CS517, DIP

Image Compression using JPEG

Prepared by **Deepak Kumar (2022CSM1002)**

Indian Institute of Technology, Ropar

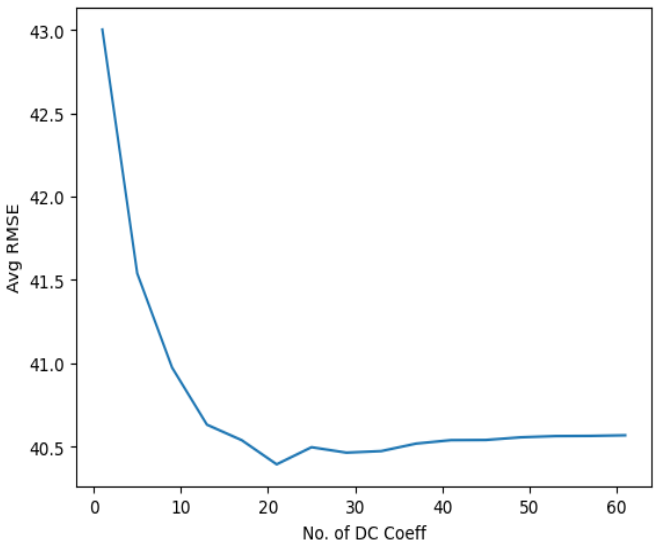
Introduction

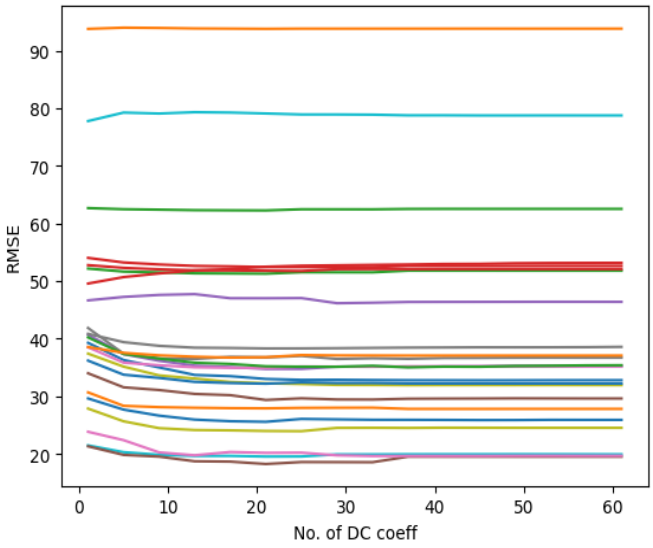
This assignment involves using JPEG and JZW compression techniques to compress a set of given images and analyzing the results. The goal is to evaluate the performance of both compression techniques and compare their effectiveness in reducing the file size while preserving image quality.
The JPEG compression algorithm works by reducing the image's resolution and color depth and then applying a discrete cosine transform and quantization to compress the data. The JZW compression algorithm uses a different approach by analyzing the image's data and identifying repeated patterns that can be represented using fewer bits. After compressing the images using both techniques, we will compare the results in terms of compression ratio, RMSE , and image quality using objective metrics such as peak signal-to-noise ratio (PSNR).

Analysis

1: Average RMSE vs DC coefficients

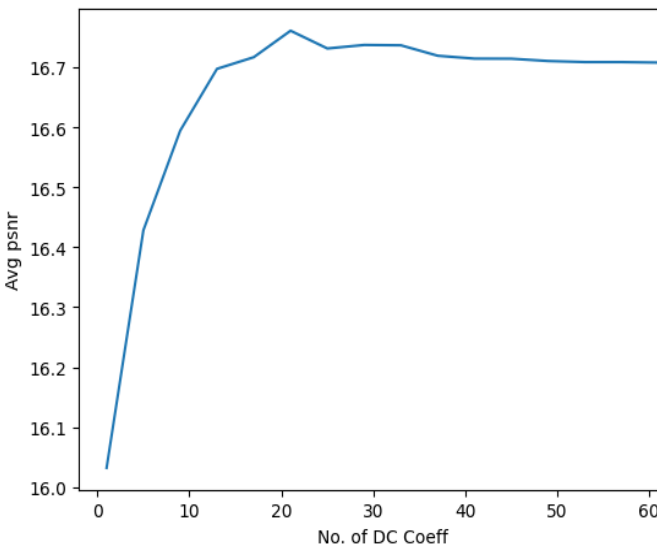
- As the number of discrete cosine coefficients used in the encoding process increases, the average RMSE decreases.
- When a larger number of DCT coefficients is used, more details from the original image are captured and preserved in the compressed image. This reduces the error introduced during the encoding process and therefore decreases the RMSE.
- On the other hand, if a smaller number of DCT coefficients is used, the compressed image loses more information and the RMSE is higher.

