HIGH-LEVEL IMPLEMENTATION OF GRAY SCALE IMAGE COMPRESSION USING LIFTING SCHEME

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Abstract- Image compression has become one of the most important disciplines in electronics because of the ever growing popularity and usage of the internet and multimedia systems combined with the high requirements of the bandwidth and storage space. The increasing volume of data generated by some medical imaging modalities which justifies the use of different compression techniques to decrease the storage space and enhance efficiency of transfer the images over the network for access to electronic patient records. Here we are presented an effective algorithm to compress and to reconstruct gray scale image and communications in medical image. Various image compression algorithms exist in today's commercial market. In this, we are introducing lifting scheme based Haar wavelet transform. The Haar wavelet is famous for its simplicity and speed of computation. Computation of the scaling coefficients requires adding two samples values and dividing by two. Calculation of the wavelet coefficients requires subtracting two samples values and dividing by two.

Keywords– Lifting Scheme, Bi-orthogonal, Haar wavelet, IWT.

I. INTRODUCTION

Lifting scheme was developed for the construction of biorthogonal wavelets. The main feature of the lifting scheme is that all constructions are derived in the spatial domain. It does not require complex mathematical calculations that are required in traditional methods. Lifting scheme is simple stand efficient algorithm to calculate wavelet transforms [1-2]. It does not depend on Fourier transforms. Lifting scheme is used to generate second- generation wavelets, which are not necessarily translation and dilation of one particular function. It was started as a method to improve a given discrete wavelet transforms to obtain specific properties. Later It became an efficient algorithm to calculate any wavelet transform as a sequence of simple lifting steps .Digital signals are usually a sequence of integer numbers, while wavelet transforms result in floating point numbers. For an efficient reversible implementation, it is of great importance to have a transform algorithm that converts integers to integers. Fortunately, a Lifting step can be modified to operate on integers, while preserving the reversibility. Thus, the lifting scheme became a method to implement reversible integer wavelet transforms. Constructing wavelets using lifting scheme consists of three steps: The first step is split phase that split data into odd and even sets. The second step is predicting step, in which odd set is predicted from even set. Predict phase ensures polynomial cancellation in high pass. The third step is update phase that will update even set using wavelet coefficient to calculate scaling function. Update stage ensures preservation of moments in low pass [3].

II. REASONS FOR THE CHOICE OF LIFTING SCHEME

We have used lifting scheme of wavelet transform for the digital compression because lifting scheme is having following advantages over conventional wavelet transform technique.

- It allows a faster implementation of the wavelet transform. It requires half number of computations as compare to traditional convolution based discrete wavelet transform. This is very attractive for real time low power applications.
- The lifting scheme allows a fully in-place calculation of the wavelet transform. No auxiliary memory is needed and the original image can be replaced with its wavelet transform.
- Possible to implement reversible integer wavelet transforms. In conventional scheme it involves floating point operations, which introduces rounding errors due to floating point arithmetic. While in case of lifting scheme perfect reconstruction as is possible for loss less compression. It is easier to store and process integer numbers compared to floating point numbers.
- Easier to understand and implement.
- It can be used for irregular sampling also.

III. LIFTING SCHEME BASED ON HAAR WAVELET TRANSFORM

Alfred Haar introduced the first wavelet systems in the year 1910. Wavelet systems of the Haar have been generalized to higher order dimension and rank. Two types of coefficients are obtained from the wavelet transform. Scaling coefficients are obtained by averaging two adjacent samples. These scaling coefficients represent a coarse approximation of the speech. Wavelet coefficients are obtained from the subtraction of two adjacent samples. Wavelet coefficients contain the fine details of the speech signal. The Haar wavelet is famous for its simplicity and speed of computation. Computation of the scaling coefficients requires adding two samples values and dividing by two. Calculation of the wavelet coefficients requires subtracting two samples values and dividing by two. The inverse transform simply requires subtraction and addition. Using logical shift stopper form division eliminates the need for a complex divide unit. Furthermore, implementing a logical shift in hardware requires much less power and space than an arithmetic logic unit (ALU). Given the computational requirements, the Haar wavelet is a simple and easy to implement transform. Computational simplicity makes the Haar transform a perfect choice for an initial design implementation.

Let us consider a simple example of Haar wavelet: Letus consider that we have a discrete equence f(x) which is obtained by sampling continuous signal such as speech signal. Consider two neighboring samples X and Y of this sequence. These two samples show strong correlation. Haar transform will replace value of X and Y by Average and difference:

a = (X+Y)/2________________________(1)
d= Y-X___________________________(2)

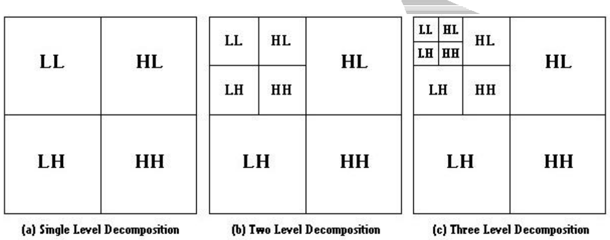

Fig 1: Pyramidal Decomposition of an Image

Figure1 shows the process involved in wavelet filter sub band decomposition. The sub bands are labeled as LL,HL, LH and HH respectively [3-4].

