Efficient Performance of Lifting Scheme Along With Integer Wavelet Transform In Image Compression

Tilak Mukherjee*, M.Koteswara Rao**
*(Department of Electronics &Communication Engg,Asst Professor,LBRCE Mylavaram, Andhra Pradesh.
** (Department of Electronics &Communication Engg,Asst Professor, CIT-Guntur, Andhra Pradesh.

ABSTRACT

In image compression using transform techniques the purpose is to reduce the data redundancy significantly, both spatial and spectral, without affecting the quality of the picture much.A lossless reversible image compression model is proposed for both continuous and discrete time cases, that exploits integer wavelet transform(IWT) employing lifting scheme(LS).Unlike its conventional counterpart in wavelet decomposition ,here both approximation as well as detailed image contents are splitted providing better compression ratio. Adequate use is made of both forward and inverse lifting schemes so as to reduce the computational complexity by a factor of two and achieve superior compression performance in terms of encoding time, decoding time,peak signal to noise ratio PSNR and better compression ratio(CR). Bi-orthogonal wavelets are constructed using lifting scheme that makes optimal use of both high pass and low pass filter values, and consequently addition and shift operations are performed on the resulting wavelet coefficients. This paper projects the advantages of IWT using LS used in real time compression of both still and color images involving non smooth domains or curves.

Keywords **–** IWT, LS, PSNR, CR, DWT, Bi-orthogonal wavelets.

I. INTRODUCTION

Large amount of data redundancy should be minimized by coding, interpixel or psychovisual redundancy for better transmission and storage of date requiring compact memory size.Restoration of the original image size is done at the receiving end so as to keep the image quality intact. Keeping in view, conventional lossless compression technique like entropy coding or JPEG is used whereas in lossless compression method some form of transform or predictive coding is generally preferred.[1] In the recent times, wavelet transform has been greatly appreciated due to its multi-resolution functionality and better compression performance even at a very low bit rate.[10] Simulation results using MATLAB 7.8 environment shows the superior compression parameters using forward lifting scheme for image compression and inverse lifting scheme for reconstruction of the image. The proposed transform technique can be applied to both lossy and lossless image compression models, making it a common core for both IWT and DWT computation.[2][3]

II. WAVELET TRANSFORM

Wavelets are small basic functions defined over a limited time and characterized by dilation and translation property. Any arbitrary function can be modeled using many such wavelets.Fourier analysis is the tool for classical wavelet construction. Conventional method of discrete wavelet transform(DWT) refers to sub band coding using both high pass and low pass(1-D) filter banks.For DWT of a finite length signal s(n) having N components, it is expressed by an NXN matrix.[3] Desirable energy is compacted, and using these filter banks both approximation and detailed analysis of any given image can be attained with considerable resolution.In wavelet filter decomposition, these 1-D filter banks are converted to 2-D filter bank structures by successive sub-sampling operation.

Fig.1 shows the wavelet filter sub band decomposition. The sub bands are labeled as LL,,HL,LH,HH respectively. [3][4]

1. **LL-**Represents approximation content of the image resulting from low pass filtering in both horizontal and vertical directions.
2. **HL**- Represents vertical details resulting from vertical low pass filtering and horizontal high pass filtering.
3. **LH**-Horizontal details resulting from vertical high pass filtering and horizontal low pass filtering.
4. **HH**-Represents diagonal image details resulting from high pass filtering both vertically and horizontally.

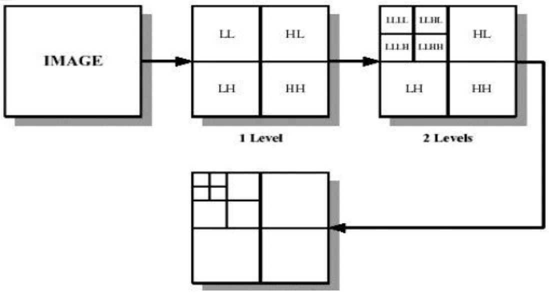

Fig.1.Wavelet filter sub band decomposition

III. INTEGER WAVELET TRANSFORM

In wavelet filter decomposition, the sub band image is further split into four groups and the approximation content is again decomposed into four smaller sub bands.[4] Here detailed contents of the image are highly neglected resulting in loss of information and poor compression performance.

