VLSI Implementation of Lossless Video Compression Technique Using New Cross Diamond Search Algorithm

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Abstract

Compression is the reduction in size of data with the purpose of save space or transmission time. There are two types of compression Lossy Data Compression and Lossless Data Compression. Lossy data compression, that allow only approximation of the original data to be reconstructed from the compression. Lossless data compression that allow the original data to be reconstructed decompression that improve the performance of a computing system from the compression. Video Compression use in modern coding techniques to reduce redundancy in video data. In this paper the proposed New Cross Diamond Search algorithm is used for video compression(lossless). Two types of techniques are used in this algorithm, they are (1) Block Motion Matching Technique and (2)Motion Estimation and Compensation. By using this new cross diamond search algorithm, the number of checking point is less when compare to another algorithm, using 9 checking point for calculating the sum of absolute difference to determine the least value.By using this least value only the motion vector will be found. compare to diamond search algorithm, checking point is less. The New Cross Diamond Search Algorithm is 40% speed without affecting picture quality.

Keywords --- New Cross Diamond Search Algorithm, Block Motion Matching Technique, Motion Estimation and Compensation.

I. Introduction

Video coding is an important process in multimedia applications. In addition to spatial redundancy, temporal redundancy plays a vital role in the transmission of video frames [1]. Motion estimatison is a technique used to decrease the temporal redundancy. It uses the correlation between the successive frames to predict the content of frames. In the process of motion estimation is division of frame into number of non overlapping areas known as blocks. Each block can be with a standard size of 16×16.The difference between the current new frame and the predicted frame contents is estimated in motion estimation. In addition to motion estimation, some additional information's are also used to indicate any changes in the prediction process. This is known as motion compensation. Motion estimation and compensation algorithms are used to obtain strong temporal redundancy. Full search block matching algorithm is an algorithm which provides a good representation with more number of search points. But, there is a tradeoff between the efficiency of an algorithm and the quality of the prediction image. The suboptimal algorithms for this purpose of use. These algorithms are computationally more efficient but they do not give a good quality as in FSBMA. The suboptimal algorithms used in this purpose of video transmission are Three step search (TSS) [2], New three step search (NTSS) [5], Diamond search (DS) [3], [4] and this like. The search speed and the performance of an algorithm are determined by the shape and size of the search patterns. The Thee Step Search and New Three Step Search algorithms are using a squared shape pattern, whereas the diamond search algorithm uses a Diamond shape. This New Cross Diamond Search Algorithm is also use a diamond shape pattern only but here is taken Less number of search point. In the following sections II & III provide background and related work, while Section IV presents the proposed hardware implementation. Section V shows results . Finally, VI section concludes this paper.

II. Background on FELICS Algorithm

A. FELICS Algorithm

FELICS algorithm is used for compression where the image information is collected from Pseudo Dual-Port RAM for both Read/Write operation to be takes place at same cycle.

B. Golomb-RiceCode

Golomb-Rice code is chosen to encode the prediction errors distributed within out-of-range. The scheme is based on entropy encoding and is optimal for alphabets following a geometric distribution. Specifically, a Rice code is equivalent to a golomb code in which the tunable parameter is a power of two. This makes Rice code convenient for use on a computer, since multiplication and division can be implemented using a bit-shift operation, which can be performed extremely quickly.

C. Prediction Template

The prediction template is suitable for racer scan which is utilized in LCD applications.

D. Intensity Processing

In this model, the intensity that occurs between L and H is with almost uniform distribution, and regarded as in-range. The intensity level higher than H or smaller than L is regarded as Above-range and Below-range, respectively. For In-range, the adjusted binary code is selected, and Golomb-Rice code is for both Above range and Below-range.

III. Related Work

Parallelism and pipelining techniques are adopted to achieve high throughput and reasonable area efficiency. Four-stage pipelining is combined with two-level parallelism to maintain sufficient processing speed. The consecutive pixels are classified into even and odd samples, and an individual hardware engine is dedicated for each one. Since parallelism is used, for both engines should read the reference pixels in previous row from line buffer, and concurrently write the previous current pixel into line buffer for the reference pixel of next row. It defines that the line buffer should be capable of simultaneously performing write and read operations. Although the dual-port memory can be applied to handle this requirement, the area efficiency would be significantly decreased. Dual port RAM has ability to simultaneously read and write different memory cells at different addresses. Single port RAM uses a 6 transistor basic ram cell, while the dual port RAM cell uses 8 transistor cells for memory. So the area of SPRAM is much smaller than the area of DPRAM cell. Gain of the advantages of both SPRAM (less area) and DPRAM (high speed) Pseudo dual port ram is introduced which can read and write the data in the same clock time, using rising and falling edges for the operations respectively, and using SPRAM memory cell for the storage of data.