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

IV. INTEGER WAVELET TRANSFORM

In wavelet Digital speech signal is a sequence of integer samples; hence speech compression algorithms should work with integers. A part from speech compression, there are many applications like image compression, image processing etc. require integer wavelet transform because of nature of input data is integer samples. In addition to this the storage and

Encoding of integer numbers is easier compared to floating point numbers. Filter bank algorithm of wavelet transform work with floating point number seven though input values actually are integer, carrying out filtering operations on these numbers will transform them in rational or real numbers because the filter coefficients need not be integers. To obtain an efficient implementation of the discrete wavelet transform, it is of great practical importance that the wavelet transform is represented by a set of integers. Because if we store wavelet coefficients as a floating point

decomposition, the sub and image is further split into four groups and the approximation content is a gain decomposed further into four smaller sub bands.[4] Here detailed contents of the image are highly neglected resulting in poor compression performance due to significant information loss.

V. IMPLEMENTATION

In the IWT implementation, rounding operation introduces nonlinearity in each step. Proper choice of the best factorization of poly phase matrix of h(z) and g(z)h as to be done. The popular criteria are:

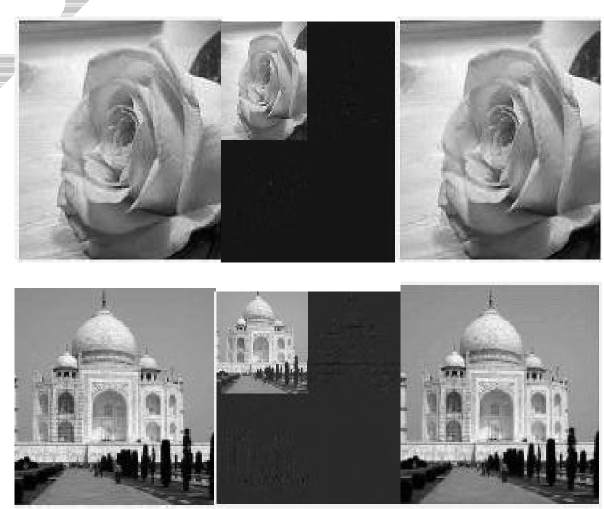

Fig 3: Original image, transformed Image and Reconstructed Image

VI. SIMULATION RESULTS

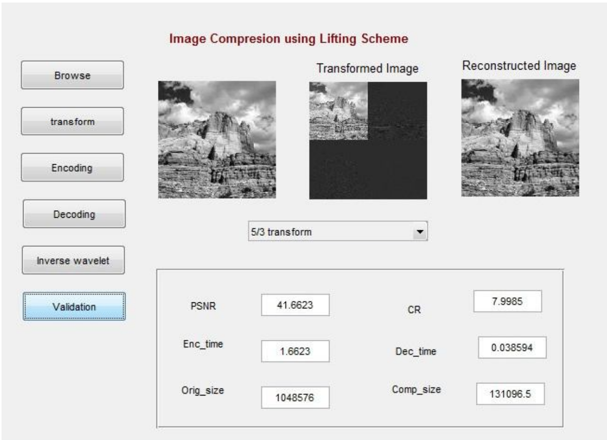

Fig 3 : Simulation result of Image "Hills".

The compression ratio is significantly improved. The transformed and the reconstructed image both are considered. This simulation results summarized inTable1.Conform to the fact that implementing the LS improves the compression parameters like PSNR, CR, encoding and decoding. LS invariably represent a distinguished choice for the implementation of loss less compression capability in terms of rate-distortion performance.

Table1, shows the compression ratio improvement for the image whose simulation results have been performed. The encoding and decoding time is significantly improved to speed up the compression process in this Lifting Scheme. The5/3transform corresponds to the fact that high pass filter has five filter taps and low pass filter has three taps in this experiment, which can be modified according to the experiment designer. Best factorization exhibit IWT performance very close to DWT for low bitrates only [10]. As the bit rate grows then online ar effects of integer transform are dominant with respect to the quantization error.

Image	Encoding Time(sec)	Decoding Time(sec)	Compression Ratio(CR)
i)Rose	2.1977	0.082277	8.91373
ii)TajMahal	1.5665	0.062376	8.71131
iii)CameraMan	1.7791	0.080736	7.97836
iv)Rice	1.9339	0.070633	8.90938

VII. CONCLUSION

In this paper, superior performance of loss less image compression model using the Lifting Scheme is analyzed and the simulation results agree to 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, Internet browsing, multispectral remote sensing, HDTV 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. Stemming from these results, VLSI architectures will be project edin future scope for the IWT that are capable of attaining very high frame rates with moderate gate complexity.

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