Performance Exploration of Discrete Wavelet Transform with SPIHT for using Video Compression Techniques

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Abstract

Video Compression is one of the most important research areas in the field of image processing. It is used for a large number of applications such as surveillance, medical and multimedia communication. In this paper, the possibility of using one of the total compression bit rate techniques, namely, Discrete Wavelet Transform (DWT) for decoding the video sequence and Set Partitioning In Hierarchical Trees (SPIHT) for encoding techniques based on lossy compression. The performance of video quality assessment method based on Mean Square Error (MSE), Prominent Peak Signal Noise Ratio (P-PSNR) and Energy Level (EL) of the medical video frames, this model was more consistent with human characteristics. The efficiency of the proposed scheme is demonstrated by results, when faced to the method presented in the recently published paper based on the bit rate coding using a rate control algorithm.

Keywords: Discrete Wavelet Transform; Set Partitioning In Hierarchical Trees ;Peak Signal Noise Ratio; Mean Squar Error; Energy Level .

I. INTRODUCTION

Digital video compression involves a large amount of storage space and transmission bandwidth. Which to reduce the amount of video sequences, and several strategies are employed that compress the information without negatively affecting the quality of the video sequence. Since images are defined over 2D digital image processing, it is enhanced in the form of multidimensional representation. It involves two types of compression such as lossless and lossy. Compression is a best of the digital image processing. It is the benefits of compression to reduce space, security and transformation time [1-3]. Video compression is the development of compressing and decompressing a digital video signal. Subjective measurements are time consuming of human viewers. Objective measurements are easier to implement of a human observer. Utmost video codec are necessarily lossy, because it is stored and transmit the uncompressed video signals. Even though furthermost codecs algorithms are developed, which are based on analyses of human vision and perception. Many formats, including MPEG4, H.264/AVC and all varieties of DV, use a fairly complicated algorithm called *SPHIT encoding and DWT decoding.* Decomposed is starting to be used for DWT codecs [4,5]. Video compression application in human lives, such as medical, eCommerce, cable TV distribution ,interactive communications like video phone ,video conferencing ,and video , digital storage media ,broadcasting and video surveillance**.** These large data volumes can quickly fill the available storage media and are difficult to transfer between sites over communications links on which the data rates are limited to several MB/s or below. The storage and transmission problems can be significantly mitigated by the use of compression techniques. In this paper, proposed a wavelet based image compression, while the data access is video made up of number of frames that are projected at proper rate 30 frames per second[6,7].

The Discrete wavelet transform is only in decomposed technique which improves a real application of the modern image and video. It has been widely used in digital photos for a different format of the images. Preprocessing technique regulates compression bitrates to obtain optimal encoding quality. It must be employed in video compression. Histogram equalization is secondhand to determine the subband parameter (SP) of an encoder to achieve the target bit rate and good visual quality [8, 9]. All other algorithms are recycled for buffer control to avoid buffer overflow, underflow, subjective and objective video quality. Gaussion Filter is a critical component in video compression and communication of the filtered image. The subband parameter is applied for the image to be encoded in DWT. To predict a suitable Subband parameter (SP) for an intraframe, beginning and ending frame models has been proposed [10]. The initial SP is the model, which is to improve the performance of the proposed discrete wavelet transform and the measurement of the quality video sequence [11].

However, lossy compression requires a reduced memory, low transmission bandwidth, a low power consumption because its compression bit (CR) is high. Also, it is hard to restrict the frame memory size in the lossy compression as the CR is regular. Therefore, lossy compression is suitable for different type of video sequence applications. On otherhand, as the CR lossless compression low, high memory space, a large memory size in the lossless compression as the AR is irregular [12]. The length of the encoded bitstream is not allowed to exceed the target bit length (TBL). The SPHIT, wavelet coefficients are encoded in an ascending order of bitplanes. A basic operation within the SPIHT uses almost the same as that within the original 2D SPIHT because 1D SPIHT encodes wavelet coefficients in the descending bit-plane order. However, unlike the original 2D SPIHT, SPIHT cannot make use of the redundancy in the vertical direction of encoding the video sequence, thus its compression efficiency is substantially reduced when compared with the original 2D SPIHT encoding video. In the previous SPIHT presented in [13], the compression unit is an entire line of an image, thus its memory size is still large because it stores the video data of that line. To reduce memory requirement, research on the block compression unit including a development of a block-based bit allocation scheme is needed. In order to improve compression efficiency, this paper proposes hybrid coding and bit allocation schemes for SPIHT algorithm. In order to allocate more bits to a complex block than that allocated to a simple block, a bit allocation scheme that differentiates the amount of bits allocated to each block based on its complexity is proposed [14].

