Using Singular Value Decomposition for performing image/video compression from scratch (without Python libraries).

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***Abstract*—The increasing usage of digital information also requires storage and transmission of images and videos. A technique called SVD (Singular Value Decomposition) is used to compress these images without affecting the quality of the image. This linear matrix transformation uses a product of three matrices and compresses the image by keeping necessary features. It finds the basic structure of the image by transformation into a series of linear approximations. The main idea behind this is to select some eigenvalues to compress and reconstruct the image. It deals with the rank of image and compression ratio.**

Keywords— Singular Value Decomposition, linear matrix transformation, linear approximations, eigenvalues, rank, compression ratio.

I. Introduction

The use of digital information is increasing day by day with the advancement in technology. Images or videos are used to store the media material. The issue here is storing and transmitting photos and videos. Compression is a clever method to store things in less memory. However, compression should be done in such a way that the content's quality is not compromised. By employing a linear transformation, SVD aids in this endeavor. Matrix A is an image matrix that may be expressed as the product of three matrices: U, S, and V, with S being a diagonal matrix containing singular values of matrix A.

II. Background

With large amounts of data becoming the norm, it is very crucial to transfer and store the said data efficiently. That is why compression of data, for its efficient storage and transfer, is extremely important. In this project, we will use Singular Value Decomposition (SVD) which is a very popular method used for image compression without compromising with the quality. The SVD was discovered over 100 years ago independently by Eugenio Beltrami (1835–1899) and Camille Jordan (1838–1921), James Joseph Sylvester (1814–1897), Erhard+ Schmidt (1876–1959), and Hermann Weyl (1885–1955).

III. Motivation

As previously said, it is critical to store and transfer data in such a way that vital information is retained. The primary purpose of creating this project report is to learn how to accomplish it. When compared to other compression algorithms, SVD produces good compression results with reduced computing complexity. Learning how to apply linear algebra in the realm of file compression can be extremely beneficial.

IV. Literature Survey

Image compression is the process of removing superfluous or extraneous data from an image. Removing redundancies is the same as lowering the number of bits necessary to represent a picture without sacrificing image quality. To achieve this, different image compression approaches use different ways or more properly coding algorithms. Only a few singular values are preserved after applying SVD to compress an image, while other singular values are destroyed. This is due to the fact that singular values on the diagonal of D are sorted in descending order, with the first singular value containing the most information and following singular values containing diminishing quantities of image information.

As a result, lower singular values carrying no or little information can be eliminated without causing severe visual distortion.

The application of SVD is not only compressing images but also in noise reduction, data science, face recognition, watermarking, and many more. The main general idea is choosing the appropriate value of k (number of eigenvalues used to compress and reconstruct an image). From a research paper by Miss Samruddhi Kahu and Ms. Reena Rahate, it can be observed that compression ratio and image quality go hand in hand. A smaller value of k will give a higher compression ratio but has more image degradation and vice versa. Thus, the appropriate value of k helps to compress the image without degrading the image quality to a certain extent.

Another research paper by Mrs. Rehna V.J and Mr. Abhranil Dasgupta shows jpeg compression using MATLAB R2010.

With the help of three principle types of data redundancies that are coding redundancy, spatial redundancy, and irrelevant information are used in the steps to compress an image. The step-by-step transformation of RGB components and reconstruction of the same is linked with applying approximation on matrices and removing singularity in order to reconstruct the image.

REFERENCES

1. Jameela, Rehna. (2011). *JPEG Image Compression using Singular Value Decomposition*. IOSR Journal of Electrical and Electronics Engineering. 1. 81 - 88.

2. Kahu, S. and Rahate, R., 2013. *Image Compression using Singular Value Decomposition*. [ebook] SciResPub., pp.244-248. Available at: <http://www.ijoart.org/docs/Image-Compression-using-Singular-Value-Decomposition.pdf> [Accessed 28 September 2021].