ITC PROJECT

Image Compression using SVD

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Agenda

- ✔ To study and understand Image Compression and its applications.
- ✔ We will discuss various aspects and steps involved in SVD and its utilization in image compression.
- ✔ We will attempt to understand how the concept of SVD in image compression is implemented and how to maintain balance between compression and image quality.

Keyword – SVD (Singular Value Decomposition)

Objectives

- Reducing the size of an image and aiming to increase the capacity storage of media (limited in capacity). Images of lower size can be transmitted faster over the network.
- The objective of image compression is to reduce the redundancy of the image and to store and transfer the data in efficient form.
- The technique that we are going to use for the purpose of image compression is SVD which is known as singular value decomposition. We achieve compression by minimizing the number of bits to represent an image.

Redundancy Removal

Psycho Visual Redundancy

- Limitation of human eye to interpret fine details

Inter Pixel redundancy

- Redundancy due to similarities in neighboring pixels.

Coding redundancy

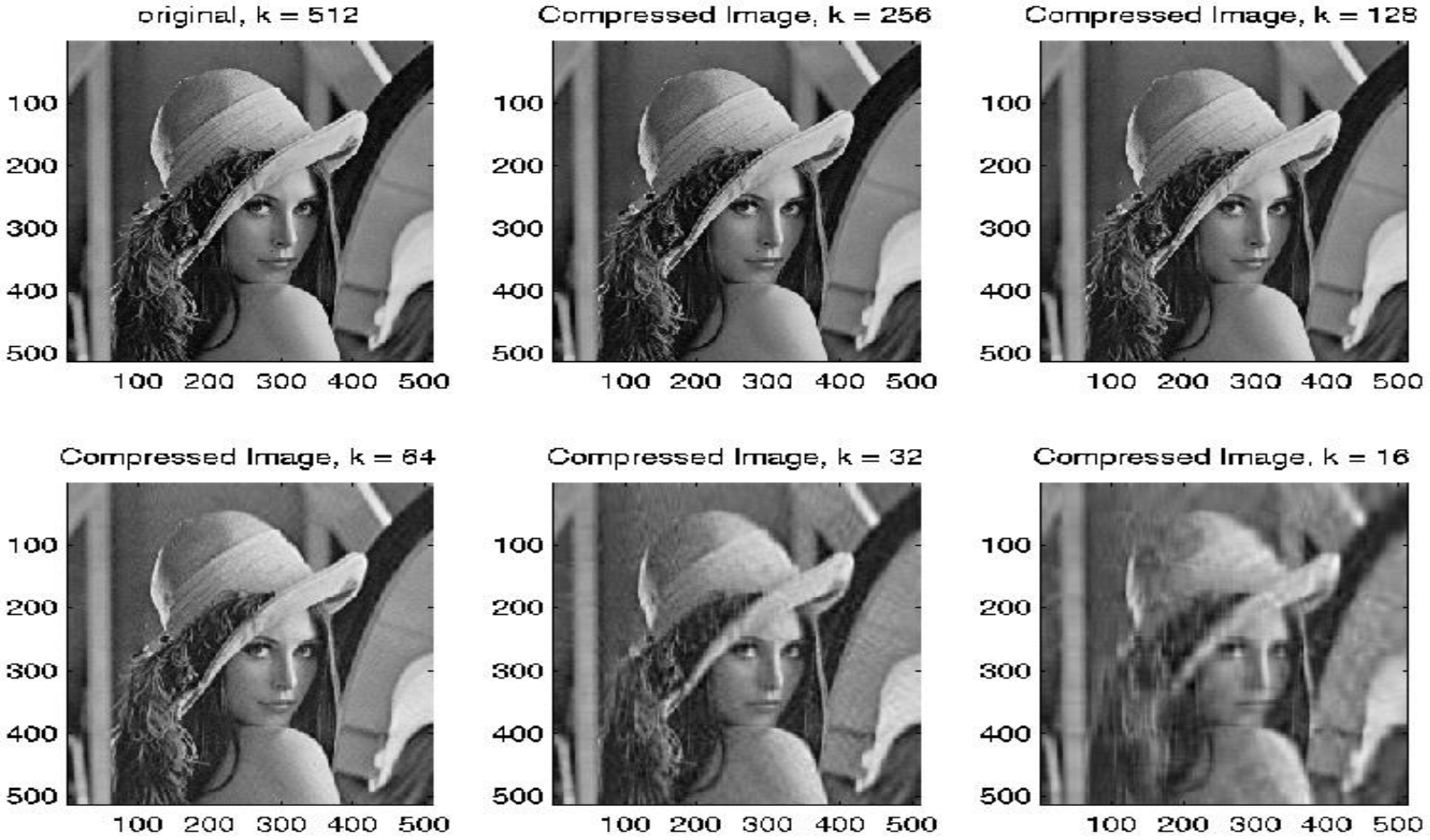
- Happens when more bits are used to define image than required

