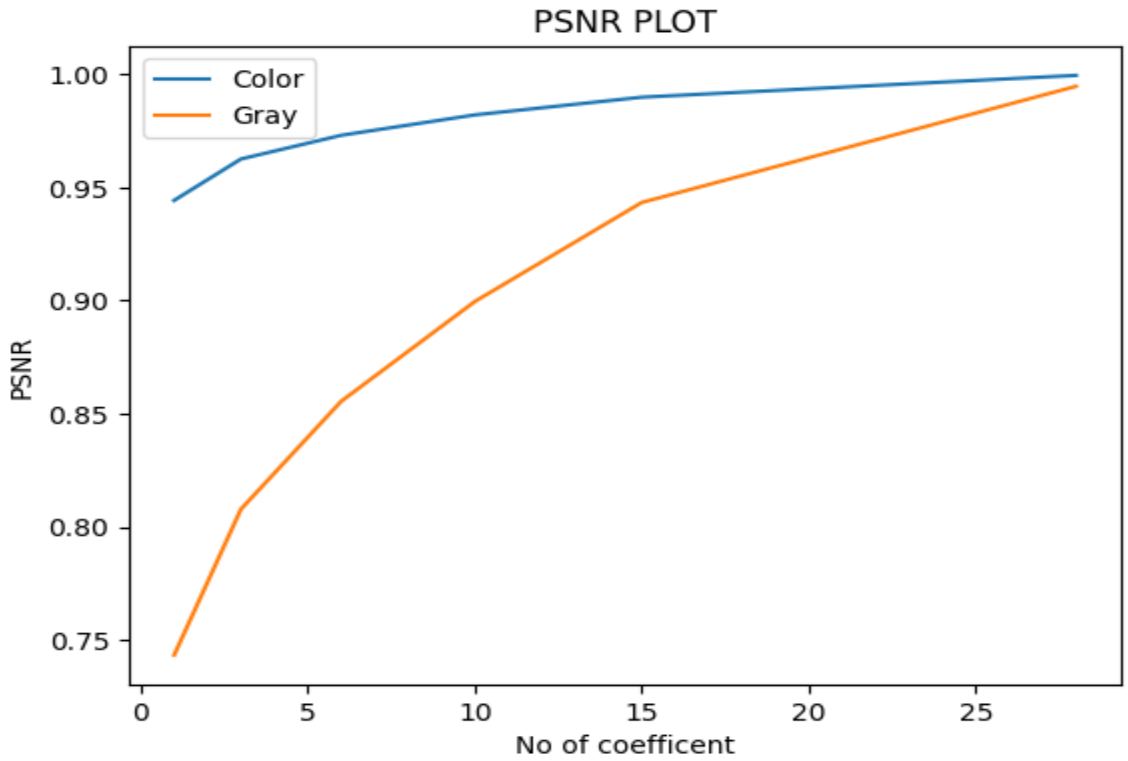
```
quantization_matrix_cbcr = [[17, 18, 24, 47, 99, 99, 99, 99],
                            [18, 21, 26, 66, 99, 99, 99, 99],
                            [24, 26, 56, 99, 99, 99, 99, 99],
                            [47, 66, 99, 99, 99, 99, 99, 99],
                            [99, 99, 99, 99, 99, 99, 99, 99],
                            [99, 99, 99, 99, 99, 99, 99, 99],
                            [99, 99, 99, 99, 99, 99, 99, 99],
                            [99, 99, 99, 99, 99, 99, 99, 99]]
```

ANALYSIS

- **PSNR TABLE**

SR No.	Block Size	No of Coeff.	Avg PSNR (Color)	Avg PSNR (Gray)
1	8 x 8	1	0.944256995	0.743342025
2	8 x 8	3	0.962547313	0.807812318
3	8 x 8	6	0.973014915	0.855461966
4	8 x 8	10	0.982027634	0.899546618
5	8 x 8	15	0.989850991	0.943341415
6	8 X 8	28	0.999486672	0.994667357

