iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** VI **Month of publication:** June 2017

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Image Compression & Decompression using Discrete Wavelet Transform Approach

Ritika Batra[1], Indu Khatri[2]
[1,2] *Department of Computer Scienc Gateway Institute of Engineering & Technology (GIET), Deenbandhu Chhotu Ram University of Science & Technology (DCRUST), Sonepat*

Abstract*: Image compression deals with reducing the amount of data required to represent a digital image. When multimedia data such as images, video and audio is not compressed then these data requires vast amount of computer storage and also these types of data occupies more transmission bandwidth. Also when such types of data are transferred from one location to another through networking then they occupy more time for transmission. There are multiple techniques available for compressing the multimedia data such as Discrete Cosine Transform, Discrete Wavelet Transform, Huffman Coding etc. Wavelets are becoming attractive in image processing where high computational performance and parallel architectures are required. In the research work, we are going to implement wavelet based compression algorithm.
Keywords*: Discrete Wavelet Transform, Discrete Cosine Transform, Haar wavelet.

I. INTRODUCTION

The amount of data associated with visual information is so large that its storage would require enormous storage capacity. Also when such types of data are transferred from one location to another through networking then they occupy more time for transmission. Therefore we need compression for visual data so that storage capacity can be saved and transmission speed can be increased.

Image storage is required most commonly for educational and business documents, medical images used in patient monitoring systems, and the like. Because of their wide applications, data compression is of great importance in digital image processing. For example, Frame with 352 x 288 contains 202,752 bytes of information.

Recoding of uncompressed version of this video at 15 frames per second would require 3 MB, one minute 180 MB storage and 24-hours day 262 GB. Using compression, 15 frames/second for 24 hours 1.4 GB, 187 days of video could be stored using the same disk space that uncompressed video would use in one day. Transmission and storage of uncompressed video would be extremely costly and impractical [2].

In the research work, we are going to implement wavelet based compression algorithm. The wavelet based image compression technique compress the image by representing some part of image with some other parts of same image of same quality.

II. IMAGE COMPRESSION PRINCIPLES

An image may be defined as a two-dimensional function, $f(x, y)$, where x and y are spatial (plane) coordinates, and the amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. We call such types of images as digital images if amplitude value f and coordinates values x and y are finite values of type real.

Image compression is used to minimize the amount of memory needed to represent an image. Images often require a large number of bits to represent them, and if the image needs to be transmitted or stored, it is impractical to do so without somehow reducing the number of bits. The problem of transmitting or storing an image affects all of us daily. TV and fax machines are both examples of image transmission, and digital video players and web pictures are examples of image storage. Image compression is the process of reducing the amount of data required to represent an image. How to achieve compression means by removing the redundant information, we can achieve it. We have three types of redundancies [2]:

A. Coding redundancy

Image is nothing but combination of pixels and each pixel is represented in binary bits. The number of bits used to represent each pixel is based on number of gray levels used to represent the image.

If we use variable length code (number of bits used to represent each pixel) is different for different pixels in an image. If we use

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

less number of bits for more frequent gray levels and more number of bits for less frequent gray levels in the image, then we represent the entire image by using least possible number of bits. In this way we can reduce the coding redundancy.

B. Inter pixel redundancy

In an image each pixel depends on its neighbors. Information is unnecessarily replicates in the representations of the correlated pixels. Correlation of pixels means completely dependent on one another. Examples: In video, if frame rate is high then the successive frames contain almost same information. In still images, if spatial resolutions is high then inter pixel redundancy is high.

C. Psycho visual redundancy

Information that is ignored by human visual system or its extraneous to the intended use of an image are obvious candidates for omission. We can define compression ratio as ratio of original image size to the compressed image.

III.OVERVIEW OF WORK

The amount of data associated with visual information is so large that its storage would require enormous storage capacity. Although the capacities of several storage media are substantial, their access speeds are usually inversely proportional to the capacity. Typical television image generate data rates exceeding 10 million bytes per second. There are other image sources that generate even higher data rates. Storage and transmission of such data require large capacity and bandwidth which could be very expensive.

