Comparative Analysis of Spatial-orientation Trees Wavelet (STW) and Adaptively Scanned Wavelet Difference Reduction (ASWDR) Image Compression Techniques

Mukesh Kumar, Deepak Sharma
Desh Bhagat Foundations Group of Institution Moga

ABSTRACT

In this research paper, the author analyzes the method to reduce the requirement of the bits required to represent the image and stored information of acceptable quality data. The complete chain of compression includes deteriorate, pack, and decompress a grayscale or genuine nature picture utilizing different compression methods. In this paper, we compared the wavelet-based algorithms i.e. adaptively scanned wavelet difference Reduction (ASWDR) and spatial-orientation trees Wavelet (SWT). In this research, the author analyzed different images (GIF, JPEG and PNG etc.) and their output is analyzed. These algorithms are compared in terms of Mean Square Error (MSE), Compression Ratio (CR), Peak Signal to Noise Ratio (PSNR), and Bit per pixels. It gives high CR and PSNR with better image quality. The purpose is to show how to improve the performance of compression and decompression of a grayscale or true color image using SWT and ASWDR compression methods. After experimenting with a number of gray scale and color images it is observed that the final compression ratio (CR) and the Bit-Per-Pixel (BPB) ratio are very satisfactory in case of ASWDR algorithm

Keywords: Image compression, Spatial-orientation Trees Wavelet, adaptively scanned wavelet difference Reduction.

1. INTRODUCTION

An image can be defined as a function $f(x, y)$ in which $x$ and $y$ are spatial coordinates as a defining image. When $x, y$, and the intensity values of $f$ and are all finite, discrete quantities then image is called as the digital image. This organization of image processing task is summarized in Fig. 1. The diagram does not imply that every process is implied to an image processing. The expectation is to pass on a thought of the multitude of strategies that can be applied to pictures for various purposes and conceivably with various targets. The essential activities acted in a computerized picture handling frameworks incorporate obtaining, stockpiling, preparing, correspondence, and show. Information about issue space is coded into a picture handling framework as an information base. Two principal applications of digital image processing include improvement of image information, and scene data processing [10].

Image acquisition: Image acquisition could be as simple as being given an image that is already in digital form. Generally, the image acquisition stage involves pre-processing, such as scaling. It is acquired a digital image.

Image pre-processing: Image restoration is an area that also deals with improving the appearance of an image. However, unlike enhancement, which is subjective, image restoration is objective, in the sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation and it is used to improve the image in ways that increase the chances for success of the other processes.

Image segmentation: In general, autonomous segmentation is one of the most difficult tasks in digital image processing. Segmentation procedures partition an image into its constituent parts or objects. The segmentation procedure brings the process successful solution of imaging problems that require objects to be identified.
Individually.

Fig 1: Fundamental steps in digital image processing

Image representation and description: Image representation is used to convert the input data to a form suitable for computer processing and image description is to extract features that result in some quantitative information of interest or features that are basic for different.

Image recognition: The image recognition is used to an object be information provided by its descriptors reiterating one class of objects from another.

Image interpretation: To assign meaning to an ensemble of recognized objects. The result obtained after analyzing or processing the image is stored in Knowledge database.

2. IMAGE COMPRESSION

Image compression is mainly used to transfer the large amount of data using small bandwidth. The data to be transmitted can be text data, video data, audio stream, heavy graphical images etc. Such data need to be compressed during the transmission process. The digital image is essentially a variety of different pixel esteem. In the computerized picture, Pixels of the area are associated with the goal that these pixels contain repetitive pieces. By utilizing the pressure calculations excess pieces are eliminated from the picture so that picture size is decreased and the picture is compacted. Pressure of the picture has two fundamental segments: insignificant information decrease and repetition decrease. Repetition decrease is accomplished by eliminating additional pieces or rehashed bits. While in immaterial decrease, the littlest or less significant data is overlooked, which won't get by the collector. There are three kinds of redundancies for coding redundancy, Inter-pixel redundancy and psycho-visual redundancy.