This paper presents a method extending the Discrete Wavelet transform to incorporate the SPIHT based compression ratio as YUV color in order to improve the correlation between predicted and subjective quality. The quality metric is organized as follows. Section 2 describes the related work of the discrete wavelet transform and SPHIT encoding technique evaluation process. Section 3 gives a description of to obtain the process of proposed technique for different data set video sequence [7]. Section 4 presents the method of extending the quality metric to incorporate both spatial and temporal texture with converting to the YUV to grayscale. The performance of the proposed method is evaluated in Section 5. Section 6 contains conclusions and future work.

II. RELATED WORK

Mahdi et al. [3] proposed the optimum nonnegative integer bit allocation for wavelet based signal compression and coding of compressed video sequences. It depends the ONIBA algorithm is proposed for transform coding with lower computational complexity. This algorithm is developed for wavelet based subband coding. Finally the algorithm is modified for adaptive subband coding. Then, which is derived the ONIBA problem formulation for wavelet based SBC and extended the ONIBA algorithm for SBC. Chao –Hsung[5] planned a reduced complexity image coding scheme using wavelet based contourlet transform. This transform is adopted for image coding for its computational complexity is very high, In this paper , proposed three tools to enhance the WBCT coding scheme, in particular ,on reducing the computational complexity. The proposed scheme saves over 92% computing time of the original scheme. Yadong et al. [7] developed a novel method for total variation based rate control algorithm which is used to visual quality. The proposed method is used to change the frames and an intraframe with better quality of whole combined video sequence and higher average metric. This technique is applied an IDPID (incomplete derivative proportional integral derivative) buffer controller to reduce the frame skipping and the degradation of video sequences. The ARDCT approach is significant improved the rest of the competitors for all analyzed video sequences. The total variation (TV) is based to measure frame layer rate control algorithm and analytic model. The limitation of this paper more accurate rate control, reducing frame skipping, decreasing quality flection and improving the overall quality metric.

Rema et al [7] proposed image compression using SPIHT with modified spatial orientation trees for improving compression efficiencies for monochrome and color images has been proposed. Reordering ensures that SPHIT algorithm is coded more significant information in this initial bits. For color images an altered parent offspring relationship. An extra level of wavelet decomposition on chrominance planes were performed. PSNR improvement of 32.06% was achieved at 0.01 bpp for monochrome images and 19.76% for color images at 0.05 bpp compared to conventional schemes. Kuan et al [8] projected a Set Partitioning in hierarchical Trees (SPIHT) algorithm has performed efficiency of the image and video coding. A flickering metric for intra coded frames is AE-SPIHT properly exploits a bit-arrangement method. It is rearranging bits foveately from eye-insensitive regions. According to texture content and bit-rate is to eye-sensitive ones. AE-SPIHT algorithm improves the visual quality of the experiments show that attention regions in conventional 3-D SPIHT in most cases. Yongseok et al. [10] anticipated a block based pass parallel algorithm (BPS). It is decomposed a wavelet transformed image encodes all the BPS reorganizes the three passes of the original SPIHT algorithm and then BPS encodes/decodes the reorganized three passes in a parallel and pipelined manner. The pre calculation of the stream length of each pass enables the parallel and pipelined execution of these three passes by not only an encoder but also a decoder. The modification of the processing order slightly degrades the compression efficiency. In this paper proposed technique show that the peak signal-to-noise ratio loss. The BPS is between approximately 0.23 and 0.59 dB when compared to the original SPIHT algorithm.

Yue Wang et al. [11] planned transformation uses the connectivity information of the 3D model to adventure the inter-pixel correlations. An Orthographic projection is used for converting the 3D mesh into a 2D image-like representation. The proposed conversion method does not change the connectivity among the vertices of the 3D video sequence. There is a correlation between the pixels of the composed image due to the connectivity of the 3D mesh. The proposed spatio temporal sequence is uses an adaptive predictor that exploits the connectivity information of the 3D model. The image compression tools cannot take advantage of the correlations between the samples. The quality metric of is then encoded using a zero-tree wavelet based method. Since the encoder creates a hierarchical bitstream, the proposed technique is a progressive mesh compression technique. Experimental results show that the proposed method has a better rate distortion performance than MPEG-3DGC/MPEG-4 mesh coder.

