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RESEARCH ARTICLE

Fast Stereo Images Compression Method based on Wavelet Transform and Two dimensional Logarithmic (TDL) Algorithm

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ABSTRACT

In this paper, a fast stereo images compression method has been proposed. In proposed method, Firstly, stereo images were transformed using Discrete Wavelet Transform (DWT) in order to reduce computation time. The disparities between these images were estimated by Two Dimensional Logarithmic (TDL) algorithm. The result of the Motion Vector (MV) was encoded into a bit stream by Huffman encoding while the remaining part is compressed like the compression that is used in still image. The proposed method produced good results in terms of Peak Signal-to-Noise Ratio (PSNR), CR, and computation time.

Keywords: Stereo imaging, stereoscopy, discrete wavelet transform, motion estimation, Two Dimensional Logarithmic.

INTRODUCTION

A pair of stereo images is very similar each other as they are the images of a stationary object taken from two different angles. This is why compressing both images independently is an in-efficient way of compressing stereo images [1]. In this research, has been selected a pair of stereo images which are very similar to each other are taken from two different angles (and this is why the pressure of each of the images independently, which means in the efficiency of the stereo image compression).We can get the sequence of these images by film cameras or generated by demand sequentially. Compress these pictures is the foundation necessary to reduce this data through the difference between the two images Account (matching), also known as disparity estimation, then squeeze one image independently. This is known as image as a reference, and can either is the right image or the left image, then use the reference image and vector disparity to rebuild the second image.

The work aims to propose an efficient technique for stereo images compression by transformed using Discrete Wavelet Transform technique (DWT) in order to reduce computation times, we show that in Section 2.The disparity vectors between them (The left and right image after transform in to DWT levels) were estimated by *Two Dimensional Logarithmic (TDL).*The remaining image is compressed as still image; we show that in Section 3. The two images are very similar to each other; so that the disparity vectors between the two images are estimated. Section 4 and Section 5 are gives the proposed method and evaluation criteria. Experimental results show in Section 6. Finally, the paper has been concluded in Section 7.

Discrete Wavelet Transform (DWT)

Wavelet transform is one of important and useful computation tools for a variety of signal and image processing applications. In image processing field, the main process in wavelet transform is to filter signal of image by two filters, namely, low pass filter (L) and high pass filter. Then, it will down sampled by factor of two leading to compose transform of one level. Repeating of one level transform on the part of low pass output only, results multiple level transform. Two dimensional (2-D) wavelet transform can be obtained by applying 1-D wavelet transform, wavelet filter separately.

This computation is done by carrying out 1- D transform on the rows signals one time and on the columns signal another time. As a result of that, it separates image signals into four sub-band images: LL (low frequency in horizon and

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vertical), LH (low frequency in horizon and high frequency in vertical), HL(high frequency in horizon and low frequency in vertical), HH(high frequency in horizon and vertical).

Therefore, it is possible to use different methods for the sake of enhancement of the details in different frequency domain [2]. LL sub-band image often contains the most important information of the original image and it is usually called approximations the three other sub-band images are named as details. HH sub- band normally includes the small coefficients which are more likely due to undesirable noise [3]. Fig. 1 shows Foreman image and its three levels DWT.

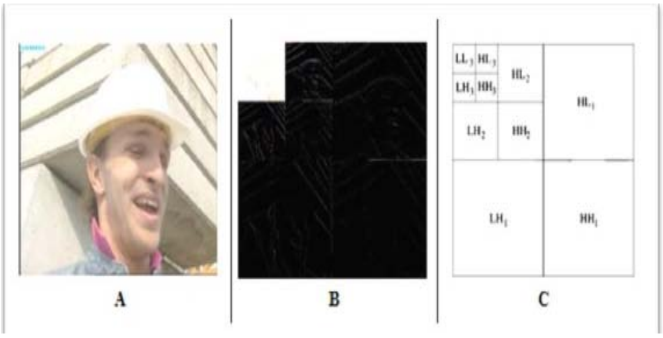


Fig. 1: A) Foreman image B) Three levels Discrete Wavelet Transform of Lena image
C) Low and High sub-bands resulted from three levels DWT[3].