2.1 Compression Algorithm

There are basically two techniques used to compress an image. These techniques include lossless compression and lossy compression. In case of lossless technique the output of the system is same image as was the input image and the quality is not degraded. On the other hand in case of Loosy compression technique there is some loss in the quality of the image and hence the image is not exactly the same as was the input image.

2.1.1 Lossless Compression Techniques

In this scheme, the output of the image is same as the input. This approach first change the pictures into the picture pixels. At that point handling is done on each and every pixel. In the first step, next pixel is estimated
from neighbor or nearby pixels. In the subsequent steps, remaining pixels are coded using encoding techniques. [2]

![Architecture of Lossless compression technique](image)

**Fig. 2 Architecture of Lossless compression technique**

### 2.1.2 Lossy Compression Techniques

This technique provides higher compression ratio in comparison with lossless compression. This is because of the fact that the output of this method produces nor the same image due to presence of some losses in the image. SVD based compression is lossy due to nature level of the process. However, the qualitative loss is not visible up to some point. The SVD compression techniques offer very good values but low compression ratios. WDR based compression is lossy due to nature of the method. However, the qualitative loss is noticeable in some point. The WDR compression offers very good values and good compression ratios. Lossy compression scheme is shown in fig1.2. [4]

![Block diagram of Lossy compression method](image)