Image data compression techniques are concerned with reduction of the number of bits required to store or transmit images without any appreciable loss of information. The underlying basis of the reduction process is the removal of redundant data, i.e. the data that either provides no relevant information or simply restate that which is already known. Data redundancy is the central issue in digital image compression. If n1 and n2 denote the number of information carrying units in two data sets that represent the same information, then the compression ratio is defined as below:

CR = n1 / n2

In this case, relative data redundancy RD of the first data set can be defined as follows:

RD= 1 - 1/ CR

When n2 = n1 then CR = 1 and hence RD = 0. It indicates that the first representation of the information contain no redundant data.

When n2 << n1 then CR -> ∞ and hence RD -> 1. It implies significant compression and highly redundant data.

In the final case when n1 << n2 then CR -> 0 and hence RD -> -∞, indicating that the second data set contains much more data than the original representation.

Generally CR =10(10:1) defines that the first data set has 10 information carrying units for every 1 unit in the second or compressed data set. Thus the corresponding redundancy of 0.9 means 90 percent of the data in the first data set is redundant with respect to the second one.

In order to be useful, a compression algorithm has a corresponding decompression algorithm that reproduces the original file once the compressed file is given. There have been many types of compression algorithms developed. These algorithms fall into two broad types, lossless algorithms and lossy algorithms. A lossless algorithm reproduces the data exactly same as the original one. A lossy algorithm, as its name implies, loses some data. Data loss may be unacceptable in many applications. For example, text compression must be lossless because a very small difference can result in statements with totally different meanings. There are also many situations where loss may be either unnoticeable or acceptable.

A common characteristic of most images is that the neighboring pixels are highly correlated and therefore contain highly redundant information. The foremost task is to find an image representation in which the image pixels are de-correlated. Redundancy and irrelevancy reductions are two fundamental approaches used in compressions. Whereas redundancy reduction aims at removing redundancy from the signal source (image or video), irrelevancy reduction omits parts of the signal that will not be noticed by the signal receiver. In general three types of redundancy in digital images and video can be identified [3][4]:

A. Spatial redundancy or correlation between neighboring pixel values
B. Spectral redundancy or correlation between different color planes or spectral bands
C. Temporal redundancy or correlation between adjacent frames in a sequence of energies.

Image compression aims at reducing the number of bits needed to represent the image by removing the spatial and spectral

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

redundancies as much as possible.

IV. PROPOSED WORK

Image compression deals with reducing the amount of data required to represent a digital image. Uncompressed multimedia (graphics, audio and video) data requires considerable storage capacity and transmission bandwidth. Despite rapid progress in mass-storage density, processor speeds, and digital communication system performance, demand for data storage capacity and data-transmission bandwidth continues to outstrip the capabilities of available technologies. The recent growth of data intensive multimedia-based web applications has not only sustained the need for more efficient ways to storage and communication technology. The problem inherent to any digital image is the large amount of bandwidth required for transmission or storage. Wavelets [5] are becoming attractive in image processing where high computational performance and parallel architectures are required.

Image compression is a dynamically changing field with many different varieties of compression methods available. Images contain large amount of data hidden in them, which is highly correlated. A common characteristic of most images is that the neighboring pixels are correlated and therefore contain redundant information [6].

In this work we first study the existing image compression techniques. Next we present a new 3-level Discrete Wavelet Transform (DWT) for image compression. In wavelet image compression, parts of an image are described with reference to other parts of the same image. We can achieve high compression ratio in images using 3 level Wavelet Transform by applying different compression thresholds for the wavelet coefficients.

V. DISCRETE WAVELET TRANSFORM

The wavelet transform (WT) has gained widespread acceptance in signal processing and image compression. Because of their inherent multi-resolution nature, wavelet-coding schemes are especially suitable for applications where scalability and tolerable degradation are important. Recently the JPEG committee has released its new image coding standard, JPEG-2000, which has been based upon DWT [7].