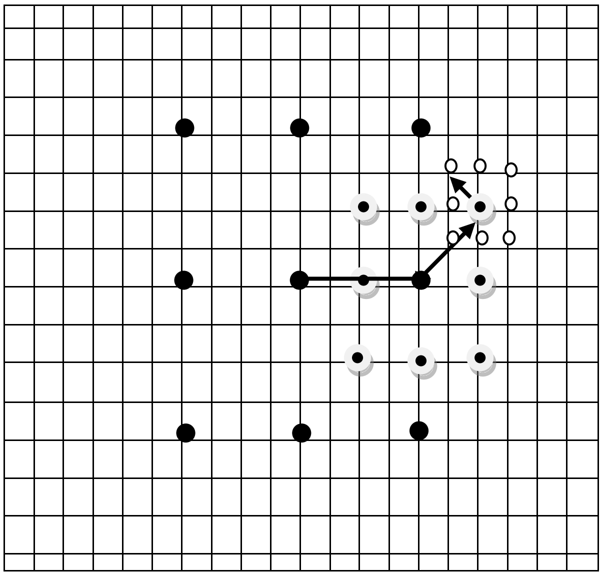
Motion Estimation

Motion Estimation (ME) is the process of analyzing successive frames in any image sequence to identify objects motion. In this paper, motion estimation used to process of analyzing two stereo images using TDL. The motion of an object is usually described by a two-dimensional motion vector, which is the placement of the co-ordinate of the best similar block in previous frame for the block in current frame. This placement is represented by the length and direction of motion [4, 5].

- **Three Step Search (TSS)**

  TSS is one of the earliest attempts at fast block matching algorithms and dates back to mid1980s. The TSS is the algorithm that limits the number of checking points in a search area. The general idea is represented in Fig. 2, it starts with the search location at the center and sets the „step size‟ S = 4, for a usual search parameter value of 7. It then searches at eight locations +/- S pixels around location (0, 0). From these nine locations searched so far it picks the one giving least cost and makes it the new search origin. It then sets the new step size S = S/2, and repeats similar search for two more iterations until S = 1.At that point, it finds the location with the least cost function and the macro block at that location is the best match. The calculated motion vector is then saved for transmission. It gives a flat reduction in computation by a factor of 9 [6, 7].

Fig. 2: Example Path for Convergence of Three Step Search.



First Step. Second Step. Third Step.

- **Disparity Estimation Using the Two Dimensional Logarithmic Algorithms**

  Algorithm was introduced by Jain and around the same time that the Three Step Search was introduced and is closely related to it. Although this algorithm requires more steps than the Three Step Search, it can be more accurate, especially when the search window is large [2]. The algorithm may be described as:

  Step1- Pick an initial step size. Look at the block at the center the search are and the four blocks at a distance of s from this one the X and Y axes. (The five positions from a + sign)

  Step 2- If the position of best match is at the center, halve the step size. If however, one of the other four points is the best match, then it becomes the center and step 1 is repeated.

  Step 3- When the step size becomes 1, all the nine blocks around the center are chosen for the search and the best among them is picked as the required block.

  A particular path for the convergence of the algorithm is shown in the following figure:

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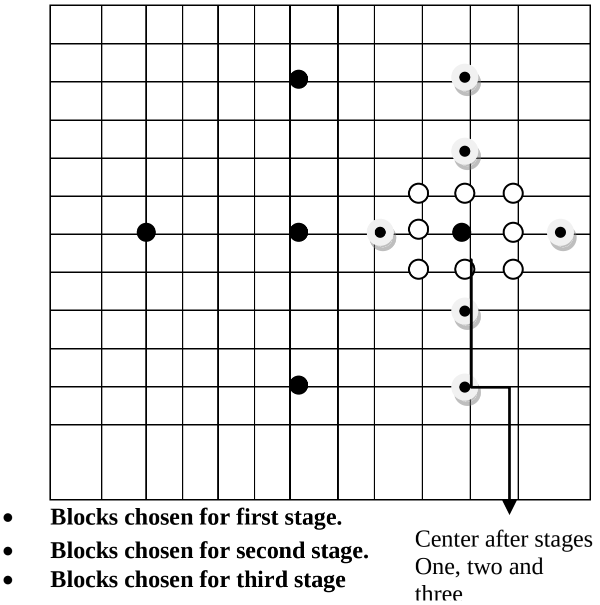
Fig. 3: Example Path for Convergence of Two Dimensional Logarithmic Searches.