For truly lossless coding, efficient robust algorithm is proposed in IWT where both approximation and detailed contents of the image are decomposed and yields better compression parameters.[9] A better approach is to round off the values of wavelet transformation, and as compared to floating point operation they need less storage space.This yields integer values with finite precision and the faster computation of the coefficients is possible by the recursive algorithm, lifting scheme, that is invariably used to compress and restore the original image.[10] This eliminates the need for temporary arrays for storage of the coefficients, and is much faster implementation of wavelet transform. Simple shifting and addition operations are performed on the wavelet kernel to produce bi-orthogonal second generation wavelets.[8]The next section analyses the LS both in forward and reverse direction, and the encorporation of this potential algorithm in IWT so as to attain superior image compression model including multilevel image decomposition.[5]

IV. PROPOSED LIFTING SCHEME

The proposed method invariably is used to separate the odd and even coefficients, thereby producing bi-orthogonal second generation wavelets.In place and much faster computation of DWT is performed is three steps-split,predict and update.Reverse operation is performed for the signal reconstruction at the receiving side with update, predict and merge steps respectively.[5]Every transform by the lifting scheme can be inverted, making it good for perfect reconstruction. Speed up is increased by a factor of two, utilizing the properties of both high pass and low pass filters.[9]A series of convolution and accumulate operations are performed on the split signal in a recursive manner.Forward LS is used for the image compression and inverse LS is used for the reconstruction of the image.Such transformation is done entirely in the spatial domain, so Fourier analysis no longer plays important role.[8]The signal decomposition is designed by using two filter function h(z) and g(z) respectively as shown in Fig. 2.These wavelet filter function values are entered in the polyphase matrix where they are split and decomposed.Predict and update operators are performed on those coefficients to get the detailed and approximation content of the signal or image.[6]Forward lifting scheme is illustrated in Fig.3.

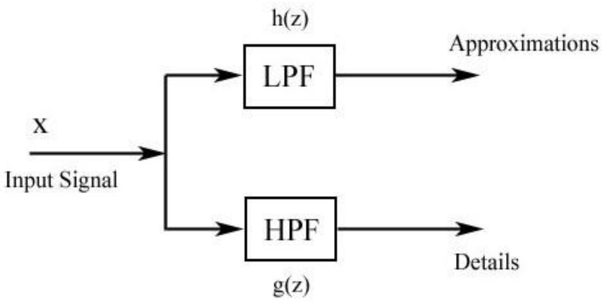

Fig.2.Signal decomposition

The basic steps for forward LS are:

1. SPLIT-Divide into odd and even samples the input co-efficients.
2. PREDICT-Predict the odd sample as linear combination of even values and subtracting it from the odd values to form prediction error.
3. UPDATE-Final step consists of updating the even values by adding them to the prediction error.

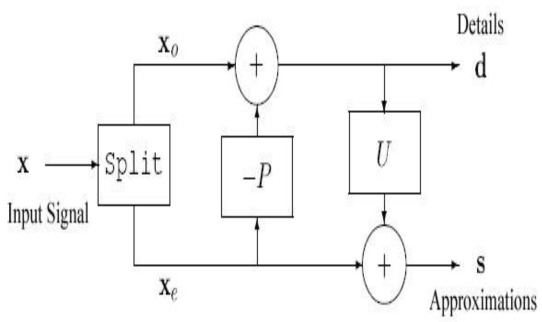

Fig.3.Forward Lifting Scheme

A similar reverse operation is performed so as to restore the perfect original image by Inverse Lifting scheme.[7]The basic steps are-Update,Predict and Merge so as to perform inverse wavelet transform as shown is Fig.4.The signal s(n) is equal to the input original signal x .[9]

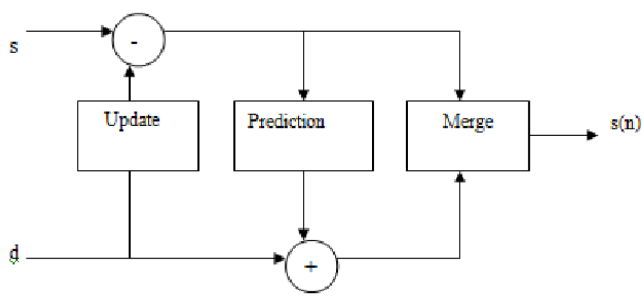

Fig.4.Inverse Lifting Scheme

V. SIMULATION RESULTS

Using MATLAB 7.8,simulations are performed using two different images in the GUI interface.In the first case taking 'Lena' image in Fig.5 the result is shown.

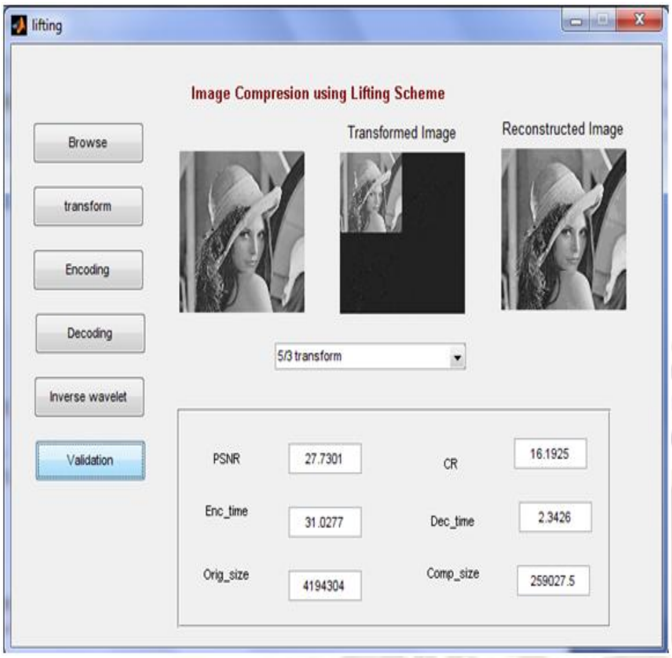

Fig.5.Simulation result of Image 'Lena'.