Wavelets are functions defined over a finite interval and having an average value of zero. The basic idea of the wavelet transform is to represent any arbitrary function (t) as a superposition of a set of such wavelets or basis functions. These basis functions or baby wavelets are obtained from a single prototype wavelet called the mother wavelet, by dilations or contractions (scaling) and translations (shifts). The Discrete Wavelet Transform of a finite length signal x (n) having N components, for example, is expressed by an N x N matrix.

basic structure of baseline wavelet based coder is illustrated in figure 1 and 2. This structure is the skeleton for all wavelet based algorithms. It consists of two parts, the encoder and decoder. The encoder consists of four processes: wavelet transform, quantization, and encoder. The decoder has the inverse operations of encoder.

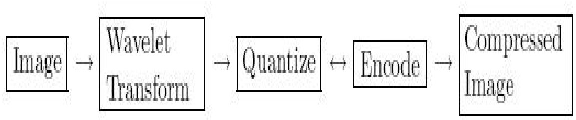


Figure 1: Compression of image

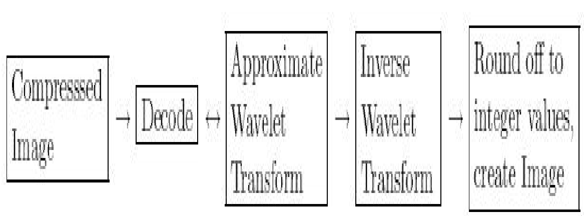


Figure 2: De-Cmpression of image

A. Wavelet-based Compression

Despite all the advantages of JPEG compression schemes based on DCT namely simplicity, satisfactory performance, and

Volume 5 Issue VI, June 2017
ISSN: 2321-9653

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

availability of special purpose hardware for implementation; these are not without their shortcomings. Since the input image needs to be ``blocked," correlation across the block boundaries is not eliminated. This results in noticeable and annoying "blocking artifacts" particularly at low bit rates. Lapped Orthogonal Transforms (LOT) attempt to solve this problem by using smoothly overlapping blocks. Although blocking effects are reduced in LOT compressed images, increased computational complexity of such algorithms do not justify wide replacement of DCT by LOT.

Over the past several years, the wavelet transform has gained widespread acceptance in signal processing in general and in image compression research in particular. In many applications wavelet-based [8] schemes (also referred as subband coding) outperform other coding schemes like the one based on DCT.

Since there is no need to block the input image and its basis functions have variable length, wavelet coding schemes at higher compression avoid blocking artifacts. Wavelet-based coding is more robust under transmission and decoding errors, and also facilitates progressive transmission of images. In addition, they are better matched to the HVS characteristics. Because of their inherent multi resolution nature [6], wavelet coding schemes are especially suitable for applications where scalability & tolerable degradation are important.

B. Haar Wavelet Transform

Wavelets are mathematical functions that were developed by scientists working in several different fields for the purpose of sorting data by frequency. Translated data can then be sorted at a resolution which matches its scale. Studying data at different levels allows for the development of a more complete picture. Both small features and large features are discernable because they are studied separately. Unlike the Discrete Cosine Transform, the wavelet transform is not Fourier-based and therefore wavelets do a better job of handling discontinuities in data. In this thesis we would be employing Haar wavelet transform for image compression [10].

The Haar wavelet operates on data by calculating the sums and differences of adjacent elements. The Haar wavelet operates first on adjacent horizontal elements and then on adjacent vertical elements. The Haar transform is computed using:

$$\frac{1}{\sqrt{2}}\begin{bmatrix}1 & 1\\ 1 & -1\end{bmatrix}$$

One nice feature of the Haar wavelet transform is that the transform is equal to its inverse. As each transform is computed the energy in the data in relocated to the top left hand corner; i.e. after each transform is performed the size of the square which contains the most important information is reduced by a factor of 4 (shown in figure 3, 4 & 5).