Stephan et al. [13] proposed a new rapid method for the compression implement the coronary angiogram video sequences. The method is based on the philosophy that diagnostically significant areas .That image should be allocated the greatest quantity of the total allocated bit. The approach uses a wavelet-based transform coder based on the set partitioned embedded block coder. Incorporated into this framework is a region-of-interest (ROI) detection technique. The result is an approach that removes the low-level coefficients for some diagnostically insignificant regions of the image in an extremely efficient manner. This allows additional bits to be used within the proposed to improve the quality of the significant areas. The results are compared for a number of real data sets and evaluated.

III. PROPOSED WORK

The proposed compression scheme consists of six steps. First, a six level 2 dimensional Discrete Wavelet Transform (2D-DWT) is applied in a hierarchical fashion to achieve 20 sub-bands. The energy of each of these sub-bands is different with respect to its energy level, as well as its position. Therefore, different histogram equalization are to be used for different sub-bands. In the second step, Gaussian filter and sobel filter image are used to the decomposed DWT image [2]. The final a Set Partitioning in hierarchical Trees (SPIHT) encoding values are then used to remove the coefficients which are bit per pixel (bpp) value is the target bit ratio of the video sequence. In this way, the wavelet coefficients with excellently accurate sub-bands, leading to gain a compression. The SPIHT decoding is based on the energy level of the video sequence using in each frames. In the following sub-sections, the proposed system each of these steps in more detail.

A. 2-D Discrete Wavelet Transform(DWT) Decoding

A wavelet transform (WT) decomposes a signal into its sub-band components of non – bandwidth and can be realized by a filter bank [2]. Like the sobel, Gaussian filter and Discrete Wavelet Transform is applicable to both continuous as well as discrete signals. In addition, the algorithm can represent various functions in the form of the form of its wavelet expansion. If the filter, conversion of video to frame sequence, DWT and SPIHT functions are discrete time, the SPIHT series expansions: one corresponding to the approximation of low pass filter, and other hand to the details of the image high pass filter [8].

The reconstructed image is a grayscale image , it can be converted to RGB to gray scale image coder. In the proposed algorithm ,this video sequence on a regular grid, that represents the motion image ,is transformed into wavelet domain using an Gaussian reconstructed DWT is superior to its the directional neighborhood information between pixels. The proposed Gaussian decomposed scheme takes the connectivity of the better exploit the neighborhood information of the sub bands of six levels of image sampling. The neighborhood histogram equalization is not relation in the images same as in common grayscale images. In ordinary gray scale images, it is natural to predict one frame pixel to another frame pixel in a video sequence. There is no general 2D compression algorithm that works on YUV video sequence [9].Our aim here is to utilize the correlation between the multi-level band separation and compression bit ratio. For this purpose, the wavelet transformation stage of the SPIHT encoder and proposed connectivity decomposed the Gaussian Wavelet transform that uses decomposed video frame in spatial mode to predict the pixel values from their connected neighbor pixel to check. The main motivation to use 2D projection of 2D video sequence is to utilize the SPIHT image compression algorithms with minor modification for the compression of YUV video sequence.

B. SPIHT Encoding Techniques

The 2D SPIHT can be implemented with two separate applications of the 2D dimensional decomposition in the horizontal and vertical directions shown in fig.1 (a).The up and down sampling are applied to the image along rows and columns separately, and the sampling outputs are sub sampled by 2, resulting in four detailed sub –images horizontal high and low pass subband (HL), vertical low and high pass subband (LH), and diagonal high-pass subband (HH) and one approximate low-pass sub-band(LL). The decomposition process is then repeated on the low pass sub –band LL to create the next level of the decomposition. In this way the original image is filtered by Gaussian noise and decomposed into a six resolutions resulting in twenty subimages:LL6 ,and (HL,LH,HH),i=6,5,4,3,2,1.where LL6 is the lowest resolution low pass subband at layer 6 of the hierarchy. Fig.1 (b) shows a Six –stage 2D wavelet transform of akiyo image. The number of the used wavelet decomposition levels is another factor affecting the compression ratio. Increasing the number of wavelet decomposition levels as much as possible brings in better Compression in SPIHT. This situation undesirably affects the performance in terms of computational complexity. Another drawback of increasing decomposition levels is the corrupted neighborhood relationship information between the pixels at lower sub-bands [2,10].