**Fig 3. Block diagram of Lossy compression method**
3. LITERATURE SURVEY

Saini et al. (2016) in his paper discussed the image compression has become vital in today’s scenario because lots of digital images has become spread over the servers which uses lots of space[22]. K.Sheeba et al. (2016) presented fractal picture pressure is a functioning region of examination with new encouraging strategy that will work adequately in territories where we need to manage a colossal size of information .In Fractal pressure significant test is the comprehensive correlation required in the encoding stage. In this paper a strategy for cycle free-detail space fractal picture pressure is available, in which season of encoding is decreased without trading off much on the nature of picture and this calculation ensures a high pressure proportion. This is a half and half calculation of fractal science and wavelet Transform. When contrasting and the current half breed strategies the benefit of this current strategy is, just the guess space goes through comprehensive correlation and along these lines it ensures higher speed than the current Hybrid procedures. Uncertainties (Iterated work arrangement) of detail space are determined utilizing the aftereffect of estimation space. Trial results show that in the current technique [13]. Sandhu et al. (2016) discussed that Picture Compression is exceptionally fascinating as it manages this present reality issues. It assumes critical part in the exchange of information, similar to a picture, from one client to other. This paper presents the utilization MATLAB programming to actualize a code which will take a picture from the client and returns the packed structure as a yield. WCOMPRESS work is utilized which incorporates wavelet change and entropy coding ideas. This paper presents the work done on different kinds of pictures including JPEG (Joint Photographic Expert Group), PNG and so on and dissected their yield. Different pressure procedures like EZW, WDR, ASWDR, and SPIHIT which are normal in picture preparing are utilized [26]. Kaur et al. (2016) discussed that image compression method eradicates redundant and/or unrelated information, and resourcefully encodes leftovers. Practically, it is frequently essential to toss away both non-redundant information and relevant information to attain the essential compression. In any case, the ploy is discovering methods that permit important information to be resourcefully extracted and represented. This paper copes with dissimilar compression methods for comprising the information in an image. The information can be compressed by means of Lossy techniques such as Quantization, Transform coding, Block Transform Coding or Lossless techniques such as Run Length Coding, Lossless Predictive Coding, Multi-resolution Coding. All these techniques have been discussed in this paper and the performance of any technique/method is analyzed on various parameters like MSE and PSNR. [38] Kumar et al. (2016) performed an analysis of EZW and SPIHT compression along with de-noising algorithms. Result is inspected utilizing X-beam clinical jpg picture on various wavelets. The nature of picture is measure by PSNR and correlation is done on pressure proportion. SPIHT based pressure having better pressure proportions contrasted with EZW for all wavelets. Denoising is determined by adding Speckle clamor for both delicate and hard limit [5]. Singh et al. (2015) analysis wavelet transform is a mathematical tool for hierarchically decomposing functions. Wavelet transform has been proved to be a very useful tool for image processing in recent years. The most distinctive feature of Haar Transform lies in the fact that it lends itself easily to simple manual calculations. The aim of this paper is to describe the algorithm for image compression using Haar Transform. The quality analysis of this method has been checked for three different levels of HT scaling with varying quantization with threshold encoding scheme. In this paper, the image quality analysis is done using two sets of parameters, namely the popular peak signal to noise ratio and compression ratio. [19] Kodgule.et al. (2015) presented Fractal based technique for compression is one of the popular
methods for compression of videos and images. It has generated much interest due to its promise of high compression ratios at good decompression quality and it enjoys the advantage of very fast decompression and resolution independent decoding. But it suffers from highly computationally intensive encoding process which makes it unsuitable for real time applications. Many approaches have been suggested but they do not satisfy the requirement of low encoding time and high quality reconstructed images. Experimental results show significant reduction in encoding time and quality of reconstructed images is also good compared to other approaches making this technique suitable for real time applications such as image retrieval, image denoising, Image authentication and encryption, satellite and medical imaging [31]. Rawat et al. (2015) presented Advanced wavelet change based pressure strategies have higher pressure rate with less measure of memory prerequisites, reversible and give a superior recreated pictures. In this paper execute picture pressure method utilizing EZW and SPIHT plans. By utilizing of various wavelet channels that is demy, Symlets, Daubechies, Coiflets, invert bi-symmetrical analyze the pressure execution. This strategy produces safeguarding the majority of the picture data and the picture is duplicated without debasing the picture quality. Implanted zero tree wavelet is presented by Shapiro and Amir Said presented set apportioning in various leveled trees. The best remake pictures with better PSNR and least execution time give by these procedures. The two methods are looked at by different boundaries, for example, PSNR, CR, BPP, MSE and execution time. The consequences of picture pressure calculation dissected utilizing MATLAB programming and wavelet tool compartment [34]. Gupta et al. (2014) discussed the compression of pictures where average debasement is required. With the wide utilization of PCs and thusly need for huge scope stockpiling and transmission of information, effective methods of putting away of information have gotten essential. With the development of innovation and passage into the Digital Age, the world has ended up in the midst of a tremendous measure of data. It has excellent compaction for highly correlated data. Wavelets transform divided the image into high frequency components [35]. Mahmood et al. (2014) analysis a simple lossless image compression method based on a combination between bit-plane slicing and adaptive predictive coding is adopted for compressing natural and medical images. The idea basically utilized the spatial domain efficiently after discarding the lowest order bits namely, exploiting only the highest order bits in which the most significant bit corresponds to last layer7 used adaptive predictive coding, while the other layers used run length coding. The test results leads to high system performance in which higher compression ratio achieves for lossless system that characterized by guaranty fully reconstruction [24]. Pareek et al. (2014) presented, Image compression is decreasing size of pictures in bytes of a picture without debasing the nature of pixels present in pictures to an inadmissible level. At whatever point pictures are resized then it gives extra room to different documents. In this paper we have examined another methodology for picture pressure, where multilayer wavelet is to be utilized, by utilizing double tree complex wavelet change with multilayer that safeguard the predominant brilliance level and power of the focused on picture in layers, which brings about layered wavelet coefficients near zero. The Thresholding likewise can alter the coefficients to deliver more zeros which permit a higher pressure proportion. The wavelet investigation needs expansion uphold for packing the information so Huffman coding is utilized alongside wavelet examination of a picture to pack the information. At last get the best outcome with higher psnr and pressure proportion and least mse in the analyzed present. [16]

