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Two Step Quadrant Based Gradient Directional Descent Search

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ABSTRACT: Gradient descent is a first-order iterative optimization algorithm for finding a local minimum of a differentiable function. Search point pattern-based fast block motion estimation algorithms provide significant speedup for motion estimation but usually suffer from being easily trapped in local minima. A multipath search using more than one search path to improve the robustness of block-based gradient descent search (BBGDS) but the computational requirement is much increased. This paper proposed a novel directional gradient descent search (DGDS) algorithm using multiple one-at-a-time search (OTSs) and gradient descent searches on the reference frame in eight directions is used. The Diagonal and adjacent diagonal directional gradient descent search algorithm, using multiple OTSs and gradient descent searches on the reference frame in sixteen directions is proposed. And also four step directional based gradient search is proposed. Simulation result achieves the better performance in calculated parameters.

KEYWORDS: Directional, Gradient, Quadrant, Descent Search.

I. INTRODUCTION

Video compression is the process of reducing the total number of bits needed to represent a given image or video sequence. Video compression is most commonly performed by a program with a specific algorithm or formula for determining the best way to shrink the size of the data. In recent years, several video compression standards had been proposed for different applications such as CCITT H.261, MPEG-1 and MPEG-2. One common feature of these standards is that they use DCT transform coding to reduce spatial redundancy and block motion estimation/compensation to reduce the temporal redundancy. In addition, the encoders complexity of these video standards are dominated by the motion estimation, if full search (FS) is used as the block matching algorithm (BMA). FS matches all possible displaced candidate blocks within the search area in the reference frame, in order to find the block with the minimum distortion. Massive computation is, therefore, required in the implementation of FS. On the other hand, the H.261 and MPEG standards have not specified the BMA for motion estimation at the encoder.

As a result many of the fast BMA's has been developed to alleviate the heavy computations of FS. For examples the three-step search (3SS), the 2D-logarithm search (LOGS), the conjugate directional search, the cross-search algorithm, and the dynamic search-window adjustment algorithm, etc. Among the proposed BMA's, the 3SS became the most popular one and it is also recommended by RM8 of H.261 and SM3 of MPEG owing to its simplicity and effectiveness. However, the 3SS uses a uniformly allocated checking point pattern in its first step, which becomes inefficient for the estimation of small motions. In addition, experimental results show that the block motion field of real world image sequence is usually gentle, smooth, and varies slowly. It results in a center-based global minimum motion vector distribution instead of a uniform distribution.

Video compression is the field in electrical engineering and computer science that deals with representation of video data, for storage and/or transmission, for both analog and Digital video. Video coding is often considered to be only for natural video, it can also be Applied to synthetic (computer generated) video, i.e. Graphics. Many representations take Advantage of features of the Human Visual System to achieve an efficient representation.

The biggest challenge is to reduce the size of the video data using video compression. For this reason the terms "video coding" and "video compression" is often used interchangeably by those who don't know the difference. The search for efficient video Compression techniques dominated much of the research activity for video coding since The early 1980s, the first major milestone was H.261, from which JPEG adopted the idea Of using the DCT; since then many other advancements have been made to algorithms Such as motion estimation. Since approximately 2000 the focus has been more on Meta Data and video search, resulting in MPEG-7 and MPEG-21.

Video compression can be achieved by exploiting the similarities or redundancies and irrelevancy that exists in a typical video signal. The redundancy in a video signal is based on two principles. The first is the spatial redundancy that exists in each frame. The second is the fact that most of the time; a video frame is very similar to its immediate neighbors. This is called temporal redundancy. This temporal redundancy can be eliminated by using motion estimation and compensation procedure.

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II. BLOCK MATCHING ALGORITHMS

The underlying supposition behind motion estimation is that the patterns corresponding to objects and background in a frame of video sequence move within the frame to form corresponding objects on the subsequent frame. The idea behind block matching is to divide the current frame into a matrix of 'macro blocks' that are then compared with corresponding block and its adjacent neighbors in the previous frame to create a vector that stipulates the movement of a macro block from one location to another in the previous frame. This movement calculated for all the macro blocks comprising a frame, constitutes the motion estimated in the current frame.

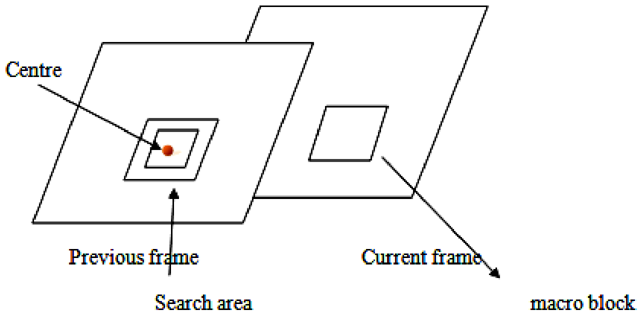

Figure 1: Block Matching

The search area for a good macro block match is constrained up to p pixels on all fours sides of the corresponding macro block in previous frame. This 'p' is called as the search parameter. Larger motions require a larger p, and the larger the search parameter the more computationally expensive the process of motion estimation becomes. Usually the macro block is taken as a square of side16 pixels, and the search parameter p is 7 pixels.