SVD implementation

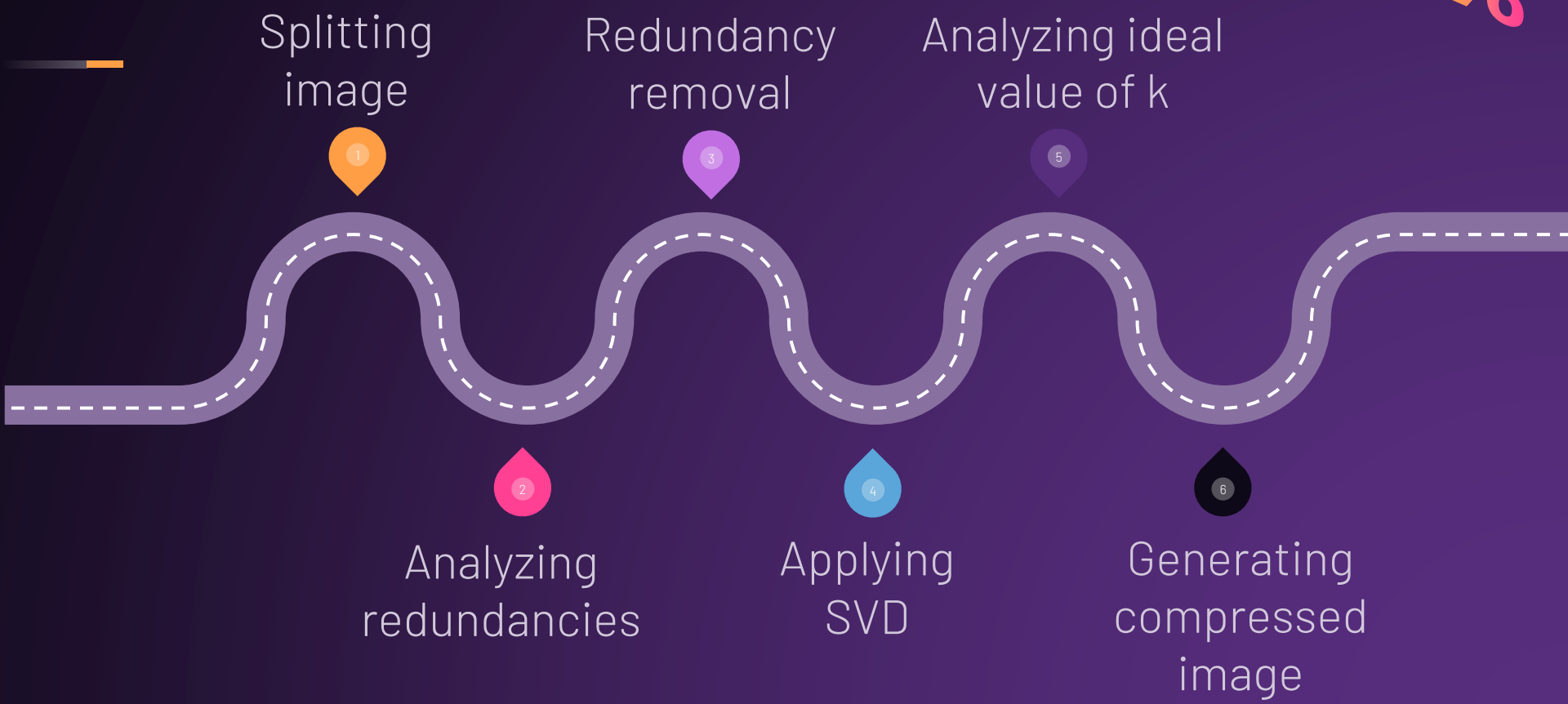
- Applying SVD does not result in reduction of the image size rather it remains the same.
- After applying SVD, We can take the first k values of these sorted(descending) singular values and the image quality is directly proportional to the value of k and inversely proportional to the compression quality.
- The removal follows the property of removing only those values which contain the least information

