International Conference on "Advances In Computing, Communication And Intelligence" ICACCI-2014 At Mauritius
Special Issue of International Journal of Electronics, Communication & Soft Computing Science and Engineering, ISSN: 2277-9477

Comparison and Study of Image Compression and Enhancement Using Various Techniques

Mr. Vaibhav B. Aundhakar[1] Mr. R.N.Khobragade[2] Dr. V. M. Thakare[3]

Abstract- **Recently, many researchers started to challenge a long-standing practice of digital photography: oversampling followed by compression and pursuing more intelligent sparse sampling techniques to compress the image and produce the high quality of image and thus, it can be transmitted without any change to current image coding standards and systems. In this paper comparison between three image compression techniques is discussed. The first technique is Lossless Hyperspectral Image Compression System-Based on HW/SW Codesign, design and implementation of a lossless compression system for hyperspectral images on a processor-plus-field-programmable gate array (FPGA)-based embedded platform is used. Software execution time of compression algorithm was profiled first to conclude the decision of accelerating the most time consuming interband prediction module by hardware realization.**

The aim of this paper is to compare various image compression techniques that overcome the drawbacks of these compression techniques that discussed here. Second aim, by way of discussing compression studies, is to highlight and evaluate the utility of these methods in various domains. This evaluation on image compression techniques will be very useful for the development and improvement of new techniques.

Index Terms—**Embedded system, field-programmable gate array (FPGA), hardware/software (HW/SW) codesign, lossless compression, DCT approximation, image compression, low-complexity transforms, 3D imaging, 3D TV, wavelet transform.**

I. INTRODUCTION

Image compression is storing images using lesser number of bits than its original size. Image compression leads to less storage space and less bandwidth for transmission. Hence in this world of internet and multimedia applications image compression is of at most important and interesting area to work on. It is used to store images in medical image database, to generate image database in biometrics and many other applications. Image compression is divided into two categories: lossy and lossless. Compression ratio and image quality of decompressed image, these are two major things to be considered in image compression. As compression ratio increases, quality of reconstructed image starts degrading. Many compression techniques like vector quantization, predictive coding, differential image coding, transform coding have been developed. Transform based techniques are popular for image compression especially at low bit rate.

II. BACKGROUND

The design and implementation of a lossless compression system for hyperspectral images on a processor-plus-field-programmable gate array (FPGA)-based embedded platform. Software execution time of compression algorithm was profiled first to conclude the decision of accelerating the most time consuming interband prediction module by hardware realization. Efficient algorithm to hardware mapping led to a high throughput accelerator design in FPGA capable of

processing 16.5 M pixels/s. A set of optimization techniques were applied systematically to enhance the overall system performance. These include a hierarchical memory access scheme to resolve the bus bandwidth limitation, DMA assisted data transfers to shorten the hardware/software (HW/SW) communication, and various coding style and compiler options to optimize the software execution time. With the development of 3D integral imaging, image compression becomes mandatory for the storage and transmission of 3D integral images.

III. PREVIOUS WORK DONE

Lossless compression scheme which consists of three major modules, i.e. intraband prediction, interband prediction and entropy coder is experimented in [1]. An orthogonal approximation for the 8-point discrete cosine transform (DCT) is also introduced. The proposed approximation method modifies the standardDot-matrix by means of the rounding-off operation experimented [2] The use of the lifting scheme in the application of a 3D Wavelet Transform for the compression of 3D Integral Images is proposed. The lifting-based approach is more efficient computationally than the transversal approach [3].

This Review paper introduces analytical study of three image compression methods and the paper is organized as follows. **Section I** introduction. **Section II** discusses Background. **Section III** discusses previous work done. **Section IV** introduces Image compression existing methodologies. **Section V** includes Analysis and Discussion in which attributes and parameters and how they affect image quality is discussed. **Section VI** gives the proposed methodology suggesting new advancement in the existing methodologies and overcoming some of the drawback. **Section VII** provides the possible outcome and results and evaluates performance of methods and obtained results by applying these methods on images. Finally **Section VIII** Conclude this review paper.