IV. Proposed Modified Cross Diamond Search Algorithm

This section initially describes the New Cross Diamond Search Algorithm. The objective of the Block motion matching technique is to find the best matching block in the frames and relative difference between the macro blocks and its best matched block. Motion Estimation and Compensation is to estimate the moving object. The videos is converted into the series of frames and each frame is compared with the previous frame and the noise in the frame is found and this is called the optical flow of the frames. Existing FELICS algorithm is designed only for spatial level compression. It uses current pixels and nearby pixels for computing intensity level differences. This method should not compress if edges existing only at particular pixels. Also it doesn't provide any compression technique for adjacent frames in video codecs. For efficient compression, we propose a new method "Block Motions matching technique" where compression takes place at both Spatial and Temporal domain. In Block Motion Matching, images are sub divided into micro blocks of 16x16 matrices and it is checked with nearby blocks. Also this method is applied for video compression techniques. The advantage of Block Motion Matching over existing system is that it compresses block level compression instead of pixel level compression that improves execution speed and adapt for fast process

In this paper a New Cross Diamond Search Algorithm is proposed. The performance of this algorithm is compared with other algorithms by means of error metrics and number of search points in the new cross diamond search. This algorithm achieves close performance with that of Three Step Search. It uses less number of search points than Three Step Search. When compared with original DS algorithm, this algorithm requires less time of Computation and gives an improved performance.

A. Cross Diamond Search Algorithm

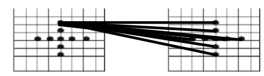


Figure 1: Cross Diamond Search Algorithm

B. Block Diagram for Cross Diamond Search Algorithm

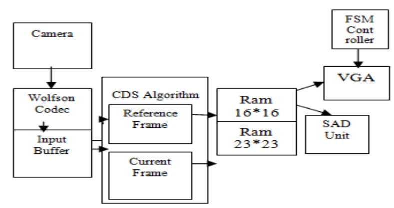


Fig- 2: Block Diagram for Cross Diamond Search Algorithm

C. Module Description

WOLFSON CODEC: To convert Analog Video signals into digital frames and vice versa. Wolfson codec is available in ALTERA CYCLONE DE II FPGA.

INPUT BUFFER: To accumulate frames from WC to avoid congestion.

CDS ALGORITHM USED IN FRAME:1. Reference memory: Loads reference frame pixels. i.e 1st frame from video sequence per second. 2. Current memory: Loads current frame pixels to be compared with reference frame. i.e. 2-30th frames from video sequence per second.

Steps for CDS Algorithm

Step 1: Consider a macroblock of the reference frame and current frame

Step 2: Calculate the SUM OF ABSOIUTE DIFFERENCE value by using CDS algorithm

$$SAD(V_i) = \sum_{x=0}^{M}\sum_{y=0}^{N}\left|S_l(x,y) - S_{l-1}\left(x + d_{x,y} + dy\right)\right|$$

Step 3: Take the 1 point of reference frame and calculate that point to 9point of current frame .

Step 4: Add the SAD values of each point.

Step 5: Step 3 and step 4 is repeated upto all the 9 points of reference frame.

Step 6: From the above 9 points, least point should be determined.

Step 7: If the least point is found from the center point of the reference frame, the process will be stopped.

Step 8: If the least point is determined from any other point of reference frame, then take that point as center point and surround it with 8 points.

Step 9: Therefore, the process will continued for each macroblock of all the frames.

RAM16×16: It consists of pixels information from partitioned microblocks of reference frame.

RAM 23x23: It consists of pixels information from partitioned microblocks of current frame.

SAD& Comparator: Takes 9 points from reference and current frames, Find out sum of absolute difference between 9 points and least point will be determined.

FSM Controller: Find out the motion vectors based least cost point and loads next consecutive frames into memories.