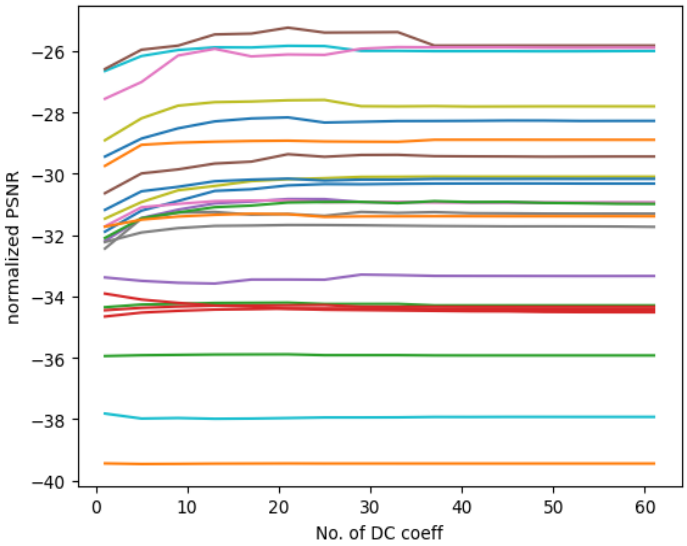




2: Average PSNR vs DC coefficients

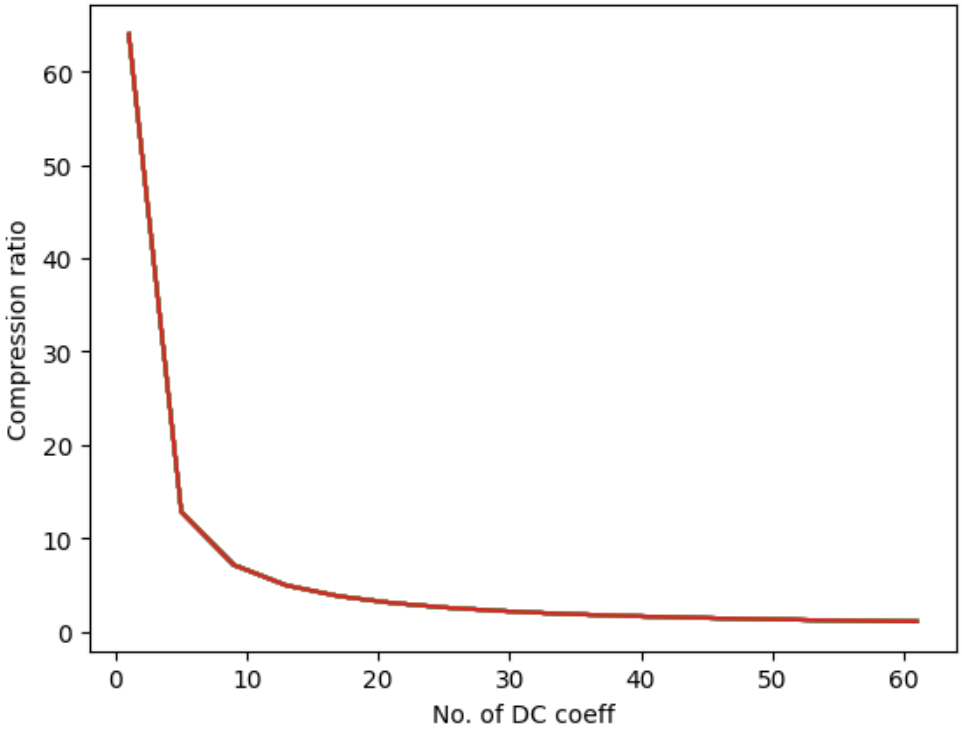
- As the number of discrete cosine coefficients used in the encoding process increases, the average PSNR also increases. This happens because using more DCT coefficients results in a better approximation of the original image, which leads to a higher PSNR.
- It is worth noting that this relationship between the number of DCT coefficients and PSNR is not always strictly increasing. There may be cases where increasing the number of DCT coefficients beyond a certain point does not result in a significant improvement in image quality