IV. EXISTING METHODOLOGIES

In lossless compression scheme, as shown in Fig. 1.1, consists of three major modules, i.e., intraband prediction, interband prediction, and entropy coder. This method provides the hardware level approach towards the image compression and how the pixels in the image can be minimized to make it more compact is experimented using a special hardware and processor

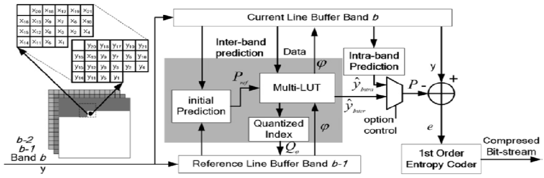


Fig. 1.1 Block diagram of the proposed lossless hyperspectral image compression scheme.

The interband prediction adopts a two-stage prediction approach consisting of initial prediction and final prediction. In initial prediction, a prediction *reference* value is first calculated. The multi- LookUp Table (LUT) module uses it to look up the final prediction value. Following fig 1.2 explains how the combination of the software and hardware can be implemented in making the image compression system more convenient and suitable for the particular applications.

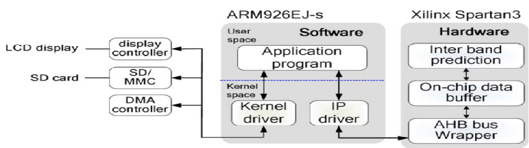


Fig 1.2 HW/SW partitioning for image compression system

The final prediction value is obtained by searching the previous band for the pixels with the same pixel value and then comparing their colocated pixel in the current band against the referenced value to reduce the lookup table size, the table is indexed by a quantized instead of the original pixel value. The quantization factors are band independent and of the forms of power of two to avoid any division. In entropy coding, the prediction errors are coded using separate entropy models for the sign bit and the magnitude.

This method emphasizes on the mathematical representation of image specially in the form of matrix and then compressing the image using different mathematical operations and functions.

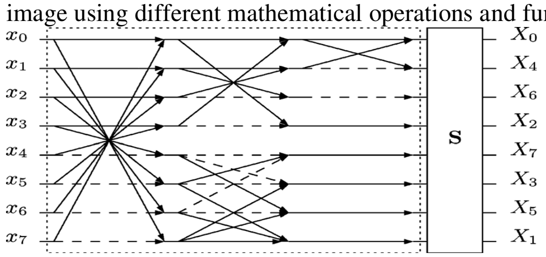


Fig 1.3 Flow diagram of fast algorithm relating input data to the corresponding approximate DCT coefficient

In terms of complexity assessment, matrix may not introduce an additional computational overhead. For image compression, the DCT operation is a pre-processing step for a subsequent coefficient quantization procedure. Therefore, the scaling factors in the diagonal matrix can be merged into the quantization step. This procedure is suggested and adopted in several works.

To record an integral photograph Lippmann used a regularly spaced array of small lenslets closely packed together in contact with a photographic emulsion. Each lenslet views the scene at a slightly different angle to its neighbor and therefore a scene is captured from many view points and parallax information is recorded. After processing, if the photographic transparency is re-registered with the original recording array and illuminated by diffuse white light from the Rear, the object will be constructed in space by the intersection of ray bundles emanating from each of the lenslet.

PRE-PROCESSING/POST-PROCESSING

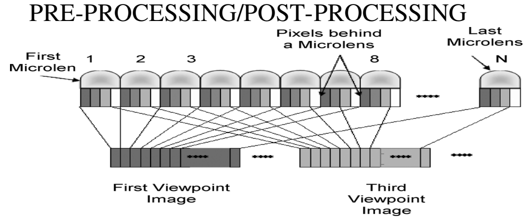


Fig.1.4 Illustration of viewpoint image extraction

2D WDT-BASED COMPRESSION OF 3D INTEGRAL IMAGES

The general structure of the 2D wavelet-based compression scheme is shown below. The input to the encoding process is a 3D integral image. Prior to computation of the 2D DWT, different viewpoint images are extracted from the original 3D integral image. The viewpoint image components are then decomposed into different decomposition levels using a 2D WDT.