The idea is represented in Fig 1. The matching of one macro block with another is based on the output of a cost function. The macro block that results in the least cost is the one that matches the closest to current block.

$$\text{MAD}= \frac{1}{N*N} \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} |C(i,j) - R(i,j)|$$

$$\text{MSE} = \frac{1}{N*N} \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} (C(i,j) - R(i,j))^2$$

where N is the side of the macro bock, Cij and Rij are the pixels being compared in current macro block and reference macro block, respectively.

There are various cost functions, of which the most popular and less computationally expensive is Mean Absolute Difference (MAD) given by equation (i). Another cost function is Mean Squared Error (MSE) given by Equation (ii). Peak-Signal-to-Noise-Ratio (PSNR) given by equation (iii) characterizes the motion compensated image that is created by using motion vectors and macro clocks from the reference frame.

$$\text{PSNR} = 10\log_{10} \frac{(\text{Peak to peak value of original data})}{\text{MSE}}$$

The search can be carried out on the entire past frame, but is usually restricted to a smaller search area centered on the position of the target block in the current frame. This practice places an upper limit, known as the maximum displacement, on how far objects can move between frames, if they are to be coded effectively.

The maximum displacement is specified as the maximum number of pixels in the horizontal and vertical directions that a candidate block can be from the position of the target block in the original frame.

III. PROPOSED METHOD

A. TWO STEP QUADRANT BASED GRADIENT DIRECTIONAL SEARCH

Two step quadrants based gradient directional descent search for fast block motion estimation algorithm, uses two steps, it divides the macro blocks into the quadrant and then apply multiple OTSs in and gradient descent searches on the reference frame and current frame in different directions. It starts searches from center, and then searches in all directions of gradient. As soon as it found the minima value it stops the searching, and indicates the minima as motion vector. It means we get the motions only where it occurred. If it is at the center of the search window then it shows there is no motion occurs. The search point patterns in each stage depend on the minima found in all directions and thus the global minimum can be traced more efficiently.

Firstly we apply searching technique in the reference frame. Searches start from centre of the search window, it calculate the mean absolute difference i.e MAD value of the centre, then it start moving toward all diagonal, adjacent diagonals and vertical and horizontal directions. Based on first search round it starts find the minimum in the search window. And come up with search point pattern depends on the minimum found in the different directions and thus the global minimum can be traced more efficiently.

It will be efficient searching technique for the low complex video sequences, it will helpful to find the minimum in the first search round itself. During the implementation process I found it is efficient gradient descent technique to find the minimum distortion. Algorithm of diagonal and adjacent diagonal gradient descent searches given below.

TQBGDS Algorithm

Step 1: Calculate The BDM of the Search Window Center And Set The Value As CURRENT_MIN.

Step 2: For Each of the Eight Directions of the Point with CURRENT_MIN

(a) Goto CURRENT_MIN quadrant.

(b) Perform Point-By-Point Directional OTS

(c) Set The Minimum BDM Found In The Current Direction.

Step 3: The Algorithm is completed. Return with the Final Motion Vector (MV) Pointing To the Position with CURRENT_MIN.

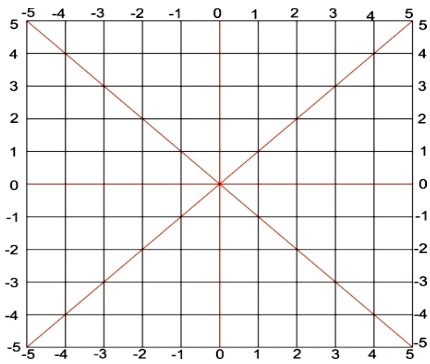

Figure 2: Quadrants and Directional Based

It outperforms TQBGDS by considering all descending gradient paths while achieving lower computational complexity than MPS by using one-step search in eight directions with making macro blocks into the quadrants. The Two Step Quadrant Based Gradient Search shown in fig 2, which using two step quadrant based gradient searches technique on the reference frame in diagonal directions is proposed. Firstly it starts searches from the center, searches in all directional gradients. The point it found the minima it stops the searching, and indicates the minima as a distortion by indicating it as a motion vector. If it is at the center of the search window then it shows there is no motion occurs. In OTS, the point-by-point search along a direction is continued if a newly searched point has lower distortion than the previously searched point. Otherwise, the search in that direction stops. The minimum distortion found by each directional search is set as a directional minimum (DIRECTNAL_MIN) and process continues in the minima directional gradient quadrant. The search point patterns in each stage depend on the minima found in these eight directions along with quadrant, and thus the global minimum can be traced more efficiently.