Jaiswal et al. (2014) discussed that the wavelet change is generally utilized in picture preparing calculations. In this paper two distinctive wavelet pressure methods are applied on the picture. The pressure is
performed utilizing EZW and SPIHT wavelet based pressure procedures. In pressure, wavelets have introduced a
decent adaptability to a wide scope of information, while being of sensible intricacy. These methods are more
effective and give a superior quality in the picture. The methods are thought about by utilizing the presentation
boundaries Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE), Compression Ratio (CR) and Bit rate
(BR) at different threshold. In the end the conclusion is observed to know which technique is better for image
compression. It is observed that compression ratio for SPIHT is better as compared to compression ratio of EZW
[23]. Amruta et al. (2013) presented with expanding interest for applications in interactive media, versatile
interchanges and PC organizations, the field of picture coding pulls in numerous scientists. Achievement of higher
pressure proportion while holding great picture quality is needful in the present requesting climate. Numerous
sight and sound applications are requesting for low circle memory necessity, quicker and great perceptual quality
for pictures/video. In this paper, creators have inspected bountiful endeavors made by analysts to satisfy the
necessity of lossy to lossless picture coding. Perhaps the most ideal decision for picture coding was DCT which
is supplanted by DWT. Creators have introduced condition of workmanship for different strategies in lossy to
lossless coding area. With the headway in examination in the fields in particular channel banks and lifting based
wavelet changes, picture coding with channel banks is presently best appropriate technique in all viewpoints [12].
Firas et al. (2013) analysis Image compression is an important filed in image processing. The science welcomes
any tinny contribution that may increase the compression ratio by whichever insignificant percentage. Therefore,
the essential contribution in this paper is to increase the compression ratio for the well-known Portable Network
Graphics (PNG) image file format. The contribution starts with converting the original PNG image into k-
Modulus Method (k-MM). Practically, taking k equals to ten, and then the pixels in the constructed image will be
integers divisible by ten. Since PNG uses Lempel-Ziv compression algorithm, then the ability to reduce file size
will increase according to the repetition in pixels in each k- by-k window according to the transformation done
by k-MM. Experimental results show that the present technique (k-PNG) produces high compression ratio with
smaller file size in comparison to the original PNG file. [32]