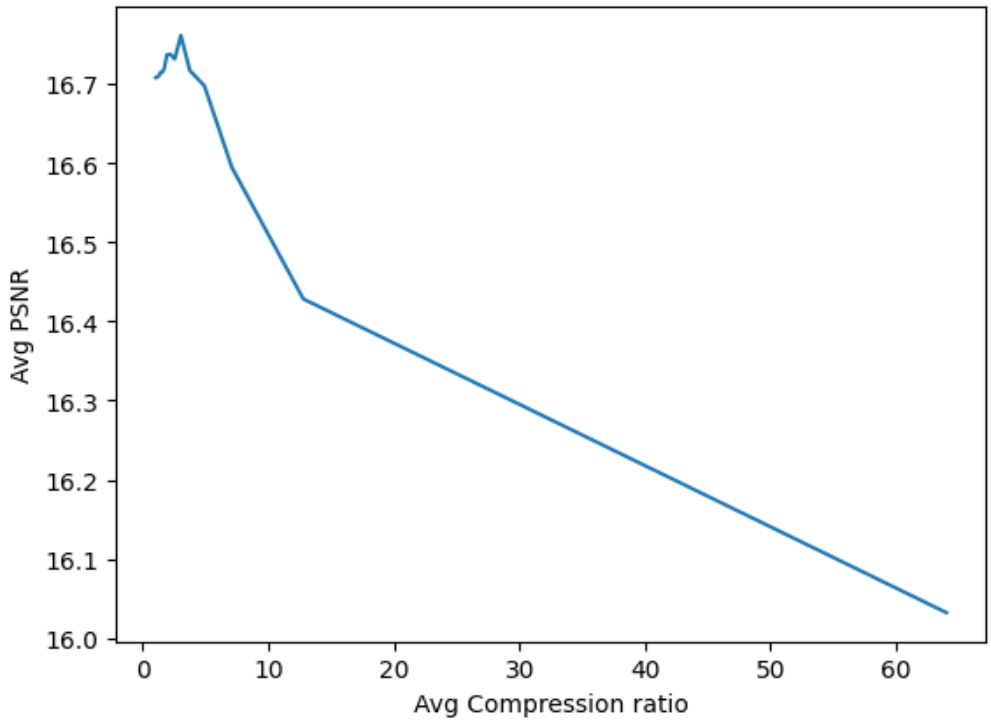
3: Compression ratio vs DC coefficients

- The compression ratio is a measure of the amount of compression achieved by the algorithm, and it is defined as the ratio of the size of the compressed data to the size of the original data.
- As the number of Discrete Cosine Coefficients (DCT) used in JPEG compression increases, the compression ratio generally tends to decrease. This is because using more DCT coefficients allows for a more accurate representation of the original image, which in turn requires more bits to encode. As a result, the compressed file size increases, leading to a lower compression ratio.



3: Average PSNR vs Average Compression ratio for multiple images

- As the average compression ratio increases, the average PSNR generally tends to decrease. This is because higher compression ratios mean that more data is being discarded or approximated, resulting in a loss of information in the compressed image.