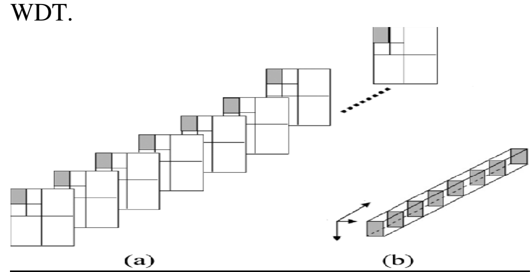
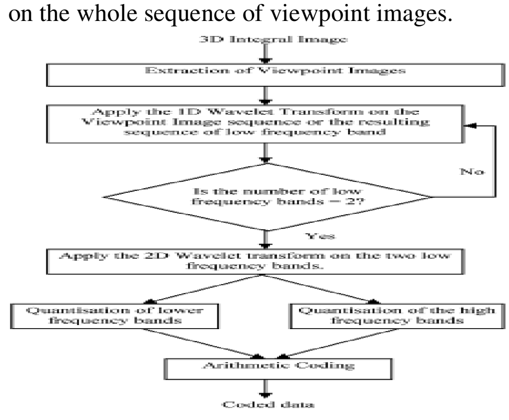


Fig.1.5 (a) 2-levels 2D-DWT on viewpoint images, (b) Grouping of the lower frequency bands into 8x8x8 blocks.

After decomposition of the viewpoint images using the 2D-DWT the resulting lowest frequency sub-bands are assembled, as shown in Fig. (b) And compressed using a 3D-DCT. This will achieve de-correlation within and between the lowest frequency sub-bands from the different viewpoint images. The 3D DCT is performed on an 8x8x8 volume. Hence, the 56 lowest frequency sub-bands are assembled together, giving seven groups of eight viewpoint images each.

3D DWT-BASED COMPRESSION OF 3D INTEGRAL IMAGES

The different steps of the proposed compression algorithm are described as shown below (coder only). The decoder follows the reverse steps of the encoder. The 56 extracted viewpoint I ages are DC level shifted. Then, a forward 1D DWT is applied on the whole sequence of viewpoint images.



V. ANALYSIS & DISCUSSION

In lossless image compression method, the implementation of multi-LUT scheme utilizes on-chip SRAM modules generated by the Xilinx core-generator. Each LUT operation requires two data accesses, one for read and one for write (LUT update). To achieve this in one clock cycle needs a dual-port memory configuration. Due to limited resources of block RAMs, a single-port memory configuration was chosen and the prediction throughput was reduced to 16.5 M pixels per second The initial prediction module utilizing dedicated 18 X 18 multipliers occupies only a small portion of the entire circuit complexity. Compiler optimization options were also turned on to improve the code quality. To control the hardware acceleration IP, a character type device driver was developed. The interband prediction IP was designed as an AHB slave device and only the processor can initiate data transactions.

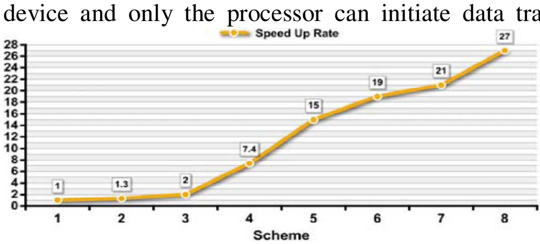


Fig 1.6 Cumulative throughput improvements versus enhancement measures

In dct approximation of image compression each image is divided into 8 X 8 sub blocks, which were submitted to the two-dimensional (2-D) approximate transforms implied by the proposed matrix.. According to the standard zigzag sequence, only the initial coefficients were retained, with the remaining ones set to zero. The inverse procedure was then applied to reconstruct the processed data and image degradation is assessed. As suggested in the peak signal-to-noise ratio (PSNR) was utilized as figure-of-merit.. Average calculations may furnish more robust results, since the considered metric variance is expected to decrease as more images are analyzed. Moreover, it could also outperform the BAS-2008 algorithm for high- and low-compression ratios. In the mid-range compression ratios, the performance was comparable. This result could be achieved at the expense of only two additional arithmetic operations. Additionally, it also considers the universal quality index (UQI) and mean square error (MSE) as assessments tools. The UQI is understood as a better method for image quality assessment and the MSE is an error metrics commonly employed when comparing image compression techniques

Following graphs depict the absolute percentage error (APE) relative to the exact DCT performance for the average UQI and average MSE, respectively. According to these metrics, the proposed approximation leads to a better performance at almost all compression ratios. In particular, for high- and low-compression ratio applications the proposed approximation is clearly superior. The resulting reconstructed images using the proposed method are close to those obtained via the DCT..