The compression ratio is significantly improved.The transformed and the reconstructed image both are considered.One more simulation result using 'grain 'image is shown in Fig. 6.These simulation results conform to the fact that implementing the LS improves the compression parameters like PSNR,CR,encoding and decoding time.

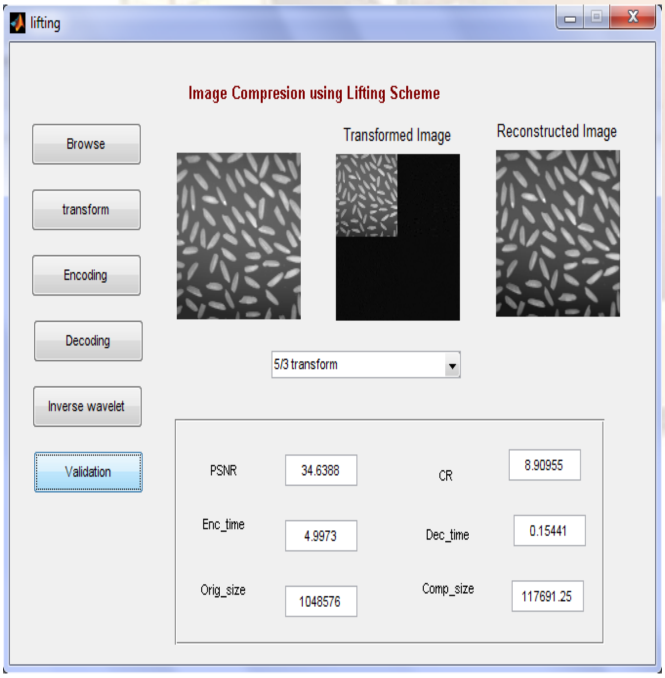

Fig.6.Simulation result of Image 'Grain'.

Table 1.Performance parameters of two Images under test

Parameter	Image 1'Lena'	Image 2 'Grain'
PSNR	27.7301	34.6388
Compression ratio	16.1925:1	8.90955:1
Encoding Time	31.0277s	4.9973s
Decoding Time	2.3426s	0.15441s

Table 1. shows the compression ratio improvement for the two images whose simulation results have been performed.The encoding and decoding time is significantly improved to speed up the compression process in this Lifting Scheme.The 5/3 transform corresponds to the fact that high pass filter has five filter taps and low pass filter has three taps in this experiment.

VI. CONCLUSION

In this paper,lossless image compression model using the Lifting Scheme is projected and the simulation results agree to the superior performance of such efficient compression model.It has the potential to speed up the splitting and decomposition process by exploiting the features of both low pass and high pass filter taps.In software based video conferencing and real time image compression systems where speed is a deciding factor, this reversible compression model can work out suitably, without the need of temporary arrays in the calculation steps.The implementation of LS along with IWT definitely improves the PSNR and compression ratio significantly, projecting it to be a more effective and robust compression technique in image processing areas using medical, seismic,satellite,manuscript and heavily edited images.

REFERENCES

[1] Cebrail Taskin,Serdar Kursat, '*'Overview of Image Compression Approaches" IEEE 3rd International Conference on Digital Telecommunications*,2008.

[2] C.Lin,Bo Zhang and Yuan F.Zheng,"*Packed Integer Wavelet Transform constructed by Lifting scheme" International Journal of Computers,Information Technology and Engineering,June* 2008.

[3] Subhasis Saha."*Image Compression from DCT to wavelets:A Review",The ACM Student Magazine.*

[4] Amir Averbuch,Danny Lazar and Moshe Israeli.*''Image Compression using wavelet transform and multiresolution analysis" IEEE Transactions on Imge Processing Vol.5 No.1*,January 1996.

[5] Geert Uytterhoeven,Dirk Roose and Adhemar Bultheel,"*Integer wavelet transforms using the Lifting Scheme"* CSCC 1999 Proceedings.

[6] S.Dewine and Comelis,"*Lossless Integer wavelet transform",IEEE Signal processing Vol.4*,March 1997.

[7] G.K Kharate,A.A. Ghatol and P.PRege,''*Image Compression using Wavelet packet Tree",ICGST-GVIPJournal,Vol.4,Issue 7*,July 2005.

[8] Wade Spiras*,"Lossless Image Compression via the Lifting Scheme",*University of Central Florida,November 2005.

[9] C.Jain,Vijay Chaudhary,Kapil Jain,Saurabh Karsoliya*,"Peformance analysis of Integer wavelet Transform for Image Compression",IEEE* 2011.

[10] Anoop Mathew and Beniskar Raja Singh D,"*Image Compression using Lifting based DWT",International Journal of Computers,Information Technology and Engineering*.Jan-June 2009.