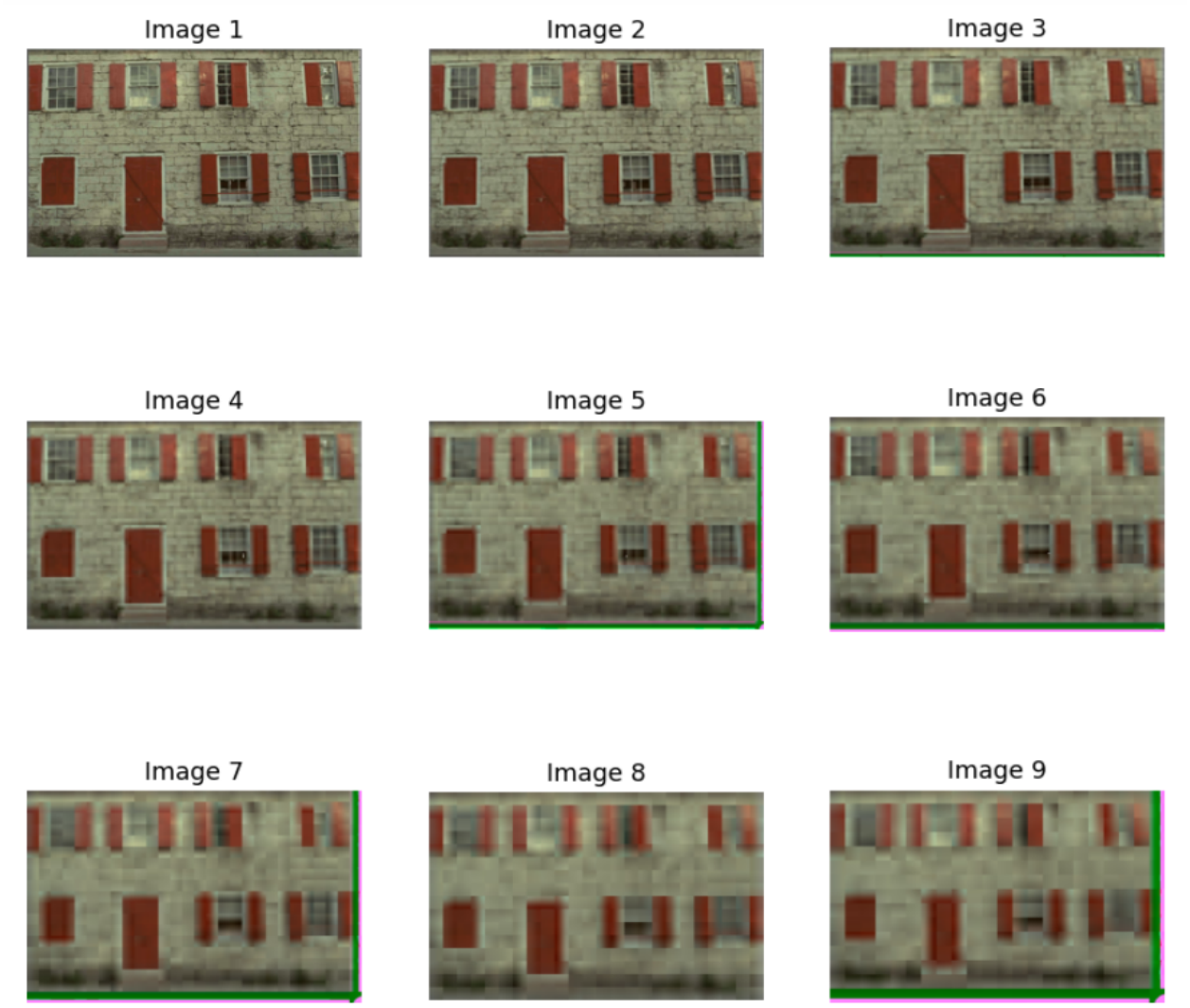


File name	1	5	9	13	17	21	25	29	33	37	41	45	49	53	57	61
kodim01.png	16.24	16.93	17.24	17.57	17.63	17.75	17.79	17.79	17.8	17.81	17.81	17.82	17.82	17.81	17.81	17.81
kodim02.png	8.69	8.67	8.68	8.68	8.69	8.69	8.69	8.69	8.69	8.69	8.69	8.69	8.69	8.69	8.69	8.69
kodim03.png	13.78	13.87	13.89	13.92	13.92	13.93	13.89	13.89	13.89	13.84	13.84	13.84	13.84	13.84	13.84	13.84
kodim04.png	13.68	13.76	13.8	13.83	13.84	13.84	13.85	13.8	13.8	13.8	13.79	13.79	13.8	13.8	13.8	13.8
kodim05.png	15.94	16.69	16.96	17.17	17.23	17.31	17.3	17.21	17.2	17.22	17.2	17.2	17.18	17.18	17.19	17.19
kodim06.png	17.5	18.14	18.27	18.46	18.53	18.77	18.69	18.74	18.75	18.71	18.7	18.69	18.69	18.69	18.69	18.69
kodim07.png	16.41	17.04	17.15	17.24	17.26	17.27	17.21	17.21	17.21	17.2	17.2	17.2	17.2	17.2	17.2	17.2
kodim08.png	15.69	16.67	16.87	16.89	16.8	16.82	16.76	16.89	16.86	16.88	16.85	16.84	16.83	16.83	16.83	16.83
kodim09.png	19.22	19.94	20.35	20.47	20.49	20.53	20.54	20.33	20.33	20.34	20.32	20.33	20.33	20.33	20.33	20.33
kodim10.png	21.48	21.97	22.17	22.25	22.25	22.3	22.29	22.14	22.14	22.13	22.13	22.13	22.12	22.12	22.13	22.13
kodim11.png	18.69	19.28	19.61	19.84	19.94	19.97	19.8	19.83	19.85	19.85	19.86	19.87	19.87	19.85	19.86	19.86
kodim12.png	18.39	19.08	19.14	19.18	19.2	19.21	19.18	19.18	19.17	19.24	19.24	19.24	19.24	19.24	19.24	19.24
kodim13.png	16.04	16.68	16.87	17.04	17.09	17.19	17.21	17.22	17.17	17.24	17.21	17.22	17.18	17.17	17.15	17.15
kodim14.png	13.48	13.61	13.66	13.7	13.72	13.74	13.74	13.74	13.74	13.7	13.71	13.71	13.71	13.7	13.7	13.7
kodim15.png	14.75	14.64	14.58	14.55	14.68	14.68	14.68	14.84	14.83	14.8	14.8	14.8	14.8	14.8	14.8	14.8
kodim16.png	21.55	22.18	22.31	22.67	22.7	22.89	22.73	22.74	22.75	22.31	22.31	22.31	22.31	22.31	22.31	22.31
kodim17.png	20.58	21.12	21.99	22.2	21.96	22.02	22.01	22.21	22.26	22.25	22.25	22.25	22.24	22.24	22.24	22.24
kodim18.png	15.91	16.22	16.36	16.43	16.44	16.46	16.46	16.45	16.44	16.43	16.42	16.42	16.42	16.42	16.41	16.4
kodim19.png	16.67	17.21	17.59	17.73	17.89	17.95	17.99	18.03	18.03	18.04	18.04	18.04	18.04	18.04	18.04	18.04