A lot of variations of this algorithm exist and they differ mainly in the way in which the step size is changed [6,7].Some people argue that the step size should be halved at every stage. Some people believe that the step size should also be halved if an edge of the search space is reached. However, this last idea has been found to fail sometimes.

The Proposed Method

In proposed method, there are four main steps. The first step we process the images used to convert its signal to levels using discrete wavelet Transform separately. In the second step, we match the two images the director of the first stage using TSS and TDL algorithms to find the movement between the two images and estimate the motion vector for the remaining images. Then, the remaining image will be compressed as a still image. Fig.4 shows flowchart of compression a pair of stereo images.

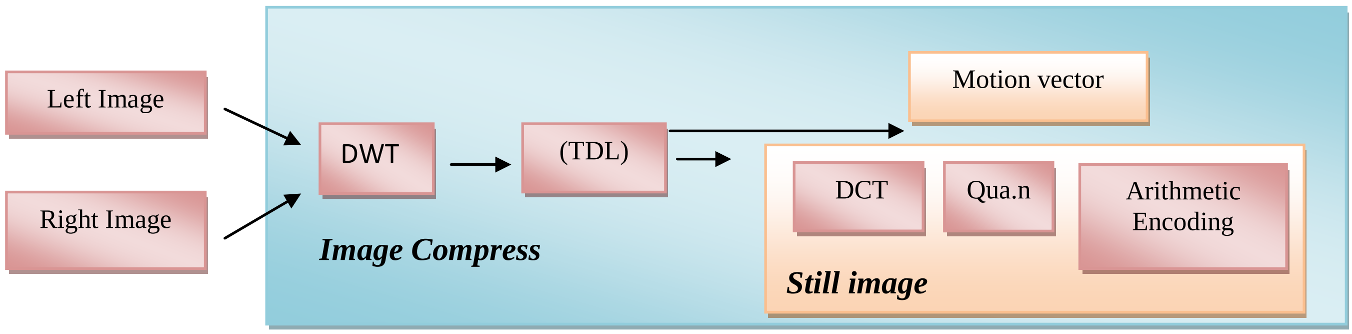


Fig.4: Flow chart of proposed method.

Evaluation Criteria

Peak signal-to-noise ratio (PSNR) is the standard method for quantitatively comparing a compressed image with the original. For an 8-bit grayscale image, the peak signal value is 255. Hence, the PSNR of an M×N 8-bit grayscale image C_{ij} and its reconstruction R_{ij} is calculated as [8, 9]:

$$PSNR = 10\log_{10}\frac{255^2}{MSE} \qquad \ldots (2)$$

Where the Mean Square Error (MSE) is defined as [10]:

$$MSE = \frac{1}{N^2}\sum_{i=0}^{N-1}\sum_{j=0}^{N-1}\left[C_{ij}(m,n) - R_{ij}(m,n)\right]^2 \qquad \ldots (3)$$

PSNR is measured in decibels (dB), M: height of the image, N: width of the image.

Experimental Results

This section explains the experiments which have been implemented on two stereo images, Aloe, child and chosen image from personal camera as test images; each one of them is in size of 256*256 and of JPEG format. MATLAB version 7.4.0.287 (R2007a) was used as a work environment to carry out these experiments.

Table (1): display the results of data (PSNR, CR and computation Time) for the TSS algorithm of stress selected three images recorded after using discrete wavelet transform.

Table1: Data for TSS Algorithm.

Images	PSNR (db)	CR	Time (sec)
Aloe	32.222	0.432	66.51
Child	33.321	0.522	72.22
Chosen Image	34.411	0.643	100.33

Table (2): display the results of data (PSNR, CR and computation Time) for the proposed method of stress selected three images recorded after using discrete wavelet transform.

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Table2: Data for the Proposed Method

Images	PSNR (db)	CR	Time (sec)
Aloe	45.32	0.566	50.32
Child	47.45	0.6.98	59.44
Chosen Image	50.28	0.789	88.76

The decoded left and right images were compared with the original left and right images. The Mean Square Error (MSE) between the original and decoded left and right images was referred in Equ. (3). The MSE of the image is the average of the MSE of the left image and the MSE of the right image as show in Equ. (4)[10].