Singh et al. (2012) presented the presentation distinction of the discrete cosine change (DCT) and the
wavelet change for dark scale pictures. Wide scope of dim scale pictures was viewed as less than seven distinct
kinds of pictures. Picture types considered in this work are standard test pictures, landscapes, faces, misc, surfaces,
aerials and arrangements. Execution examination is done subsequent to actualizing the methods in Matlab.
Remade Image Quality qualities for each picture type would be determined over specific piece rate and would be
shown eventually to distinguish the quality and pressure in the subsequent picture and coming about execution
boundary would be demonstrated as far as PSNR, for example Pinnacle Signal to Noise Ratio. Testing is
performed on seven sorts of pictures by assessing normal PSNR values [16]. Reddy et al. (2012) analysis different
wavelet techniques for image compression. Both hand- designed and lifting based wavelets are considered. These
wavelet changes are utilized to pack the test pictures seriously by utilizing Set Partitioning in Hierarchical Trees
(SPIHT) calculation and by consolidating lifting ideas. Set Partitioning in Hierarchical Trees is another high level
calculation dependent on wavelet change which is picking up consideration because of numerous likely business
applications in the zone of picture pressure. These calculations brought about reasonable favorable circumstances,
for example, unrivaled low piece rate execution, bit-level pressure, reformist transmission by pixel, exactness and
goal .The SPIHT coder is additionally an exceptionally refined adaptation of the EZW calculation and is an
amazing picture pressure calculation, that creates an inserted bit stream structure, wherein the best reproduced pictures shows a critical perceptual improvement just as an expanded PSNR [19]. Singh et al. (2011) discussed The principle target of this paper is to planned and executed an EZW and SPIHT Encoding Coder for Lossy virtual Images. Inserted Zero Tree Wavelet calculation (EZW) utilized here is basic, uncommonly intended for wavelet change and successful picture pressure calculation. This calculation is concocted by Shapiro and it has property that the pieces in the spot stream are produced arranged by significance, yielding a completely inserted code. SPIHT represents Set Partitioning in Hierarchical Trees. The SPIHT coder is a profoundly refined rendition of the EZW calculation and is an amazing picture pressure calculation that delivers an inserted bit stream from which the best remade pictures. The SPIHT calculation was incredible, proficient and basic picture pressure calculation. By utilizing these calculations, the most elevated PSNR values for given pressure proportions for an assortment of pictures can be gotten. SPIHT was intended for ideal reformist transmission, just as for pressure. The significant SPIHT highlight is its utilization of installed coding. The pixels of the first picture can be changed to wavelet coefficients by utilizing wavelet channels [5]. Anitha et al. (2010) Presented Progressed imaging requires capacity of enormous amounts of digitized information. Because of the obliged transfer speed and capacity limit, pictures should be packed before transmission and capacity. Anyway the pressure will lessen the picture devotion, particularly when the pictures are compacted at lower bitrates. The reproduced pictures experience the ill effects of impeding antiques and the picture quality will be seriously debased under the situation of high pressure proportions. Clinical imaging represents the incredible test of having pressure calculations that diminish the deficiency of loyalty however much as could reasonably be expect but then have high pressure rates for decreased capacity and transmission time. To address this difficulty a few cross breed pressure plans have been created in the field of picture preparing. This paper presents outline of different pressure strategies dependent on DCT, DWT, ROI and Neural Networks for two dimensional (2D) pictures. [21]

4. PROPOSED ALGORITHM
To verify the effectiveness (qualities and robustness) of the present Image Compression Using Wavelet Transform, we conduct several experiments on several images. The steps used in our present technique are given below:

Step 1: Firstly we develop the proper GUI for our implementation work with 2-D Tool.
Step 2: We develop a code to consider the loaded image as a color image and gray grayscale image and apply it.
Step 3: Compress with a simple method coefficients thresholding. Record positions for new significant values: new indices for which is greater than or equal to the present threshold. Encode these new significant indices using difference reduction.
Step 4: Perform a Wavelet Decompress tool that displays the wavelet coefficients approximation and details coefficients of decompress for the three directions, together with the histogram of the original coefficients.
Step 5: we used progressive methods starting with STW algorithm with wavelet haar and bior. From the Wavelet compression it is observed that increase in number of loops leads to a better recovery but worse the compression ratio.
Step 6: We further improved it by using a more recent method ASWDR with haar and bior4.4.

5. RESULTS AND DISCUSSION
For the testing of the developed system, first we tested our system using STW using Haar wavelet and bior
4.4 wavelet. The system was tested on four parameters i.e. CR, BPR, MSE and PSNR. Further we used both gray and colored images. Also the system is tested using 6 step, 9 step and 12 step. The results obtained by STW using haar wavelet are tabulated in tables 2.1 to 2.3. The results obtained by STW using bior4.4 wavelet are tabulated in tables 2.4 to 2.5.

<table>
<thead>
<tr>
<th>Table 2.1 STW using haar wavelet with 6 step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Performance</td>
</tr>
<tr>
<td>Gray</td>
</tr>
<tr>
<td>Color</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2.2 STW using haar wavelet with 9 step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Performance</td>
</tr>
<tr>
<td>Gray</td>
</tr>
<tr>
<td>Color</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2.3 STW using haar wavelet with 12step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Performance</td>
</tr>
<tr>
<td>Gray</td>
</tr>
<tr>
<td>Colour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2.4 STW using bior 4.4 wavelet with 6 step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Performance</td>
</tr>
<tr>
<td>Gray</td>
</tr>
<tr>
<td>Color</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2.5 STW using bior 4.4 wavelet with 12 step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Performance</td>
</tr>
<tr>
<td>Gray</td>
</tr>
<tr>
<td>Color</td>
</tr>
</tbody>
</table>