kodim20.png	10.31	10.15	10.17	10.14	10.15	10.17	10.19	10.19	10.19	10.2	10.2	10.21	10.21	10.21	10.21	10.21
kodim21.png	16.95	17.56	17.71	17.89	17.94	17.97	17.91	17.94	17.94	17.96	17.96	17.96	17.97	17.96	17.97	17.97
kodim22.png	16.41	16.64	16.74	16.79	16.83	16.81	16.73	16.74	16.74	16.75	16.75	16.75	16.75	16.75	16.75	16.75
kodim23.png	12.19	12.22	12.23	12.24	12.24	12.25	12.22	12.22	12.22	12.21	12.21	12.21	12.21	12.21	12.21	12.21
kodim24.png	14.22	14.03	13.92	13.83	13.8	13.73	13.7	13.69	13.68	13.66	13.65	13.65	13.63	13.62	13.62	13.62

PSNR table for varying DC coefficents

4: Result of changing block size on visual perception of image

- By dividing the image into smaller blocks, the compression algorithm can focus on compressing each block individually, allowing for more effective use of the available bits and reducing the overall file size.
- Increasing the block size can improve compression efficiency by reducing the amount of redundancy in the image data and allowing for more accurate modeling of spatial frequency components.
- However, larger block sizes can also result in more blocking artifacts, where the compressed image exhibits visible blocky patterns in areas with sharp edges or high-frequency details.
- In general, smaller block sizes tend to produce higher quality compressed images with less blocking artifacts but may result in lower compression ratios due to increased overhead. Larger block sizes, on the other hand, tend to produce higher compression ratios but may result in lower image quality due to increased blocking artifacts.



Resultant images with different block size in increasing manner

DC Coefficients	Avg Comp	Avg PSNR	Avg RMSE
1	64	16.0322	43.003
5	12.8	16.4283	41.539
9	7.1111	16.5943	40.9743
13	4.923	16.6973	40.631
17	3.7647	16.71681	40.538
21	3.0476	16.76091	40.39
25	2.56	16.73136	40.496
29	2.2068	16.7372	40.46
33	1.9393	16.7366	40.472
37	1.7297	16.71924	40.51
41	1.5609	16.714453	40.538
45	1.4222	16.7143	40.539
49	1.3061	16.7104	40.555
53	1.20754	16.7086	40.563
57	1.1228	16.708	40.56
61	1.0491	16.70786	40.5678

Resultant images with increasing DC coefficients with block size equals 64

---Thank you---