This algorithm uses, two steps to search minima i.e quadrant search with directions. The searching technique applied in the reference frame and comparing with current frame. Searches start from the center of the search window, it calculates the mad value of the center, and then it starts moving toward all diagonal, vertically and horizontal directions. The specialty of the technique, we can alter the window size without getting distortion. It will be an efficient searching technique for the low complex video sequences, it will helpful to find the minimum in the first search round itself. it is also efficient for complex video sequences by using a two-step search.

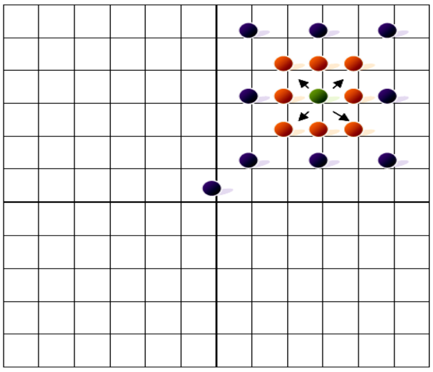

Figure 3: TQBDGS

It may give less prediction error and the number of search point per each frame. It may also improve prediction quality in terms of PSNR. So, two-step quadrant based gradient descent search is effective for the notion estimation. The main aim, to improving picture quality while applying different techniques, cause if it is not done with fast computing, the picture quality degrades and the purpose not solved. So, this technique stands with better accuracy and improves picture quality in terms of PSNR.

IV. SIMULATION RESULTS

The simulation is performed using MATLAB software. The simulation results is showing as follows-

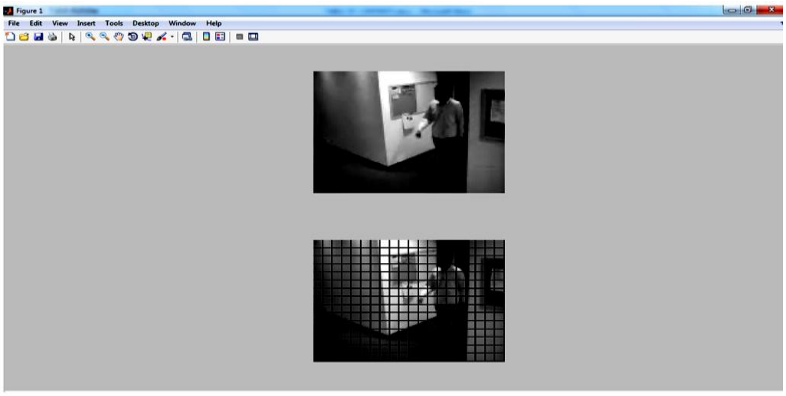

Figure 4: Single Frame Grid View

The video sequences of vipmen are taken and the reference frame and current frames are converted into small macro blocks the size of block here taken as 8*8 by using block process technique. And the motion vector shown where ever motion occurs the block process and the motion vector.