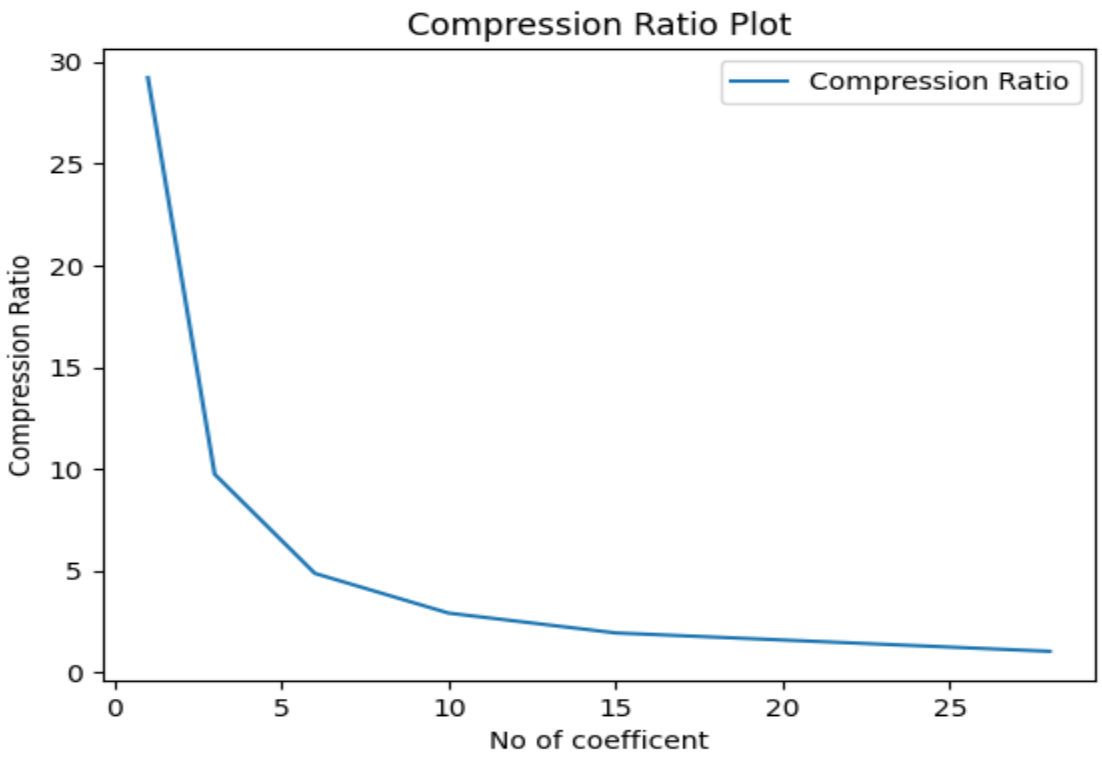
- **GRAPH - PSNR VS NO OF COEFFICIENT**



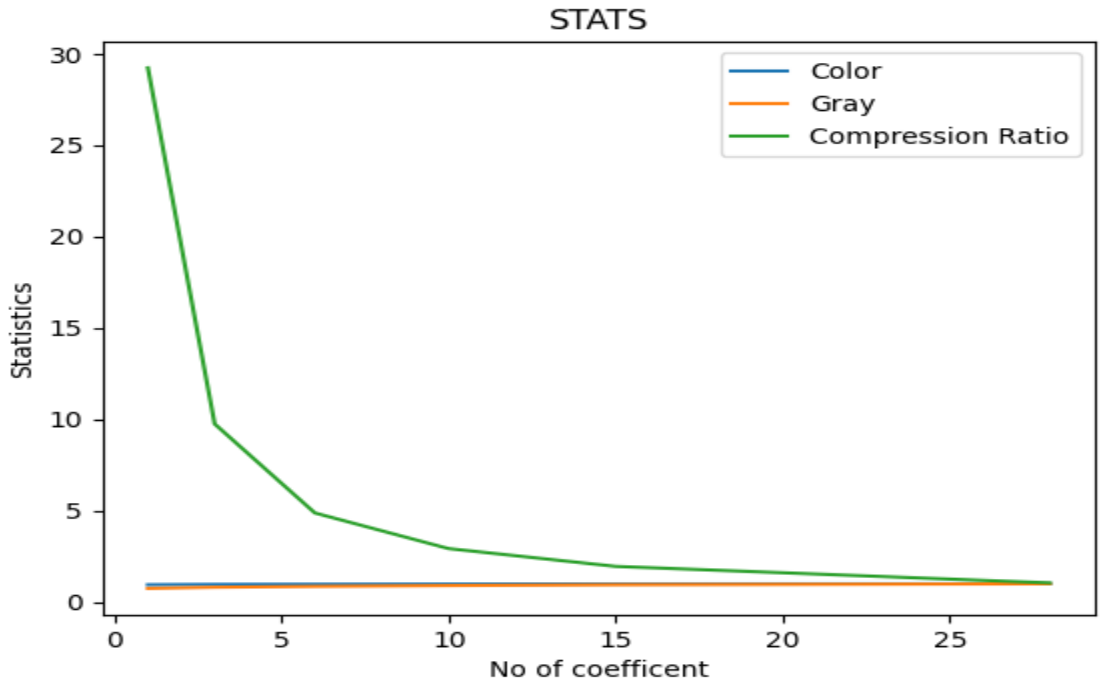
- **COMPRESSION RATIO**

SR No.	Block Size	No of Coeff.	Avg Compression Ratio
1	8 x 8	1	29.22666666666
2	8 x 8	3	9.742222222222
3	8 x 8	6	4.871111111111
4	8 x 8	10	2.922666666666
5	8 x 8	15	1.948444444444
6	8 X 8	28	1.043809523809

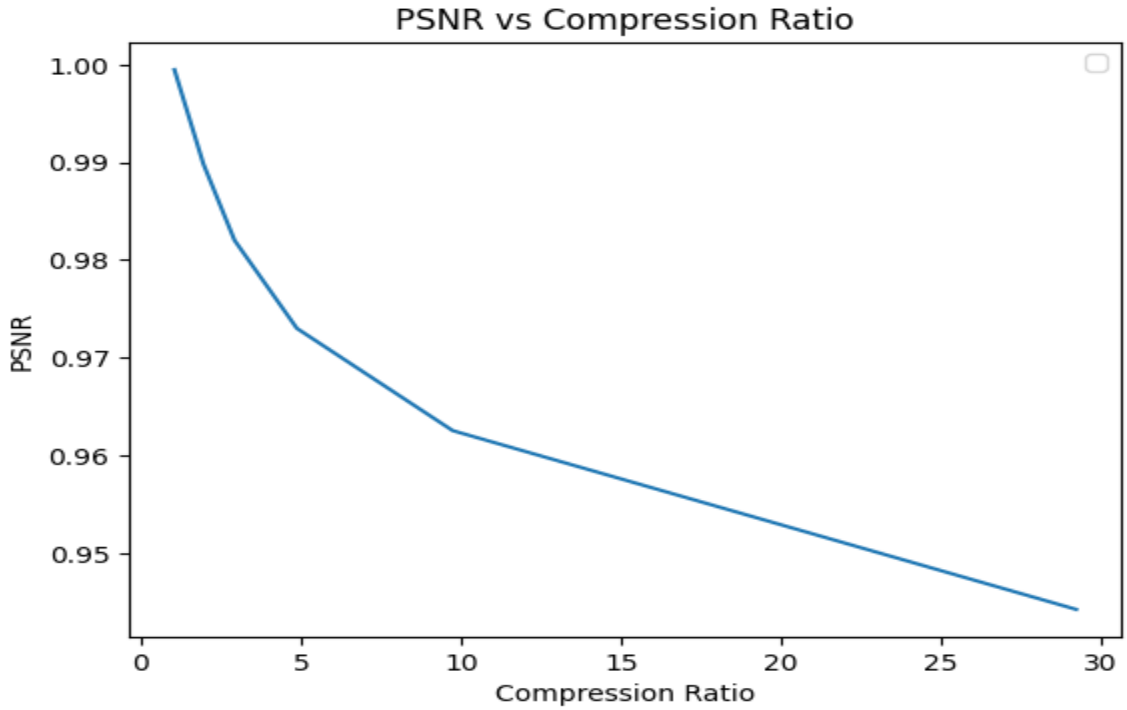
- **GRAPH - COMPRESSION RATIO VS NO OF COEFFICIENT**



- **COMBINED PLOT - COMPRESSION RATIO AND PSNR**



- **GRAPH - PSNR VS COMPRESSION RATIO**



OBSERVATIONS

- JPEG compression works well on photographic images with smooth color transitions, but may not be as effective on images with sharp edges or high-contrast areas.
- JPEG compression is a lossy compression algorithm, meaning that some information is lost during compression, which can result in a loss of image quality.
- JPEG compression allows for variable compression ratios, which can be adjusted depending on the desired balance between file size and image quality.
- JPEG compression can result in artifacts such as color banding and blurring.

CONCLUSION

Overall, JPEG compression is a useful technique for reducing the size of photographic images while maintaining acceptable image quality. It is particularly effective for images with smooth color transitions, and allows for variable compression ratios to balance file size and image quality. However, JPEG compression is a lossy compression algorithm and can result in artifacts that may be noticeable, especially at higher compression ratios. Nevertheless, JPEG compression is widely used in digital photography and is supported by most image editing software, making it an important tool in image processing and storage.