Discrete wavelet transform (DWT) transforms discrete time signal to a discrete wavelet representation. It converts input series $X_0, X_1, X_3,\ldots\ldots X_m$. into one high pass wavelet coefficient series and one low Pass wavelet coefficient series and one low pass coefficient series [5].This can be represented by

$$Hi = \sum_{m=0}^{k=1} X(2i-m).Sm(z) \quad (1)$$

$$Li = \sum_{m=0}^{k=1} X(2i-m).tm(z) \quad (2)$$

Where Sm(z) and Tm(z) are called wavelet filters, k is the length of the filter ,and i=0……[n/2]-1.[5]Practically on any image in spatial domain discrete wavelet transform is applied in two direction first level 2D DWT ,results in four parts called LL ,LH ,HL, and HH [VS].Finally input video is decomposed into four components as shown as in fig2.Then LL part can be for further decomposing or higher level of 2D-DWT on one of the frame taken from video database is shown figure 3.

<table>
<tr><td>LL6</td><td>HL6</td><td rowspan="2">HL5</td><td rowspan="3">HL4</td><td rowspan="4">HL3</td><td rowspan="5">HL2</td><td rowspan="6">HL1</td></tr>
<tr><td>LH6</td><td>HH6</td></tr>
<tr><td colspan="2">LH5</td><td>HH5</td></tr>
<tr><td colspan="3">LH4</td><td>HH4</td></tr>
<tr><td colspan="4">LH3</td><td>HH3</td></tr>
<tr><td colspan="5">LH2</td><td>HH2</td></tr>
<tr><td colspan="6">LH1</td><td>HH1</td></tr>
</table>

Fig.1. Applying DWT for 6-levels.

To this output, decomposed wavelet algorithm is applied frame by frame basis for video compression. Remaining 3 parts that is LH, HL, HH are spatially added together forming a sub frame for object detection process [2,5]

$$Sub-frame(i,j) = LH(i.j) + HL(i,j) + HH(i,j) \quad (3)$$

Algorithm 1: Enhancement of DWT and SPHIT technique

Step 1: Video to frame conversion
Step 2: **for** i =starting frame to encoding frame, read frame, bit plane value
Step 3: [m, n] size(decomposed image) equation (1) and (2)
Step 4: level. 1 of DWT **if** m is greater **than** 8 and N>= 8,d1is equal to dwavelet (I),2 X 2 matrix to divide a image
Else single image ,end
Step 5: level 2 equation(3) of DWT **if** m/2 >= 8 ,d1(1:m/2,1:n/2), and n/2,d2 >= dwavelet(a1), d2=2m x 4n ,4n x 2m **else** m x n ,end;
Step 6: level 3: **if** m/4 >= 8 and n/ 8;a2 > m x n, 8n x 4n d3=dwavelet (a2) **else** 4n x 4n ,end
Step 7: level 4: **if** m /8 >= 8 and 8m X 8n ,8n x 16 m d4=dwavelet (a3) **else** 16n x 8m ,end
Step 8: level 5: **if** m/16 is >= to 8 and n/16 >= 16m x 16n ,16m X 32 n d5 =dwavelet (a4) **else** 32m x 32 n
Step 9: level 6:**if** m/32 >= 8 and n/32 >= 8,a5=d5(1:n/32,1:n/32);d6=dwavelet (a5); **else** N row 32 is d6
Step 10: reconstruct the image in dwt
Step 11: sorting pass in SPIHT
Step 12: **for** i= 1 to size of list insignificant pixel, increment by 1
if pointer is greater than bits are finished or not in the output stream
Step 13: **if** pointer greater than whether the bits are finished or not in the output stream
Step 14: check the descendant type--D type or O type , list significant pixel of the set
Step 15: check the output stream of the significant of the tree pointer , **retur**n
Step 16: Refinement Pass of the list significant pixel
Step 17: value of the pointer add the hierarchal part
Step 18: compression ratio of the output stream header
Step19 : Insignificant set pass(ISP)
Step 20: **for** each pointer such that Sn(pointer)=0 **do**
Step 21**:** **if** pointer is a 2x 2 set then
Step 22: output Sn (pointer U d(pointer))=1 then
Step 23: significant pixel pass (SPP)
Step 24: **for** each significant pixel w(magnitude bit) **do**
Step 25: output nth bit of **|** w(magnitude bit)

