Implementation of Lossless Image Compression on Satellite Images using Microblaze Processor

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***Abstract* —** *In satellite communication, Satellite images are used to determine space information. Satellite images gets corrupted due to the channel noise, wrong ISO settings etc. Satellite images contains large amount of data which increases the size of image, due to huge size it requires more time for transmission and quality of images become degraded. To mitigate these problems in this project presents a simple design of a combined scheme for compression, denoising and fusion of satellite images. Lifting scheme is the simplest and efficient algorithm to calculate wavelet transforms. The use of lifting scheme to achieve image compression guaranteed to be lossless in presence of inaccuracies. Salt & Pepper noise is needed to corrupt the compressed image and median filter is used for denoising the image. Finally image fusion is carried out using maximum rule in high pass filter. This system is implemented in Xilinx platform studio with Microblaze soft core processor using System C language. This system achieves high image quality in terms of MSE and PSNR.*

Keywords — *denoising, fusion of satellite images, lifting scheme, lossless image compression, median filter, System C language, Xilinx platform Studio.*

I. INTRODUCTION

Satellite images have many applications in meterology, oceanography, fishing, agriculture, biodiversity conservation etc. In recent years, the wavelet transform has emerged as a cutting edge technology, within the field of image compression. Satellite imaging involves storage and transmission of satellite images. Due to constraints on bandwidth and storage capacity, a satellite image may be needed to be compressed before transmission/storage.

Satellite images get affected by the noise during the acquisition of image due to the channel noise, wrong setting of sensor etc. which degrades the quality of image. Quality of image is critical parameters which help to extract the information from the satellite images. So it is necessary to keep the quality of image during image processing. Muti Focus Image Fusion is a technique used to increase the quality of image.

II. LITERATURE REVIEW

Many of the authors have been discussed about compression techniques, denoising and fusion methods. A wide range of image compression techniques and methods have been used in the conventional times and even in the recent past years.A particular class of DWT is Daubechies wavelets with taps 4-6 are well-suited and commonly used in image compression applications[2]. A combined scheme for image compression and denoising for satellite imaging system provide better image quality[1].Here Compression process is carried out using lifting scheme DWT and denoising is carried out using kernel based bilateral filtering scheme. A lot of standard fusion methods perform well spatially but usually introduce spectral distortion. To overcome this problem, numerous multiscale transform based fusion schemes have been proposed [3]. Image fusion is the process that combines information from multiple images of the same scene. The result of image fusion is a new image that retains the most desirable information and characteristics of each input image. The main application of image fusion is merging the gray-level high-resolution panchromatic image and the colored low-resolution multispectral image [4].

In this project, enhance the quality of satellite image during processing by combining lifting based compression, denoising and image fusion.This work focuses on the implementation of lossless image compression with denoising and fusion of satellite images using Xilinx platform studio and System C language.

III. PROPOSED BLOCK DIAGRAM

The block diagram shows the proposed scheme that is used for combining the lifting based image compression, denoising, and muti focus image fusion techniques.

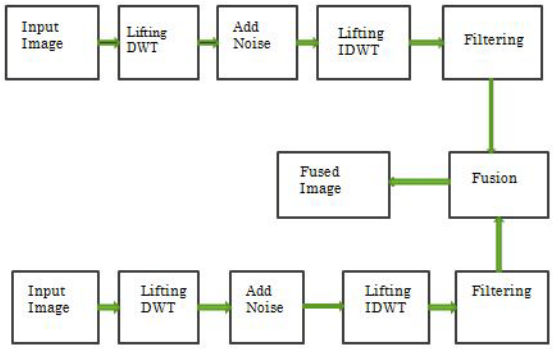

Fig.1 Proposed scheme for combining compression, denoising and fusion of images.

A. *Lifting based DWT for image compression*

In 2d discrete wavelet transform, the original image is high-pass filtered, yielding the three large images, each describing local changes in brightness (details) in the original image. It is then low-pass filtered and down scaled, yielding an approximation image; this image is high-pass filtered to produce the three smaller detail image and low-pass filtered to produce the final approximation image in upper left.

Lifting scheme of DWT has been recognized as a faster approach. The basic principle of this technique is to factorize the poly phase matrix of a wavelet filter into a sequence of alternating upper and lower triangular matrices and a diagonal matrix. This leads to the wavelet implementation by means of banded-matrix multiplications.

