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Image Compression Using SVD ON Labview With Vision Module

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Abstract

Now-a-days every one fond of taking photos and selfies, even they look for storage space and speed. In that case we have many algorithms based on image compression techniques. The main technique used in this paper is SVD algorithm and implemented using NI LabVIEW with vision module. To reduce the storage space we can use a SVD (Singular Value Decomposition) technique.

The redundancy techniques are used in SVD. Based on JPEG (Joint Photographic Expert Group) the SVD can perform easily. Based on different singular values we can evaluate Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR).

Keywords: Image Compression, SVD, PSNR, MSE.

I. INTRODUCTION

Now-a-days images play a major role and capturing with high resolution for better quality. The Image compression is an important area in the field of digital image processing, which deals with a technique to reduce storage required for transmitting it. For that high resolution images the storage space and bandwidth will be more for required transmission. Thus images are compressed before transmission such that compressed images are to be nearly original images. The main objective of image compression is to reduce thereby reduction of storage space and increasing transmission rate. A typical image can be reducing up to 80% of its original image. The applications used in various fields are Medical Imaging, Galleries, Telecommunication, Security, etc.

Image compression is of two types, lossy compression and lossless compression. In SVD the lossless compression is used. Lossless compression does not change content of the file or image. If we compress a file and then decompress it, it has not changed.

Lossy compression is to achieve the better compression ratios by selectively getting rid of some of the information in the file. These compression techniques can be used for images or sound files but not for text or program data [1].

This paper focuses on SVD (Singular Value Decomposition) is a way of factorizing matrices into a series of linear approximations that expose the underlying structure of the matrix. SVD mainly used for Object detection, Face recognition, Field matching techniques. SVD is dominant idea in algebra. SVD decomposes any rectangular matrix of mxn size into three elements such that A=U*S*V

II. SVD

In general Singular value decomposition is a matrix factorization where any arbitrary matrix A is factored into $\mathbf{A=USV^T}$.

Where the Eigen vectors of AA^T and A^TA is the columns of U and V,V^T is the conjugate transpose of V and S is the diagonal matrix of a non-zero Eigen values of both and A^TA of a rank r. Here, A is a mxn matrix, U is a mxm matrix, V is a nxn matrix and S is a mxn matrix.

SVD performs better than DCT(Discrete cosine transform) in case of images having high standard deviation(i.e.; higher pixel quality).Singular value decomposition is a linear in data transformation used for compressing images and image matrix is represented as product of these matrices. $A=USV^T$.

It expresses image data in terms of number of Eigen vectors depending upon the dimension of a image and the mainly Psycho-visual redundancies in an image are used for compression. Image can be compressed without affecting the image quality and it reduces the storage space.

Mostly used technique is JPEG which used discrete cosine transform for compaction image.DCT (Discrete cosine transform) gives high energy compression as a compared to SVD gives optimal energy compaction [2].

One of the main and easy techniques is singular value decomposition, in SVD the image is decomposed into three elements with Eigen values of the image.

In this paper SVD algorithm is implemented and analyzed using NI Lab VIEW tool. The PSNR (Peak signal to noise ratio) and the MSE (Mean square error) parameters are evaluated by considering different number of singular values. The MSE, PSNR parameters are estimated for various images using SVD.

III. IMAGE COMPRESSION USING SVD

The singular values of a matrix decreases as rank of the matrix increases, which is helpful more compression ratio by eliminating the small singular values or the higher ranks. Image compression involves reducing the irrelevant information in an image. Redundancies is in an image may be in the form of

1.Coding redundancy: - In which more number of bits than required used to encode an image the image for transmission that is less optimal code words are used.

2.Inter-pixel redundancy: - It is similar to the neighboring pixels.

3.Psycho-visual redundancy:-Which is due to the limitation of human visual system interpret very fine details in an image the non-essential information.