IV. EXPERIMENT RESULT

Discrete wavelet transform gives in these data sets, low quality metrics of 58,65,56,49, and 51. But through this proposal, these data sets can give high compression ratio of 42,40,36,39 and 37. The DWT – SPHIT technique is based data sets low compression ratio of 75,60,92,98 and 97 .But through this proposal, these data sets can give high quality metrics of 255,345,100,175 and 125. Getting on high quality metrics of from DWT-SPHIT, it reduces time complexity sequence in TABLE 1. The proposal of enhanced DWT-SPHIT usage among those two algorithms with the iteration, which is the best to give a high total bit rate [2] [5]. Performance of a perceptual quality metric depends on how well it correlates with subjective testy results. Subsequent of the performance evaluation methods adopted by the PSNR. In this paper combined two techniques to give encoding and decoding of the proposed scheme. The quality metric is the Mean Square Error (MSE) which measures the prediction accuracy of the new metric with respect to full reference results [2, 5].

Experimental results are illustrated in Table I. The performance of the proposed method of calculating improved PSNR from the spatial texture and temporal information is compressed with DWT- SPHIT based on frame texture only. It can be observed that the MSE, PSNR and SPHIT energy level calculated using both the methods and five video sequences. The situation can be observed that the MSE(2) metric produces a high correlation (>90%) with a subjective rating for a video sequence ranging from high compression ratio based on Peak Signal Noise Ratio (PSNR) such as *Akiyo, News, Container, Coastguard, Mobile, Foreman and mother and*

Daughter. In this video sequence distortion type in the distribute of PSNR and MSE of the video databases are plotted in the fig.1.The continuous line in the figure is optimized nonlinear function. To verify the effectiveness of the proposed PSNR based, full references quality metric scheme. It should be implemented the proposed scheme into the reference software Matlab 2013, and the accuracy of the proposed system improvement of the quality metrics [6,15].

TABLE 1. Comparison of RC- SAD and DWT-SPHIT Using H.264/AVC Compression ratio and PSNR

Data Sets(QCIF)	DWT-SPHIT (Kbps)	DWT-SPHIT P-PSNR(db)	RC-SAD (Kbps)	RC-SAD(db) PSNR
Akiyo	255	58	75	42.6515
Container	345	65	60	40.2755
News	100	56	92	36.1447
Mother	175	49	98	39.6600
Salesman	125	51	97	37.4574

The sequences are 10_s in duration and the coded using the DWT-SPHIT main profile, Discard B-frames and 10 reference frames in research work. The sequences used were *Akiyo, Container, News, Mother and salesman.* The DWT-SPHIT method is appropriate when video sequences at comparably low bit rate are used because the reference video is high bit rate. The presentation order of the video sequence in a different frame order that is either increasing or decreasing signals. Which are video using a training data set of QCIF (Quarter Common Intermediate Format) video sequences of 4:2:0 YUV (6) format [5]. This format is converted to grayscale video which is find out the high compression bit rate of a given data set. Fig. 1 shows the scatter plots of subjective rating PSNR versus ePSNR using different video sequences. The percentage increase in coding time when compared to the coding time of the references H.264/AVC software codec called the JM software. All the quality metrics were implemented into the software codec for the video measurement purposes only. The coding time is taken for running each quality metrics on the all video sequences of CIF resolution with 150 frames.