5.1 Handling Truecolor Images

For the colored images, we used ASWDR algorithm. The ASWDR algorithm is a very simple. In this, a wavelet transform is first applied to the image, and then the bit-plane based ASWDR encoding algorithm for the wavelet coefficients is carried out. We applied ASWDR using Haar and bior4.4 wavelet. The ASWDR using Haar wavelet is applied using 6 and 12 steps while in case of bior4.4 the steps used were 6 and 12. The results obtained are tabulated in the tables 3.1 to 3.4:
Table 3.1 ASWDR using haar wavelet with 6step

<table>
<thead>
<tr>
<th>Image performance</th>
<th>CR</th>
<th>BPP</th>
<th>MSE</th>
<th>PSNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray</td>
<td>0.26</td>
<td>0.02</td>
<td>1.60</td>
<td>32.06</td>
</tr>
<tr>
<td>Color</td>
<td>0.06</td>
<td>0.03</td>
<td>0.79</td>
<td>19.20</td>
</tr>
</tbody>
</table>

Table 3.2 ASWDR using haar wavelet with 12step

<table>
<thead>
<tr>
<th>Image Performance</th>
<th>CR</th>
<th>BPP</th>
<th>MSE</th>
<th>PSNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray</td>
<td>12.16</td>
<td>0.97</td>
<td>12.87</td>
<td>11.09</td>
</tr>
<tr>
<td>Color</td>
<td>8.20</td>
<td>1.97</td>
<td>14.09</td>
<td>36.64</td>
</tr>
</tbody>
</table>

Table 3.3 ASWDR using bior wavelet with 6step

<table>
<thead>
<tr>
<th>Image Performance</th>
<th>CR</th>
<th>BPP</th>
<th>MSE</th>
<th>PSNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray</td>
<td>0.27</td>
<td>0.02</td>
<td>1.35</td>
<td>31.31</td>
</tr>
<tr>
<td>Color</td>
<td>0.66</td>
<td>0.01</td>
<td>18.51</td>
<td>19.87</td>
</tr>
</tbody>
</table>

Table 3.4 ASWDR using bior wavelet with 9step

<table>
<thead>
<tr>
<th>Image Performance</th>
<th>CR</th>
<th>BPP</th>
<th>MSE</th>
<th>PSNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray</td>
<td>8.16</td>
<td>0.65</td>
<td>10.30</td>
<td>10.12</td>
</tr>
<tr>
<td>Color</td>
<td>5.27</td>
<td>1.26</td>
<td>10.38</td>
<td>37.96</td>
</tr>
</tbody>
</table>

From above table it can be observed that the final compression ratio (CR) and the Bit-Per-Pixel (BPP) ratio are very satisfactory in case of ASWDR algorithm. Thus it can be concluded that the ASWDR algorithm performs better as compare to SWT algorithm for color images.

6. CONCLUSIONS AND FUTURE WORK

In this paper, author presented the use MATLAB software to implement a code which will take an image from the user and returns the compressed form as an output. Author basically compared the wavelet-based algorithms i.e. adaptively scanned wavelet difference Reduction (ASWDR) and spatial-orientation trees Wavelet (SWT). Experiment is performed on various types of images including GIF, JPEG and PNG etc. and their output is analyzed. These algorithms are compared in terms of Peak Signal to Noise Ratio (PSNR), Compression Ratio (CR), Mean Square Error (MSE) and Bit per pixels. It gives high CR and PSNR with better image quality. After experiments author concluded that ASWDR compression method performs better for color images as compare to SWT compression method.

7. REFERENCES


[3]. Digital Image Processing using Matlab (Gonzalez)/Chapter 6/Color Image Representation in MATLAB.