$MSE = (MSE_L + MSE_R) / 2$ .....(4)

Results of Images

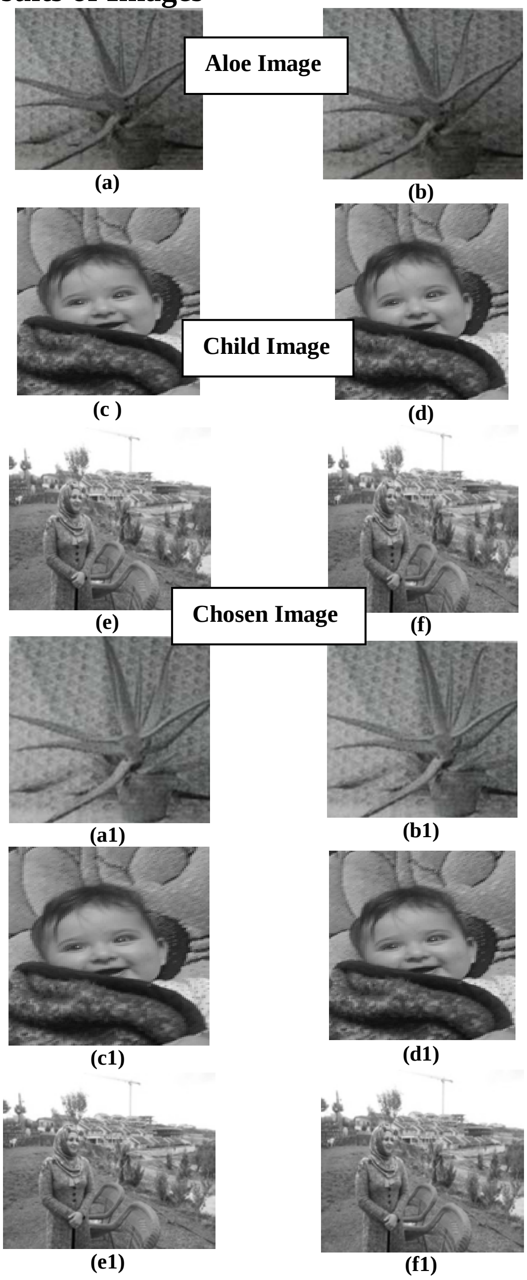

Fig.5: (a), (b), (c), (d), (e) and (f) Original Left and Right Images.
(a1), (b1), (c1), (d1), (e1) and (f1) reconstructed Left and Right images.

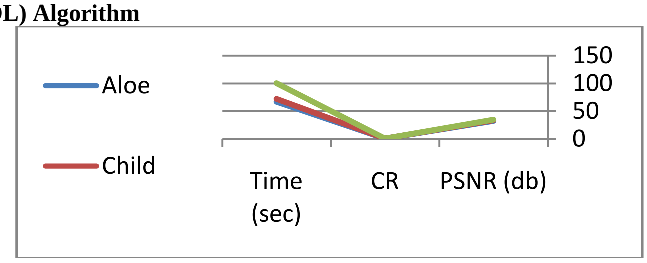

Fig. 6: PSNR vs. Bitrates for TSS Algorithm.

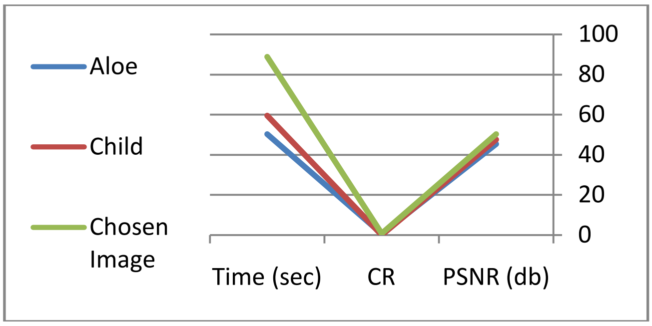

Fig. 7: PSNR vs. Bitrates for the Proposed Method.

CONCLUSION

In this paper, a method for stereo images has been proposed to decrease the computation time without much influence on PSNR and compression ratio. Referring to the results that are shown in Table 1, and Table 2, it is obviously that the values of PSNR, CR, and computation time are affected by the length and the resolution of each pair from the images. Additionally, we can notice clearly that the use of DWT minimized the processing time approximately 45%.Three pair of images were compressed and then reconstructed by reversing the steps followed to compress the images. The reconstructed images were then compared with the original images.

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