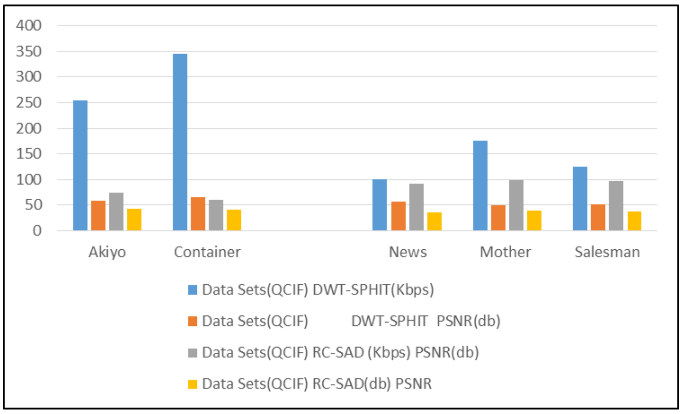

Fig.1.Performance analysis

Although the initialization method formulated in this fig.1 demonstrate the frame by frame encoding behavior for several sequences to plot the PSNR value. It can be observed that quality variation of the proposed algorithm is much smaller than that of the previous paper, while the average reduction of 38% in PSNR presents and buffer frame by frame. The quality flection of this algorithm is much smaller than the previous video sequences [18]. The differentiation of receiving the high ratio is figured out in the graph to evaluate the performance, the proposed DWT-SPHIT algorithm is implemented in the H.264/AVC reference software Matlab tool, which serves as the test bench mark [1-6] is particularly identical to the encoding algorithm proposed in [10] and outperform analysis. RCSAD is compared with DWT-SPHIT, is measured in terms of the average actual encoding high bit rate .The temporal prediction video sequences are derived with the encoding structure IPPPP……frames.

In order to verify the measurements, the high bit rate comparison study based on gray scale ordering of simultaneously played video sequences as fig 2 is performed by using 5 test sequences. In this phase, RC –SAD have included the video sequences H.264/AVC. The popular wavelet algorithm which is meant for using denoising images with sharp edges from the horizon edges. To overcome drawback, the algorithms of the total variation in the frame domain [16,1 7].It is informed that the rate control system is independent. Here the basic idea is first to select I, P frame sizes are combined as single video into one composite. Two main metrics are therefore necessary, to perform introduction for classifying the type of blurriness and measuring strength. Rate- distortion (R-D) models on the macro block (MB) level are to represent the relationship bit rate, distortion and encoding complexity. This model can achieve an accurate target bit rate and improve PSNR performance [18]. Two different methods based on this video sequence with different filters are apply to different components .The proposed method has been compared against several other methods by using different objectives and subjective quality metrics[19]. Anisotropic diffusion has been pro- posed to remove blocking artifacts, exploiting the human visual system (HVS) [10]. The efficiency of the proposed scheme is demonstrated by results, especially, when focused in the previous DWT-SPIHT paper based on the compression bit ratio. The proposed system is based on the quality metric of the video sequences.

V. CONCLUSION AND FUTURE REFERENCE

A Discrete wavelet Transform and SPIHT with video encoder and decoder values, based on prediction macro blocks, from intra/inter current frame or field of video. Hence this is the best noise reduction of the proposed enhanced six level DWT algorithm. since they are going to be very popular for its high-speed and low power image processing. Calculation of average is received by DWT-SPHIT for using a high compression video sequence of best quality metric. So the consequent advantageous performance of the video application is occurring. The proposed scheme can be applied to image frames and video sequences MSE , PSNR and energy level of SPIHT metric with several different standards, such as JPEG, MPEG and H.264/AVC, and finest enactment on different types of substances compressed with DWT-SPHIT. Currently only the frame –level features are being considered. Spatio-temporal features, improve high compression ratio and decreasing quality fluctuation will be taken into account in future work.

REFERENCES

[1]. M. Arrivukannamma , Dr. J. G. R. Sathiaseelan, “A Survey on CODEC Quality Metric in Video Compression Technique”.,vo1.2, IEEE 2015.

[2]. Kaveh Ahmadi, Ahmad Y. Javaid, Ezzatollah Salari, “An efficient compression scheme based on adaptive thresholding in wavelet domain using particle swarm optimization”, Elsevier, Signal Processing: Image Communication R. 25, 2015 ,pp. 33–39.

[3]. Mahdi Hatam, Mohammad Ali Masnadi-Shirazi, “Optimum nonnegative integer bit allocation for wavelet based signal compression and coding”, Elsevier, Information Sciences ,297 ,2015, pp.332–344.

[4]. Chao Hsiung Hung, Hsueh Ming Hang, “A reduced complexity image coding scheme using decision-directed wavelet based contourlet transform”, Elsevier, J. Vis. Commun. Image R. 23 ,2012, pp.1128–1143.