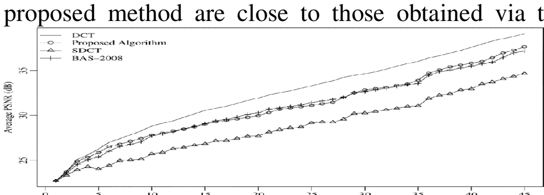


Fig 1.7 Average PSNR for several compression ratios.

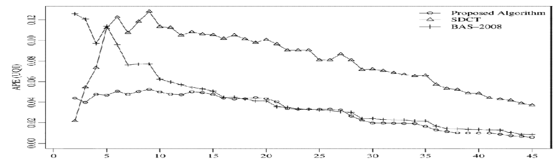


Fig 1.8 Average UQI absolute percentage error relative to the DCT for several compression ratios.

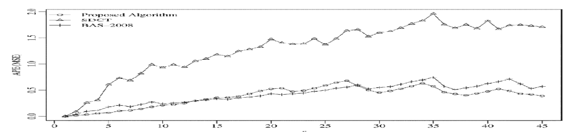


Fig 1.9 Average MSE absolute percentage error relative to the DCT for several compression ratios

In 3d image compression the encoder and decoder was measured in terms of the peak signal-to-noise ratio (PSNR) and the compression achieved expressed in bits per pixel (bpp) A mean was taken of the data resulting from tests on each of the images used it can be seen that the 3D DWT based algorithm shows a higher improvement in PSNR for all bit rate values compared to the previous 2D DWT-based scheme.

VI. PROPOSED METHODOLOGY

WAVELET DIFFERENCE REDUCTION (WDR)

One of the defects of previously discussed methods is that it only implicitly locates the position of significant coefficients. This makes it difficult to perform operations which depend on the position of significant transform values, such as region selection on compressed data. Region selection, also known as region of interest (ROI), means a portion of a compressed image that requires increased resolution. The WDR algorithm combines run-length coding of the significance map with an efficient representation of the run length symbols to produce an embedded image coder. In WDR techniques, the zero tree data structure is precluded, but the embedding principles of lossless bit plane coding and set partitioning are preserved.

WDR ALGORITHM

The WDR algorithm is a very simple procedure. A wavelet transform is first applied to the image, and then the bit plane based WDR encoding algorithm for the wavelet coefficients is carried out. WDR mainly consists of five steps as follows:

1. Initialization: During this step an assignment of a scan order should first be made. For an image with P pixels, a scan order is a one-to-one and onto mapping = Xk, for k =1,2and so on., P between the wavelet coefficient and a linear ordering (Xk). The scan order is a zigzag through subbands from higher to lower levels. For coefficients in subbands, row-based scanning is used in the horizontal subbands, column based scanning is used in the vertical subbands, and zigzag scanning is used for the

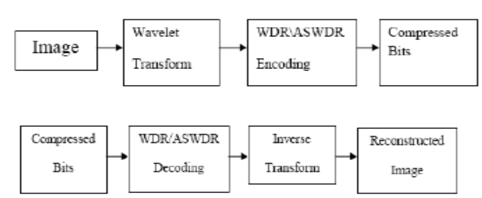


Fig 1.10 Image compression System using WDR system

diagonal and low-pass subbands. As the scanning order is made, an initial threshold T0 is chosen so that all the transform

values satisfy |Xm|< T0 and at least one transform value satisfies |Xm|>= T0 / 2.
2. Update threshold: Let Tk=Tk-1 / 2.
3. Significance pass: In this part, transform values are deemed significant if they are greater than or equal to the threshold value. Then their index values are encoded using the difference reduction method. The difference reduction method essentially consists of a binary encoding of the number of steps to go from the index of the last significant value to the index of the current significant value.
4. Refinement pass: The refinement pass is to generate the refined bits via the standard bit-plane quantization procedure. Each refined value is a better approximation of an exact transform value. 5. Repeat steps (2) through (4) until the bit budget is reached.

VII. POSSIBLE OUTCOME AND RESULTS

Different available wavelet filters such as Biorthogonal, Coiflets, Daubechies, Symlets & Reverse Biorthogonal on both the images and calculated various parameters. The important parameters which are considered are CR, BPP, and PSNR & MSE for the reconstructed images. Original Natural Image, similarly a virtual or artificial Images are also considered and for reconstruction of image. WDR algorithms have been applied for Natural gray scale and Artificial Greyscale Images using various Wavelet Families. SPIHT algorithm has low BPP compare to WDR but WDR technique provides high PSNR and low MSE values when compare to SPIHT technique. From the experiment and performance analysis it was observed that the reconstructed images are having Less Compression Ratio, low BPP also high PSNR values and low MSE values.