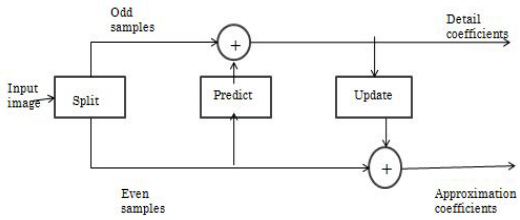

Fig.2 Forward lifting scheme

Lifting scheme has three stages namely, split, predict and update. Lifting scheme for lossless image compression proceeds as shown in Fig.2. First the input image is converted in to a matrix. In the split stage input image is divided in to odd and even samples. After the split stage predict phase predict odd samples value from the even samples. Combining predicted value with the even samples in the update stage. Then we obtain detail and wavelet coefficients of the input image matrix. This process is continued until we get the desired level for dwt.

Inverse lifting is done to retrieve the input image from the dwt as shown in Fig.3. The basic operations of inverse discrete wavelet transform include update, predict and merge.

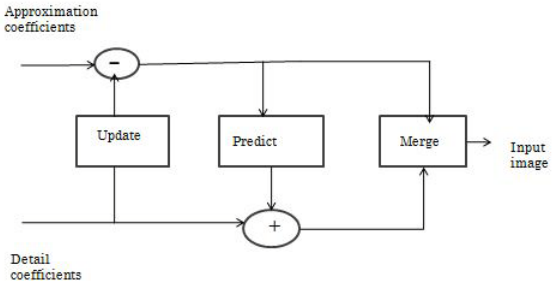

Fig. 3 Inverse lifting scheme

B. *Filtering Scheme*

Here salt and pepper noise is used to corrupt the image. Median filtering is a common step in image \pepper noise. Its edge-preserving nature makes it useful in cases where edge blurring is undesirable. Image synthesis is the process of creating new images from some form of image description.

C. *Image Fusion*

The image fusion scheme is shown in Fig.4.The term fusion means in general an approach to extraction of information acquired in several domains. The term fusion means in general an approach to extraction of information acquired in several domains. In this project multi focus image fusion is used for fusing the satellite images.

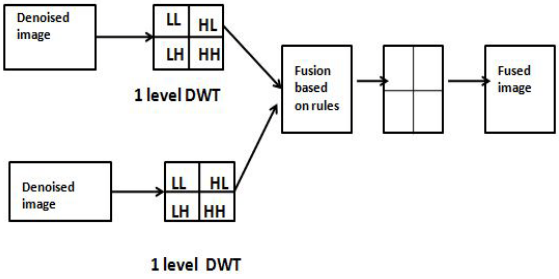

Fig.4 Multi focus image fusion

Here, original image can be divided into regions such that every region is in focus in at least one channel. For that identify the regions in focus and combine them together.

D. *Proposed Method*

First we consider one input image it is compressed using lifting operation. Add noise to the compressed image and inverse dwt is used to obtain the original image. Filtering is used to remove the noise .Similarly the above steps are repeated for the second input image. Finally both the images are fused by the fusion rule. Here pixel based fusion is adopted. Here we consider coefficients of only one channel called pixel based fusion rule.

IV. RESULTS

The Xilinx Platform Studio (XPS) is the development environment or GUI used for designing the hardware portion of your embedded processor system.In this work first create header files of the input images using Matlab. The XPS program written in System C language is used to simulate the entire system. The Algorithm is implemented in Microblaze Processor and the results are given below:

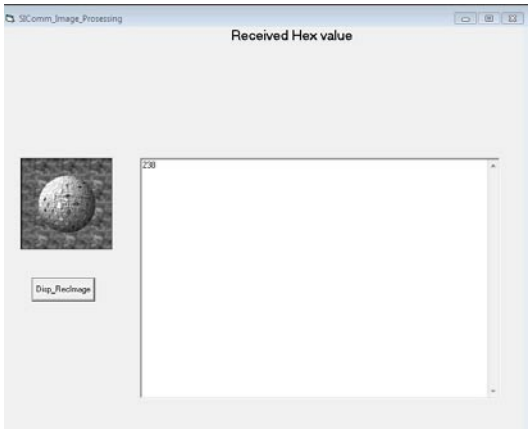

Fig.5 First Input Image

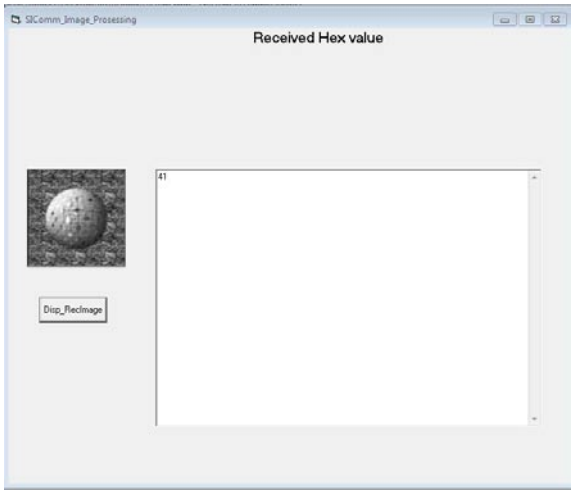

Fig.6 Second Input Image

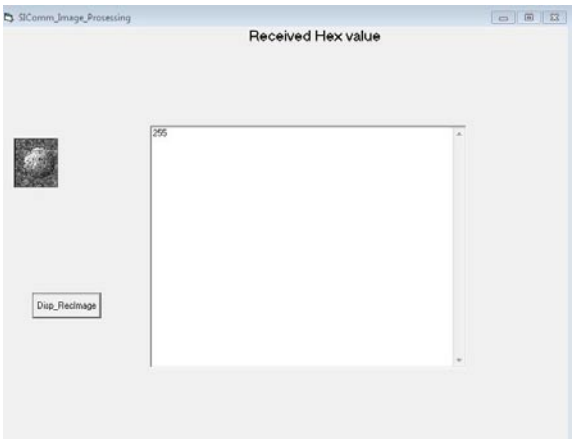

Fig.7 Compressed Noise Image

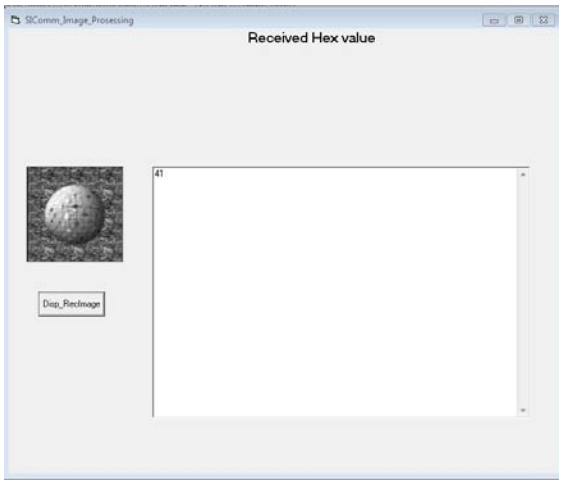

Fig.8 Uncompressed, Denoised and Fused output image

To evaluate the performance of the system two parameters such as MSE and PSNR are calculated.

$$MSE = \frac{\sum_{i=1}^{n}(pi-qi)^2}{n}$$

$$PSNR = 10\log\frac{(255)^2}{MSE}$$

Where, n: number of image pixel
pi: original image pixel
qi: retrieved image pixel

TABLE I

PERFORMANCE STATISTICS

Image Metrics	Input 1	Input 2
MSE	8.5402e+008	8.5015e+008
PSNR	41.1839	41.1642

V. CONCLUSIONS

The proposed scheme provides lossless compression of satellite images using lifting scheme along with denoising and fusion techniques. This scheme achieves better image quality after transmission of satellite image trough a channel. The PSNR and MSE values for the first image are 41.1839; 8.5402e+008 and 41.1642, 8.5015e+008 are for the second image respectively.

On-going research is focusing on designing of the lifting scheme with 6 Tap daub wavelet filter with denoising and fusion techniques.

ACKNOWLEDGMENT

For the successful completion of this project, we thank Salmanul Faris, Engineer, KECL, Kuttippuram, India for providing the resources to carry out the project.

I thank my guide Sajitha A.S, Assistant Professor in Department of Electronics and Communication Engineering, NCERC, pampady, India for providing valuable suggestions during the project.

I thank all my guides, family members and friends who helped me directly or indirectly during this work.

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