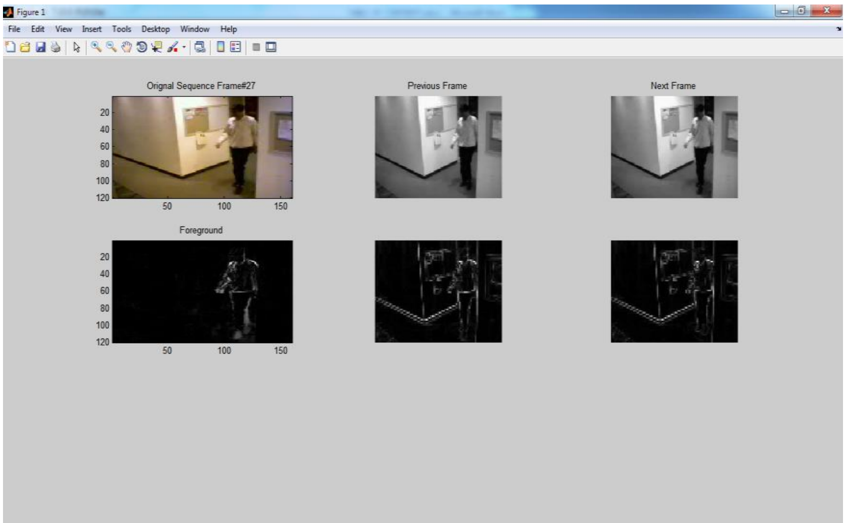

Figure 5: Block Process Technique

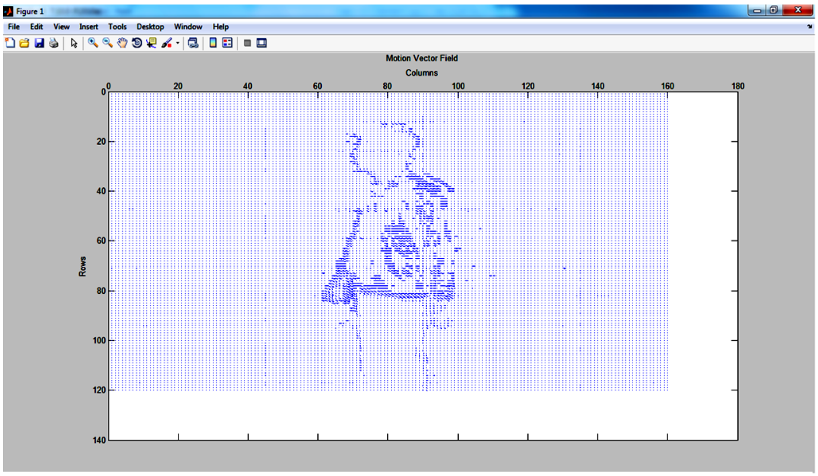

Figure 6: Motion Vector

Then, developed MATLAB code, of existing full search technique. In this the mean absolute difference is find each of the search window location throughout the simulation process I have taken search parameter as p=±7 pixels. And the size of non overlapping macro block is taken 8*8(row*col).

37.67188	32.26563	26.75	21.9375	18.85938	20.85938	26.51563	37.90625	50.6875	63.54688	74.92188	85.0625	93.51563	100.8906	106.5625
39.79688	34.95313	28.625	22.42188	15.89063	14.21875	17.8125	27.375	40.79688	54.71875	67.03125	78.21875	87.92188	96.64063	104
40.76563	35.875	29.73438	23.35938	16.60938	11.95313	11.35938	18.40625	31.39063	46.17188	59.03125	71.10938	81.82813	91.89063	100.6719
38.8125	34.04688	28.375	22.73438	17.40625	11.95313	8.234375	10.875	22.79688	37.92188	50.96875	63.375	74.96875	86.21875	96.51563
35.96875	31.9375	26.82813	21.76563	17.59375	13.96875	9	5.5	15.625	30.42188	43.65625	56	67.92188	80.07813	91.53125
33.54688	30.125	25.8125	21.34375	17.76563	15.35938	11.73438	5.15625	9.375	23.95313	37.76563	50.125	61.59375	74.01563	86.51563
31.09375	28.14063	24.70313	20.84375	17.79688	15.92188	13.5	8.171875	5.515625	18.75	32.76563	45.17188	56.0625	68.09375	80.90625
29.40625	26.875	24.3125	21.20313	18.6875	16.85938	14.5	10.90625	7.40625	14.71875	28.29688	41.15625	52	63.32813	75.39063
28.85938	26.76563	24.85938	22.35938	19.78125	17.67188	15.46875	13	11.0625	11.29688	24.07813	37.20313	48.23438	59.14063	70.26563
28.76563	26.625	25.03125	23.03125	20.54688	18.35938	16.23438	14.34375	14.17188	11.5	20.5	33.23438	44.42188	55.34375	65.64063
28.98438	26.71875	25.1875	23.42188	21.17188	19.25	17.42188	15.6875	16.70313	15.14063	16.29688	29.1875	41	52.21875	61.64063
29.29688	27.0625	25.39063	23.78125	21.6875	20.1875	18.84375	17.28125	18.67188	18.64063	14.9375	26.04688	38.46875	49.89063	58.51563
29.64063	27.84375	25.875	24.1875	22.09375	20.79688	20.23438	19.28125	20.92188	21.84375	19.07813	23.73438	36.01563	47.40625	55.54688
29.96875	28.29688	26.5625	24.78125	22.625	21.17188	21.64063	21.34375	23.14063	24.92188	23.42188	22.21875	34.01563	45.04688	53.03125
30.34375	28.71875	27.07813	25.48438	23.32813	21.76563	22.9375	23.21875	25.14063	27.4375	27.28125	23.21875	32.39063	43.21875	51.25

Table 1: TQBDGS, location of min is (0,2).

Above table shows the TQBDGS technique is applied and shows the location of minimum found. For the typical block of video sequences of vipmen and the macro typical block of image 45*25 has taken.

V. CONCLUSION

This paper present to speed up the search, a novel fast block matching algorithm based TQBDGS are proposed. Traditional fast block matching algorithms are easily trapped into the local minima resulting in degradation on video quality to some extent after decoding. Since these Evolutionary Computing Techniques are suitable for achieving global optimal solution. it will helpful in tracking the unwanted moving object, in the field of video conferencing where real time video sequences transmission needed in the real time with less computational cost, these proposed methods computationally fast and efficient techniques. This work will help in real time solution with good video quality.

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