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Rho-Square Method for Fast Block Matching in Motion Estimation for Video Compression

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Abstract

Generally, block matching algorithms are the most time consuming in the process of motion estimation in compressing the video for transmission. This paper gives a new block matching algorithms designed particularly for fast transmission purposes that will have less computations and almost same quality of the existing algorithms.

***Keywords*— block matching algorithms, diamond search, three step search, rho-square method**

I. INTRODUCTION

In this digital world, we need some compression techniques for the transmission of the video signal over a fixed bandwidth and also for storage limitations we need to compress video. Every video compression technique needs to remove the spatial redundancy and temporal redundancy. Spatial redundancy aims at removing the redundant data from the same frame and is known as still image coding or intra coding. Temporal redundancy aims at having compression among the adjacent frame and is known as inter coding. Motion Estimation is the method for removing the temporal redundancy. It aims at predicting the motion of a block of pixels over a frame. The block matching is time consuming process and it aims at finding the motion vectors for the predicted frame with reference to the intra frame.

II. PROBLEM DEFINATION

As the time is the most crucial for us, so we need to have video communication at a very high speed. For that we need our block matching algorithms to be very fast with a satisfactory quality of video. The algorithms should have same image quality and less number of computations.

III. BLOCK MATCHING ALGORIHTMS

This is the part of motion estimation /compensation in the video compression. Block matching algorithms are used to find the motion vector of every block of the frame. It aims at predicting the current frame from the reference frame.

Matching is done on the basis of two factors i.e. Mean Absolute Difference (MAD), and Mean Square Error (MSE).

$$\text{MAD} = \frac{1}{N^2}\sum_{i=0}^{N-1} \quad \sum_{j=0}^{N-1} | \; Cij - Rij \; |$$

$$\text{MSE} = \frac{1}{N^2}\sum_{i=0}^{N-1} \quad \sum_{j=0}^{N-1} (Cij - Rij)^2$$

where N : side of macro block,
Cij and Rij: pixels being compared in current macro block and reference macro block respectively.

But due to simplicity, we often use mean absolute difference (MAD) for finding the best match.

IV. RHO-SQUARE SEARCH

Rhombus Square search is the modification of the Diamond search method. As Diamond search method of block matching uses two types of fixed search pattern i.e. large diamond and small diamond. When the shape of large diamond is changed according to the figure1 as shown, which looks like rhombus inside a square, the value of computations can be decreased to a large extent with a very low change in the peak signal to noise ratio (PSNR). When the best match has been found at the centre after repeating again and again then it searches for the best match using small diamond pattern. Then the motion vector of the required block is found.

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As in case of diamond search, when the best match is found at the centre, we then switch to small diamond search. But in our rho-square search, there is no need to switch further to small search. Switching just means that we have found the best match for motion vector.

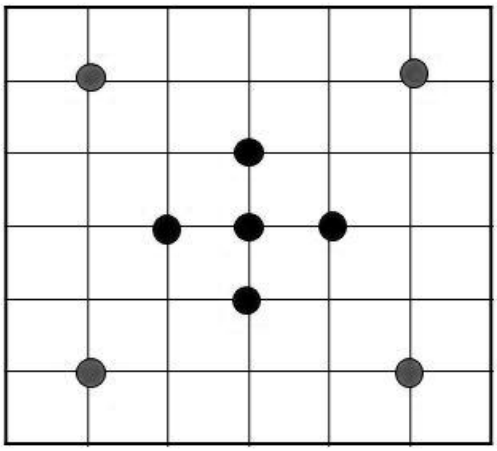

Fig.1. Rho-square search

Rho-Square method can be better implemented when the motion of the block inside the frame is to a very large extent i.e. the block is in a fast motion. As compared to diamond search, this method can find motion vector of the required block in a lesser number of steps. Hence it has less number of computations in case of fast motion.

But in case of small movement of block inside the frame, it has almost same number of computations and also the same quality of image as obtained in case of diamond search method.

V. Design Parameters

1. Computations (related to time)
2. PSNR i.e peak signal to noise ratio (related to quality)

To design block matching algorithms for obtaining efficient results, we need to have low value of computations and high value of PSNR i.e. to have good quality of video compression in less time.

VI. Simulation Result

When the algorithms is compared with the earlier three step search method and diamond search the simulation result in Matlab is as follows:

When we compare the results of our rho square method with the three step search and diamond search , we found that the computations were reduced to a larger extent. Two tables are given in reference to the simulation result of our search method for different frames. As shown in the table1 and table2, the computations is reduced to 15.8 from 22.4, and 16.5 from 21.5, as in case of diamond search. Also there is a large decrease in the computations when compared with Three Step search method as shown in the table 1 and table2.

1. From first sample frame

ALGORITHMS	PSNR	COMPUTATIONS
FULL SEARCH	40	204
THREE STEP SEARCH	39.7	23.7
DIAMOND SEARCH	39.9	22.4
RHO-SQUARE METHOD	39.3	15.8

2. From second sample frame

ALGORITHMS	PSNR	COMPUTATIONS
FULL SEARCH	38.9	204
THREE STEP SEARCH	38.6	23.7
DIAMOND SEARCH	38.7	21.5
RHO-SQUARE METHOD	38.8	16.5

VII. Conclusion

From the simulation result, we can conclude that by using our algorithm, we can get almost the same quality of the video or picture i.e. PSNR, and our computations are reduced to very large extent. So finally we obtained a block matching algorithm for fast communication purposes.

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