Singular Value Decomposition

- SVD is a linear matrix transformation used for compressing images. SVD stands of singular value decomposition.


original, k = 512
Compressed Image, k = 256
Compressed Image, k = 128
Compressed Image, k = 64
Compressed Image, k = 32
Compressed Image, k = 16
100
200
300
400
500

Steps


Splitting image
1
Analyzing redundancies
2
Redundancy removal
3
Applying SVD
4
Analyzing ideal value of k
5
Generating compressed image
6

Methodology

- The quality of the image compression is generally measured with PSNR(peak-signal-to-noise ratio) and SSIM(structural similarity index).
- We aim to show weaknesses in these metrics and make use of energy ratio as a metric to evaluate the quality of image compression.
- We aim to increase the compression ratio while minimizing the MSE as much as possible by introducing energy ratio.

Keywords – PSNR (peak-signal-to-noise ratio)
SSIM (structural similarity index)

SVD implementation

- We can take the first k values of these sorted(descending) singular values and the image quality is directly proportional to the value of k and inversely proportional to the compression quality.
- Mean Squared Error can also be calculated for the compressed images using the following relation-

$$MSE = \frac{1}{m \times n} \sum_{i=1}^{m} \sum_{j=1}^{n} \left[I(i,j) - I_k(i,j) \right]^2$$

Images given here show the results of applying SVD on frames of video, taking different values of k

Fig. 1 k = 5

Fig. 2 k = 8

Fig. 3 k = 16

Fig. 4 k = 25

Fig. 5 k = 32

Fig. 6 k = 128

Fig. 7 k = 392

Fig. 8 Original Image

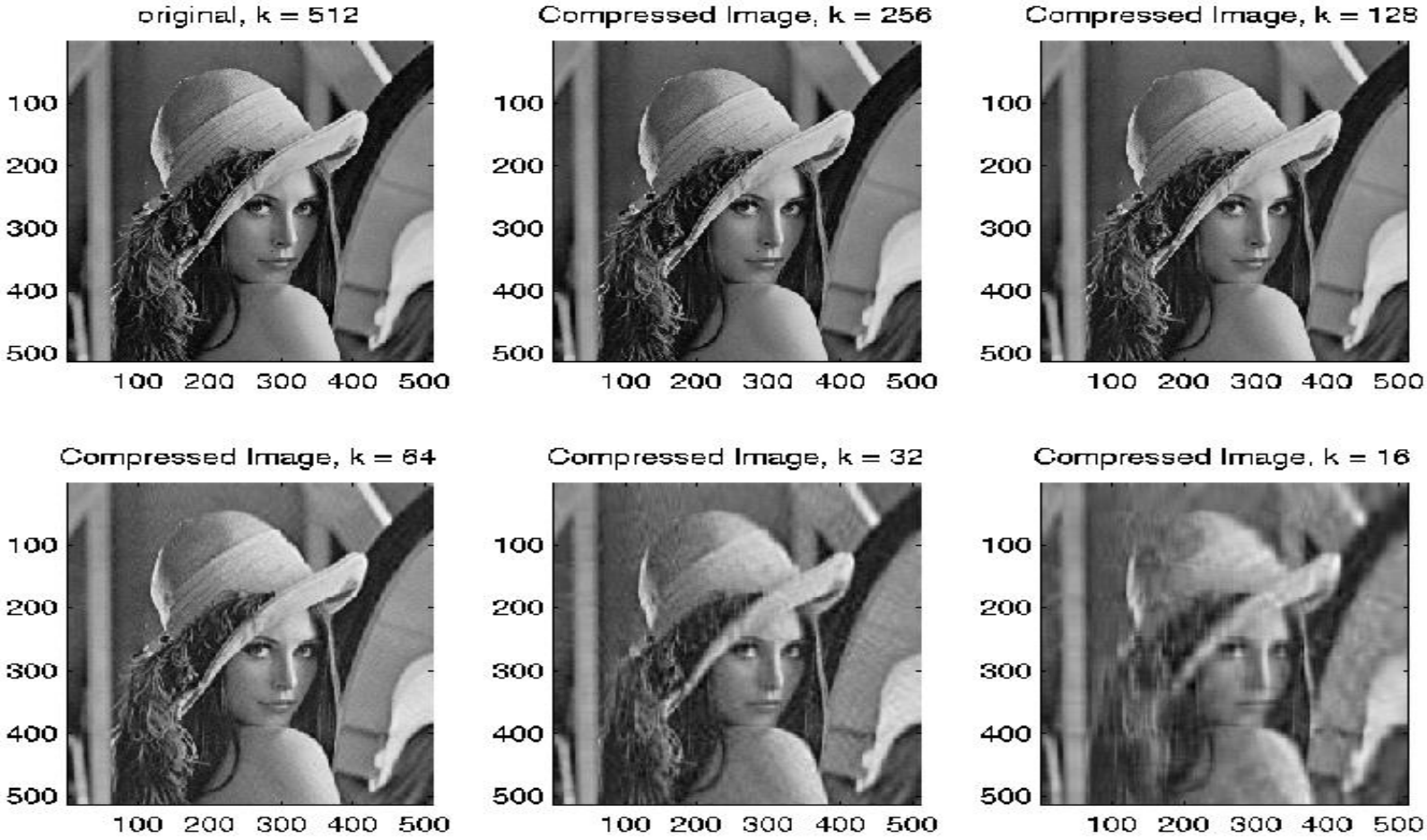
Insight on the average values of PSNR, SSIM and E