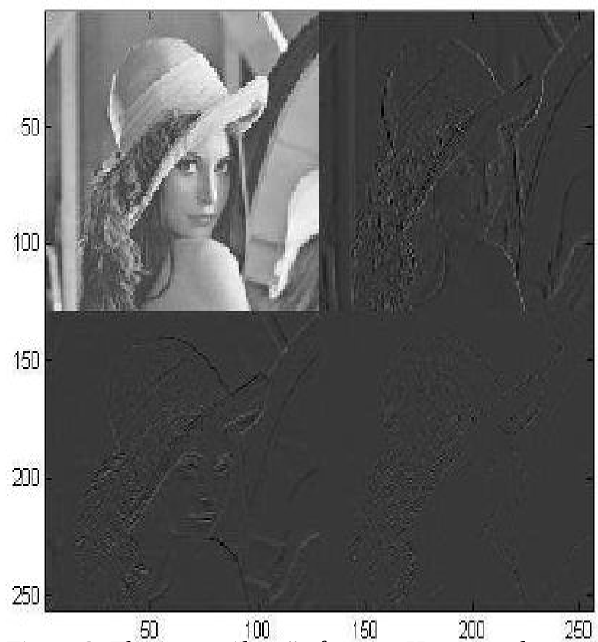


Figure 3: The image "lena" after one Haar wavelet transform

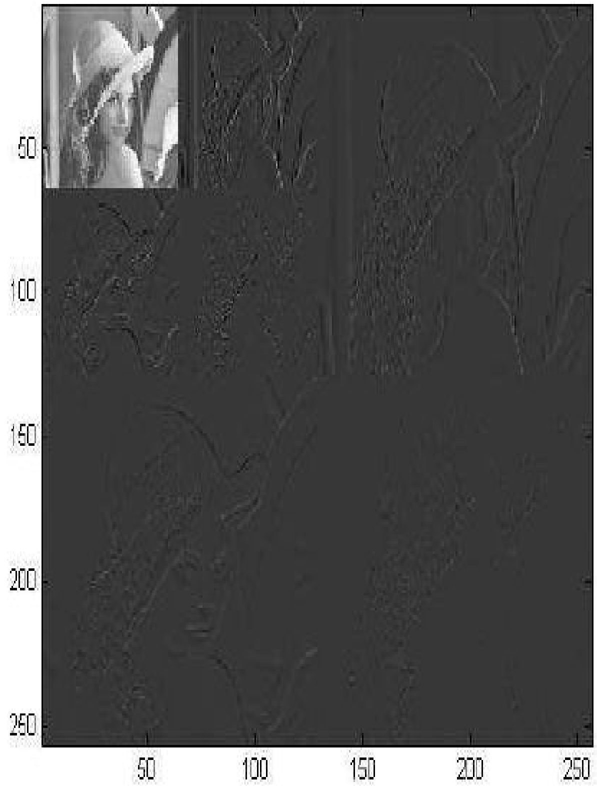


Figure 4: The image “lena” after two Haar wavelet transform

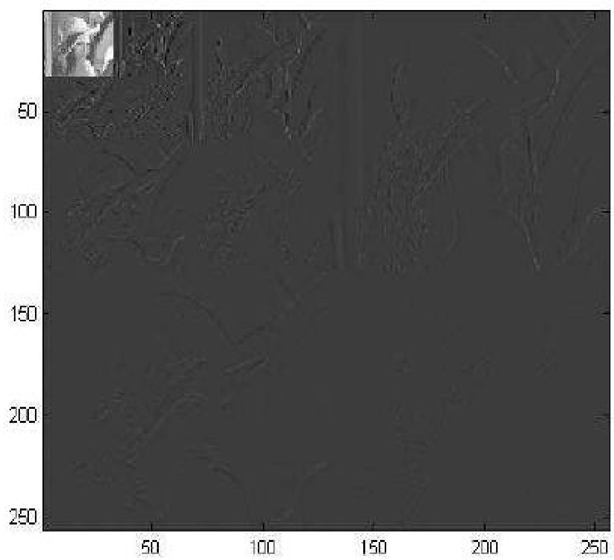


Figure 5: The image “lena” after three Haar wavelet transform

VI. RESULTS & DISCUSSION

The proposed algorithm is tested in MATLAB [11] for popular Internet image Barbara & following results are obtained. The figure 6 shows original Barbara.png image. The image size is 182kb & image dimensions are 512 x 512.