[5]. Yadong Wu, Yu, Sun, Zhidan Feng and Hongying Zhang, “A novel total variation based frame layer rate control algorithm for H.264/AVC”, Elsevier, J.Vis. Commun. Image R. 25, 2014 ,pp. 879-890.

[6]. Abharana Bhat, Sampath Kannangara, Yafan Zhao, and Iain Richardson, “A Full Reference Quality Metric for Compressed Video Based on Mean Squared Error and Video Content”, IEEE transactions on circuits and systems for video technology,vol 22, 2012, pp. 165-173.

[7]. Rema.R, Binu Ani Oommena, Mythili ,“Image compression using SPIHT with modified spatial orientation trees”, Elisevier, 46 ,2015, pp. 1732 – 1738

[8]. Kuan-Hui Lee, Pau-Choo Chung, “An attention emphasized bit arrangement in 3-D SPIHT video coding for human vision”, J. Vis. Commun. Image R. 24 ,2013, 255–269.

[9]. Awwal Mohammed Rufai , Gholamreza Anbarjafari , Hasan Demirel ,“ Lossy image compression using singular value decompositionand wavelet difference reduction” , Elsevier, J.Vis. Commun. Image R. 24, 2013, pp. 988-1001.

[10]. Yongseok Jin and Hyuk-Jae Lee, “Block-Based Pass-Parallel SPIHT Algorithm”, IEEE transactions on circuits and systems for video technology, vol. 22, NO. 7, july 2012 ,pp. 1-10

[11]. Yue Wang, Tingting Jiang, Siwei Ma, Mem and Wen Gao, Fellow “Novel Spatio-Temporal Structural Information Based Video Quality Metric”, IEEE transactions on circuits and systems for video technology, vol 22, 2012, pp.989 – 998.

[12]. Kıvanc Kose ,A. Enis Cetin, Ugur Gudukbay , Levent Onural, “3D Model compression using Connectivity-Guided Adaptive Wavelet Transform built into 2D SPIHT”, Elsevier, J. Vis. Commun. Image R. 21 ,2010, pp.17–28.

[13]. Stephan A. Rein , Frank H.P. Fitzek , Clemens Guhmann , Thomas Sikora, “Evaluation of the wavelet image two-line coder: A low complexity scheme for image compression”, Signal Processing: Image Communication ,37 ,2015,pp. 58–74

[14]. Xuguang Lan a, Meng Yang a, Yuan Yuan b,n, Songlin Zhao a, Nanning Zhen, “Adaptively post-encoding multiple description video coding”, Elsevier, Neurocomputing ,101, 2013,pp. 149–160

[15]. Pinghua Zhao, Yanwei Liu, Jinxia Liu, Song Ci and Ruixiao Yao, “SSIM-based error-resilient rate-distortion optimization of H.264/AVC video coding for wireless straming”, Elsevier, Signal Processing: Image Communication 29, 2014, pp.303-315.

[16]. WANG WEI, WANG Rang-ding, “The Analysis and Detection of Double JPEG2000 Compression Based on Statistical Characterization of DWT Coefficients”, Elsevier, Energy Procedia ,17, 2012, 623 – 629.

[17]. AwwalMohammedRufaia,GholamrezaAnbarjafarib,HasanDemirel, “Lossy image compression using singular valuede

composition and wavelet difference reduction", Elsevier, Digital Signal Processing, 24 ,2014, pp. 117–123

[18]. Xuguang Lan a, Meng Yang a, Yuan Yuan b,n, Songlin Zhao a, Nanning Zheng a , "Adaptively post-encoding multiple description video coding", Elsevier, Pattern Recognition, Neurocomputing 101 ,2013 , pp. 149–160 .

[19]. Sunwoong Kim a, Donghyeon Lee a, Hyun Kim a, Nguyen Xuan Truong a, Jin-Sung Kim b, "An enhanced one-dimensional SPIHT algorithm and its implementation for TV systems", Elsevier, 2015, pp.1-10.

[20]. Rupesh Gupta , Meera Thapar Khanna , Santanu Chaudhury, "Visual saliency guided video compression algorithm", Elsevier, Signal Processing: Image Communication , NO. 28, 2013, pp. 1006–1022.