Flow Diagram for Comparator

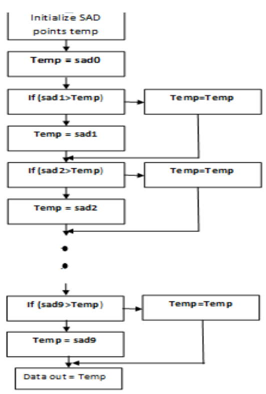
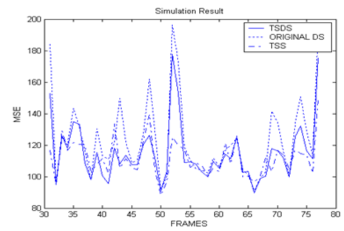


Fig- 3: Flow Diagram for Comparator

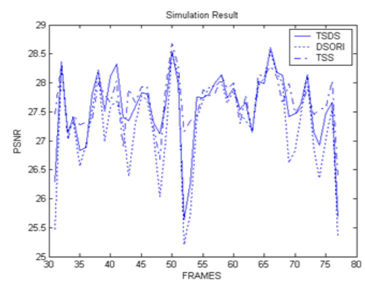
V. Results and Discussion

A window size of 15×15 is used for this algorithm and the center point of initial LDSP is at the origin of the search window. The performance of the algorithm is evaluated by error metrics such as the mean square error and signal to noise ratio. The performance analysis has been done for sequence using matlab and it is shown in fig.



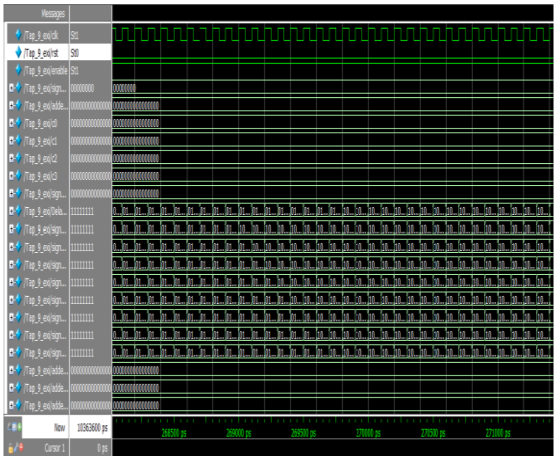
Mean Square Error

Performance comparison of CDS with TSS,DS algorithms.



Peak Signal to Noise Ratio

The proposed cross diamond search algorithm is first used in the sequence of frames images and simulated in the Matlab. The proposed cross diamond search algorithm is written in verilog hardware language, implemented and simulated on the Model sim 6.4. The Quartus II 9.0 tool is used to synthesize the designed and finally cross diamond search algorithm implemented on Altera DE2 -70 kit using cyclone II EP35F6C726.For the algorithm is simulated in Matlab used a test image or video. Simulation results of New Coss Diamond Search Algorithm using in image frames.



VI. Conclusion

In this paper, the New Cross Diamond Search Algorithm is proposed for computationally efficient block motion estimation for image compression. This technique can be applied for both spatial and temporal image. The compact shape of the search pattern and step size it outperforms other existing algorithms in terms of computational efficiency such as Three Step Seach, New Three Step Search, and Diamond Search. This algorithm can be used in video coding standards such as MPEG-4, H.264 AVC because of its ease of implementation, better performance and reduced computational complexity.

In block-matching motion estimation, the search pattern with different shape and size can impact the search performance very much. Based on the research of the search pattern and the motion vector distribution, a new cross diamond search (NCDS) algorithm using the asymmetric diamond search pattern is proposed in this paper, in which two asymmetrical search patterns are employed instead of other popular square-shaped or diamond-shaped search patterns. Simulation results has demonstrated that the proposed NCDS algorithm outperforms other well-known fast block matching algorithms greatly. In this paper, the new cross diamond search algorithm is proposed using the cross-shaped and horizontal/vertical diamond-shaped search patterns. Experimental result shows that the proposed system of New Cross Diamond Search algorithm improves the search speed significantly, up to 31.38% compared to CDS.

VII. Future Enhancement

In future, this algorithm outperforms other popular fast BMAs in efficiency and effectiveness, and is suitable for a variety of video applications.

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