k	8 to 32	40 to 120	128 to 448
PSNR	27 dB to 34 dB	35 dB to 42 dB	43 dB to 98 dB
SSIM	0,82 to 0,93	0,94 to 0,98	0,98 to 1
E	99,39 to 99,85	99,9 to 99,98	99,99 to 100
Zone	99	999	9999
Appreciation	Poor quality	Good quality	Very good quality

Analysis of Image quality

- The image quality obtained for values of k in [8 , 32] is very poor.
- The image quality is considerably better for the values of k in range [40 , 120].
- We obtain very good quality for the values of k greater than 128.

The next figure will showcase the quality of image compressed different values of k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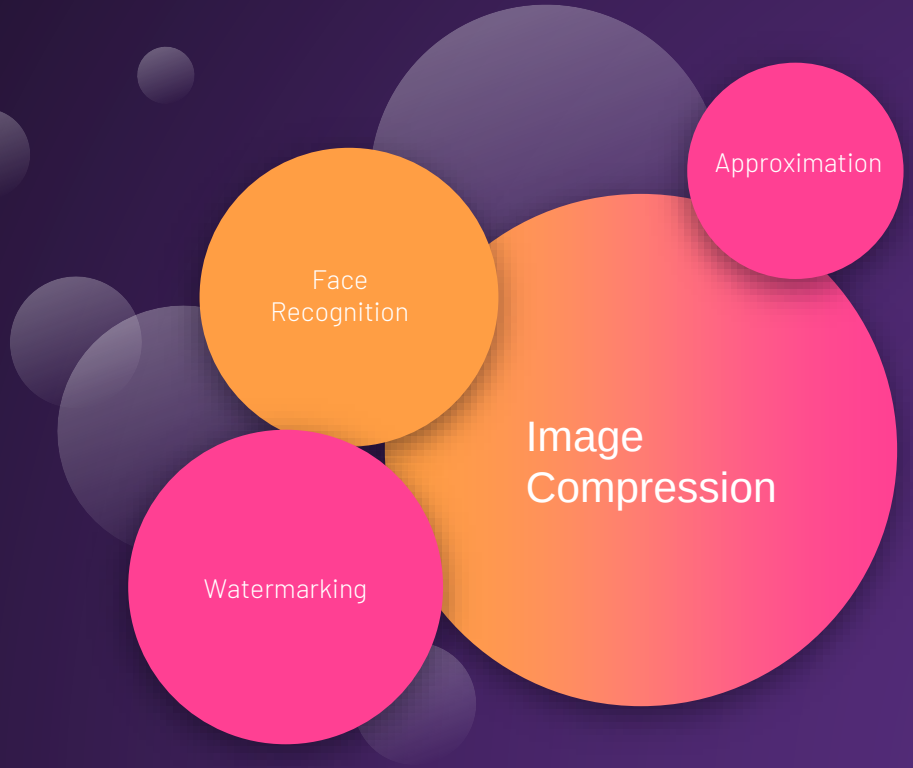
Conclusion

The given result leads to the conclusion that the advantage of SVD is it's less computational complexity and good compression result.

The degree of compression required by models and applications can be achieved by adjusting the values of k.

This results in varying degrees of compression depending on the number of eigenvalues chosen.

APPLICATIONS



THANKS!