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Figure 6: Original image of Barbara.png (182 kb)

Figure 7 shows the compressed image of Barbara after applying 1st discrete wavelet transform.

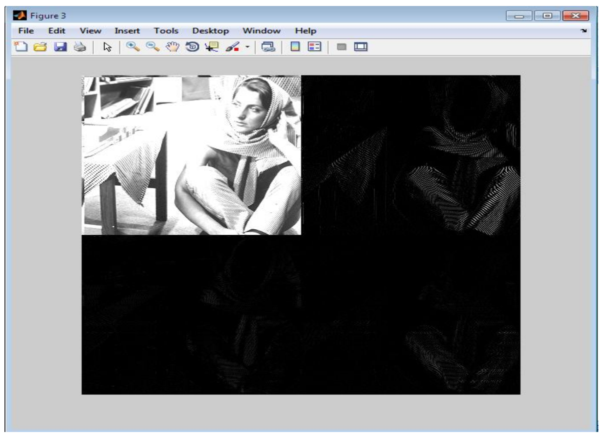


Figure 7: The compressed image of Barbara after applying discrete wavelet transform on columns.

Figure 8 shows the compressed image of Barbara after applying second haar discrete wavelet transform.

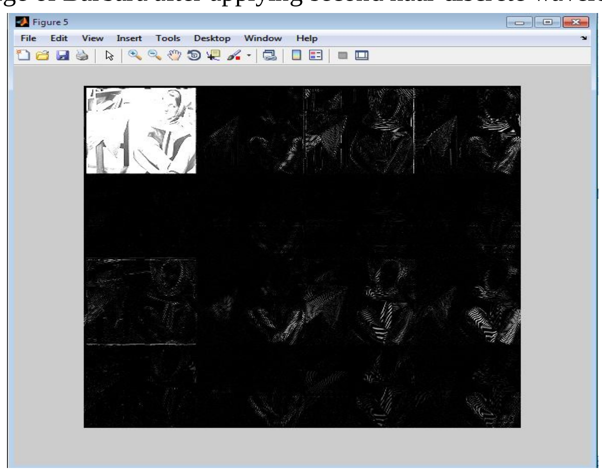


Figure 8: The compressed image of Barbara after applying 2nd haar discrete wavelet transform.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Figure 9 shows the compressed image of Barbara after applying 3rd haar discrete wavelet transform.

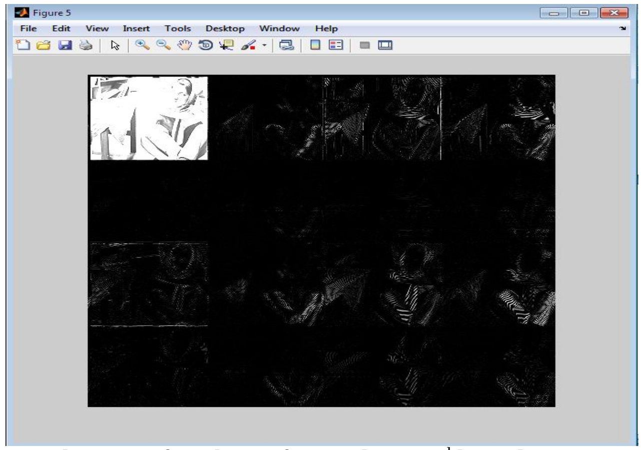


Figure 9: The compressed image of Barbara after applying 3rd haar discrete wavelet transform.

Figure 10 shows the uncompressed images of Barbara after applying inverse 1st , 2nd and 3rd discrete wavelet transform.