The image compression is represented as

$$A = USV^T$$

$$A = \sigma_1 u_1 v_1^T + \sigma_2 u_2 v_2^T + ... + \sigma_r u v_r^T$$

For compression all non-zero singular values are not considered. The singular values with small values will be eliminated for only few terms (K) will be considered. Then A can be written as A_k expressed as

$$A_k = \sigma_1 u_1 v_1^T + \sigma_2 u_2 v_2^T + ... + \sigma_k u_k v_k^T$$

The image compression is measured with compression ratio, PSNR, MSE.

Compression Ratio:

Compression Ratio is the ratio of the storage space required to store original image to that required to store a compressed image and is given by

Compression Ratio = m*n / (k*(m+n+1))

It measures the degree to which an image is compressed.

Mean Square Error (MSE):

MSE is the measure of deterioration of image quality as compared to the original image when an image is compressed. It is defined as square of the difference between pixel value of original image and the corresponding pixel value of the compressed image averaged over the entire image [3].

Mathematically,

$$MSE = [\sum \sum g(x, y) - g'(x, y)] / (m*n)$$

Power Signal to Noise Ratio (PSNR):

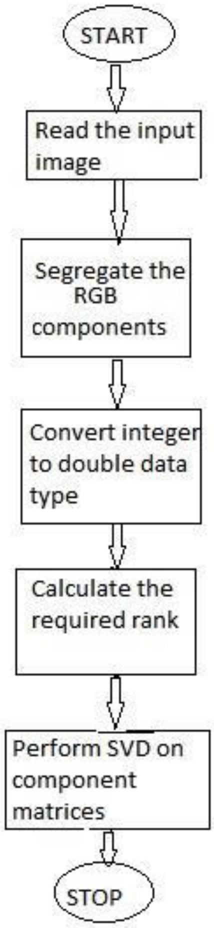
As the name suggests, Peak Signal to Noise Ratio (PSNR) is the ratio of maximum signal power to the noise power that corrupts it. In Image compression maximum signal power refers to the original image and noise is introduced to compress it. In other words, noise is the deviation of the compressed image from the original one. Therefore, it follows that PSNR gives the quality of the reconstructed images after compression. Mathematically, PSNR is given by,

$$PSNR = 10*\log 10 [255/\sqrt{MSE}]$$

Mathematical steps to calculate SVD of a matrix:

1. Give the input image matrix A.
2. First calculate A^TA and AA^T.
3. Use AA^T to find the Eigen values and Eigen vectors to form the columns of U.
4. The Eigen vectors of A^TA make up the columns of V.
5. Divide each Eigen vector by its magnitude to form the columns of U and V.
6. The singular values in S are square roots of Eigen values from AA^T or A^TA.

IV. FLOW CHART



Initially the JPEG image which has to be compressed is given as an input to the

Processor. This input image is stored as an array of integers. Before getting on with the process of compression, the amount of compression that has to be achieved for the input JPEG image is specified through the compression ratio. Compression ratio is defined as the ratio of file sizes of the uncompressed image to that of the compressed image. Compression is then achieved by performing Singular Value Decomposition on RGB components of the input JPEG image. The resultant decomposed matrix is regenerated by decoding the bit stream [4].

The flow of image compression using SVD technique is as shown in fig.1. The input image here is a JPEG image which is read and stored as an array of integers. This image is segregated into RGB or red, green, blue component matrices.

V. LAB VIEW IMPLEMENTATION USING SVD

Lab VIEW (Laboratory Virtual Instrumentation Engineering Workbench) is a platform and developing environment for a visual programming language from National Instruments. The graphical language is named “G”. Originally released for Apple Macintosh in 1986, Lab VIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of platforms including Microsoft windows, various flavors of UNIX, LINUX and MAC OS X. The latest version of Lab VIEW is version Lab VIEW 2017 with vision module.

Vision Module: This NI Vision module is a part of Lab VIEW and it is an development for the scientific imaging applications. This module includes NI Vision assistant it’s an interactive environment for developers for quick programming and IMAQ vision is an important library function for image processing [5].