VIII. CONCLUSION

This paper presented an analysis of different image compression techniques used in the different fields of Computer graphics, medical images and Computer vision. It is very important and useful to analyze all the techniques for future purposes and inventions of new techniques. In this review of image compression study, the overview of various compression methodologies applied for digital image processing is explained briefly. The results show that the execution time of the interband prediction module is drastically reduced and the speed up factor is nearly 180.
This correspondence introduced an approximation algorithm for the DCT computation based on matrix polar decomposition. The proposed method could outperform the BAS-2008 method in high- and low-compression ratios scenarios, according to PSNR, UQI, and MSE measurements. Moreover, the proposed method possesses constructive formulation based on the round-off function. Therefore, generalizations are more readily possible. For example, usual floor and ceiling functions can be considered instead of the round-off function. Hyperspectral imaging has been widely used in remote sensing for the purposes such as resource management, agriculture, mineral exploration, and environmental monitoring.

IX. FUTURE SCOPE

The working frequency of the hardware IP can be further improved with more aggressive pipelining strategies and synthesis options. The new techniques dealing with different mathematical structure and more compression ratio as compared to the proposed approximations will likely to be invented using Optical and digital techniques to convert the pseudoscopic image

REFERENCES

[1] Yin-Tsung Hwang, Cheng-Chen Lin, and Ruei-Ting Hunga. "Lossless Hyperspectral Image Compression System-Based on HW/SW Co design", IEEE Embedded Systems Letters. Vol. 3, No. 1, PP. 20-23, March 2011.
[2] Renato J. Cintra, *Senior Member, IEEE*, and Fábio M. Bayer "A DCT Approximation for Image Compression", IEEE Signal Processing Letters, Vol. 18, No. 10,PP. 579 to 582. October 2011.
[3] Amar Aggoun, *Member, IEEE*" Compression of 3D Integral Images Using 3D Wavelet Transform" JOURNAL OF DISPLAY TECHNOLOGY, VOL. 7, NO. 11, PP. 586 to 592. NOVEMBER 2011.
[4]Tai-Hsiang Huang , Kuang-Tsu Shih ; Su-Ling Yeh ; Chen, H. H," Enhancement of Backlight-Scaled Images", IEEE Transactions on Image Processing, Volume:22 , Issue: 12 PP: 4587 to 4597 Year:2013.
[5] Gang Cao ,Yao Zhao , Rongrong Ni , Xuelong Li "Contrast Enhancement-Based Forensics in Digital Images", IEEE Transactions on Information Forensics and Security, Volume:9, Issue: 3, PP: 515 to 525 Year: 2014.
[6]Sangkeun Lee "An Efficient Content-Based Image Enhancement in the Compressed Domain Using Retinex Theory" , IEEE Transactions on Circuits and Systems for Video Technology, Volume:17, Issue: 2 PP: 199 to 213, Year: 2007
[7]He, Kaiming , Sun Jian ,Tang, Xiaoou "Pattern Analysis and Machine Intelligence", IEEE Transactions on Guided Image Filtering, Volume:35, Issue: 6, , PP: 1397 to 1409 , Year: 2013.
[8]Satgunam, P.N. Woods, R.L. Bronstad, P.M. Peli, E." Factors Affecting Enhanced Video Quality Preferences", IEEE Transactions on Image Processing, Volume: 22, Issue: 12, PP: 5146 to 5157, Year: 2013.
[9]Ji Won Lee, Rae-Hong Park, Soonkeun Chang "Noise reduction and adaptive contrast enhancement for local tone mapping", IEEE Transactions on Consumer Electronics, Volume:58, Issue: 2, , PP): 578 to 586, Year: 2012.
[10] Tianshuang Qiu, Aiqi Wang, Nannan Yu ; Aimin Song "LLSURE: Local Linear SURE-Based Edge-Preserving Image Filtering", IEEE Transactionson Image Processing, Volume: 22 , Issue: 1,PP: 80 to 90, Year: 2013.