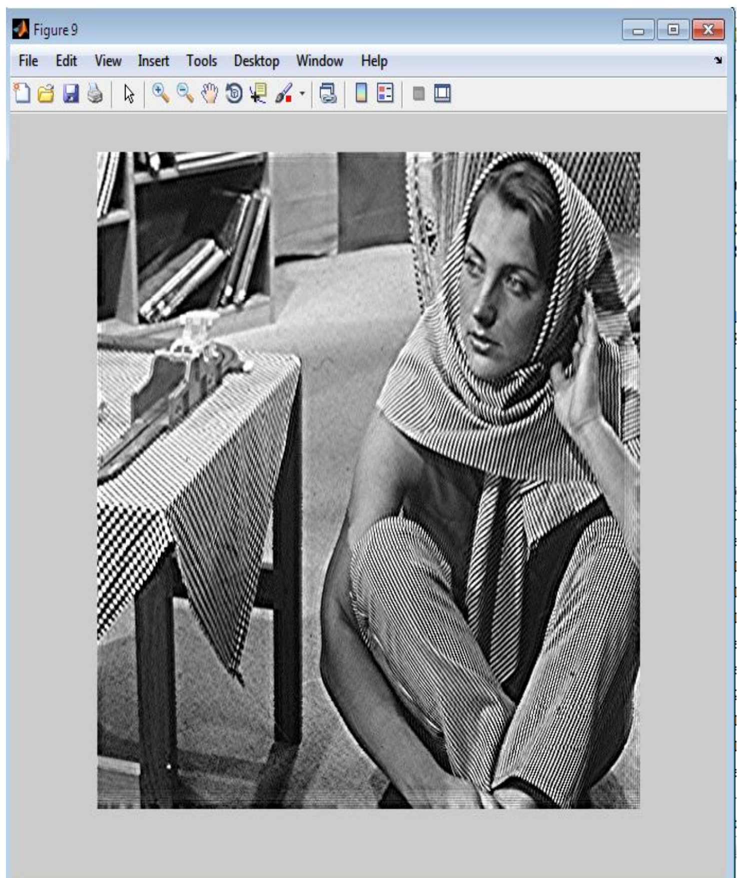


Figure 10: The reconstructed uncompressed image of Barbara

V. CONCLUSION

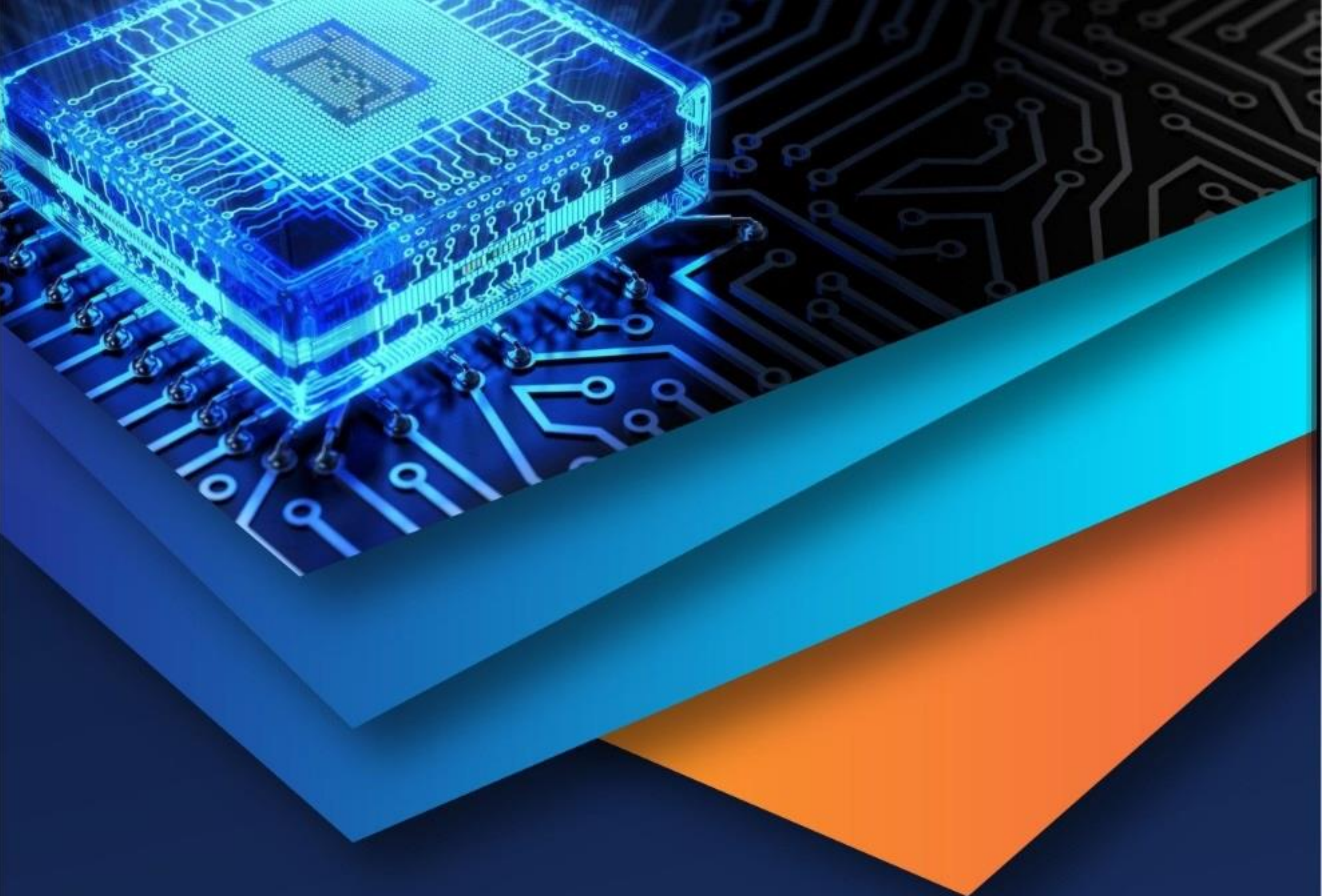
The amount of data associated with visual information is so large that its storage would require enormous storage capacity. Also when such types of data are transferred from one location to another through networking then they occupy more time for transmission. Therefore we need compression for visual data so that storage capacity can be saved and transmission speed can be incre
ased.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Wavelet analysis is very powerful and extremely useful for compressing data such as images. This is because the wavelet analysis is done on the entire image rather than sections at a time. A well known application of wavelet analysis is the compression of fingerprint images by the FBI. In the research work, we have implemented wavelet based compression algorithm.