IMAQ vision is a high level programming library. It includes an extensive set of functions for machine vision and scientific imaging. IMAQ Vision will perform some of the tasks are

1. Filter images to improve their quality before inspection.
2. Search grayscale and colour images for instances of a specified template.
3. Measures the features of the image given.
4. Calibrate the image to take accurate, real-world measurements regardless of camera perspective.

Creating an image by IMAQ Create VI to create an image reference. For creating an image it has specifications of image data types.

1. Grayscale (U8, default)- 8bit unsigned
2. Grayscale (I16)-16 bit signed
3. Grayscale SGL) floating point
4. RGB (U32)-32 bit RGB
5. RGB (U64)-64 bit RGB

The programming languages used in Lab VIEW is dataflow programming and graphical programming. This Lab view consists of two windows.

1. Front Panel

2. Block Diagram

Front panel: The front panel consists of controls and indicators. Controls are like knobs, push buttons, dials and other input devices. The indicators are graphs, led's and other output displays.

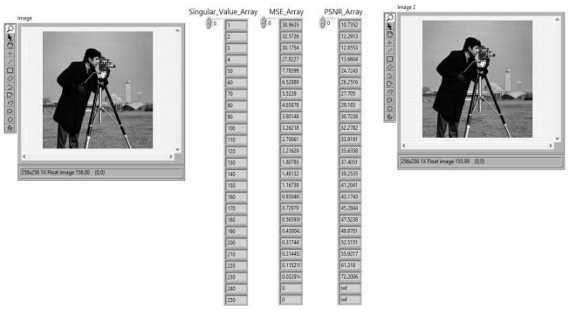


Figure. 1: Front Panel

Fig. 1 explains about the output of the program, first image is an input image i.e., we can select any image from our gallery and second image is compressed image of original image. By this we can calculate the PSNR and MSE values by using number of singular values.

Block Diagram: Block diagram consist graphical source code. Block diagram objects include terminals, sub VI's, functions, constants, structures, and wires, which transfer data among other block diagram objects.

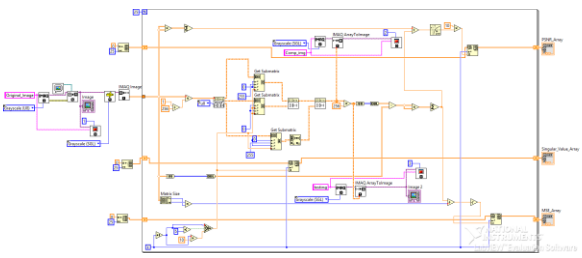


Figure. 2: Block Diagram

In block diagram implementation, we require functions of SVD are IMAQ create block, IMAQ read file, IMAQ image to array, SVD decomposition block, Get sub matrix function, Matrix multiplication, Transpose matrix. The indicators used to display the PSNR and MSE values on the front panel. Image display indicators are used to display the original image and compressed image.

VI. RESULTS AND ANALYSIS

Image compression using SVD is implemented using NI Lab VIEW tool with vision module. The compression is done by using some parameters like compression ratio, PSNR and MSE [6].

Original Image

K =2

K = 4

K = 10

K = 30

K = 50

K = 70

K = 90

K = 140 K = 190

K = 220 K = 250

Figure. 3. Original Image, Compressed image by considering different singular values.

In Fig. 3 the original image and compressed images with 2, 4, 10, 30, 50, 70, 90, 140, 190, 220, 250 singular values are shown.

VII. CONCLUSIONS

This paper establishes a Lab VIEW framework for image compression using LabVIEW; SVD transforms correlated variables into a set of uncorrelated variables. The compression ratio varies with respect to the number of singular values considered. The number of singular values to be considered if the image obtained is nearly faint from the original image, which is less space for storage or transmission. The SVD compression is tested on various images, the results are compared by using parameters such as MSE and PSNR values.

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