REFERENCES

[1] R. C. Gonzalez and R. E. Woods, "Digital Image Processing", Addison Wesley, 2004.
[2] David Salomon, "Data Compression, The Complete Reference", 2nd Edition, Springer-Verlag.
[3] Xiao Zhou, Yunhao Bai and Chengyou Wang, "Image Compression Based on Discrete Cosine Transform and Multistage Vector Quantization", International Journal of Multimedia and Ubiquitous Engineering Vol.10, No.6 2015.
[4] A. M. Raid, W. M. Khedr, M. A. El-dosuky and Wesam Ahmed, "Jpeg Image Compression Using Discrete Cosine Transform - A Survey", International Journal of Computer Science & Engineering Survey (IJCSES) Vol.5, No.2, April 2014.
[5] Anuj Bhardwaj, Rashid Ali, "Image Compression Using Modified Fast Haar Wavelet Transform", World Applied Sciences Journal, Vol. 7, No. 5, pp. 647-653, 2009.
[6] Bhawna Gupta Manju Gupta Banita Chadha "Image Compression Technique under JPEG by Wavelets Transformation", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 4, Issue 6, June 2014
[7] Bhonde Nilesh, Shinde Sachin, Nagmode Pradip, D.B. Rane, "Image Compression Using Discrete Wavelet Transform", International Journal of Computer Technology and Electronics Engineering (IJCTEE) Volume 3, Special Issue, March-April 2013
[8] K. Rajakumar and T. Arivoli, "Implementation of Multiwavelet Transform coding for lossless image compression", IEEE, pp. 634-637, 2013.
[9] S. Dharanidharan , S. B. Manoj kumar and D. Senthil kumar, "Modified International Data Encryption Algorithm using in Image Compression Techniques", IJESIT , pp. 186-191,2013
[10] Zhang Ning and Zhu Jinfu "Study on Image Compression and Fusion Based on the Wavelet Transform Technology", International Journal on Smart Sensing and Intelligent Systems Vol. 8, No. 1, March 2015.
[11] MATLAB Primer, MathWorks Inc, 2014.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY