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AN EFFICIENT BLOCK MATCHING ALGORITHM FOR FAST MOTION ESTIMATION USING COMBINED THREE STEP SEARCH AND DIAMOND SEARCH ALGORITHM

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Abstract- Recent day Communication between ends is facilitated by the development in the area of wired and wireless networks. So many researches are going on the field of motion estimation to achieve the requirement of recent day technology. Block matching algorithms are very useful in achieving the efficient and acceptable motion estimation. Total computation cost and bit budgeting can be efficiently controlled by properly modifying block matching algorithms. Video coding using Orthogonal Logarithmic Search Algorithm (OSA) is one of the best block matching algorithms used now days. Motion estimation is the most time consuming operation in a typical video encoder. This paper presents a novel method by combining modified three step (M3SS) algorithm with a different search pattern and diamond search (DS) based on dead cell for the block based motion estimation. Result shows that from the original Three step Search (3SS/TSS) method, the PSNR value has increased and the computations time has been reduced effectively by modified 3SS and again to increase the search space we combined diamond search(DS) algorithm. The experimental results based on different video frames were compared to demonstrate the advantages of proposed fast motion estimation algorithm.

Keywords- *Video Compression, Motion estimation, Block matching, Diamond Search, Three Step Search*

I. INTRODUCTION

The visual management system or user-friendly tools to assist in information retrieval from digital multimedia database is one of the important challenges in recent communication and multimedia technology. Extraction of motion parameters by using effective Block Matching Algorithms (BMA) is one of the best techniques to handle motion estimation problem in today's faster multimedia technology. It is necessary to take control over bit rate requirements in order to effectively employ in a limited transmission bandwidth.

Serving in low bit rate networks like handheld PCs and mobile phones have developed many models for next generation communication devices which is a challenge to many companies. They suffer from today's technical challenges like bandwidth limitation and computation time. So an efficient and effective algorithm is required which can work on low bit rate network and devices with low power sources. So performing motion estimation in real time with acceptable computational time is a major challenge in video compression.

It is worth mentioning that computational time and bit budgeting is principally due to Block matching algorithms used. This paper is divided into seven parts; Part I shows introduction of Block Matching: Part II deals with different block matching algorithms used in our paper: Part III describes basic theories related to Block Matching algorithms (BMA): Part IV focuses on problems and its solutions Part V describes simulation result Part VI concludes the paper and Part VII shows the references we used.

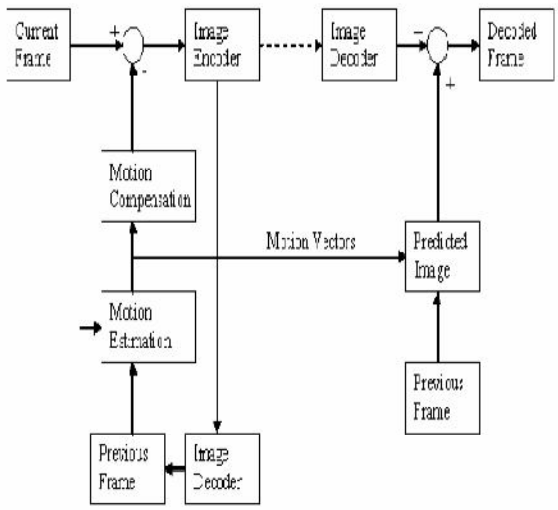

Figure 1:Video Compression Process Flow

II. BLOCK MATCHING ALGORITHMS

There are many BMAs used so far for fast motion estimation. Here we are discussing 3SS algorithm and DS algorithm, used in our proposed algorithm.

A. Three Step Search (3SS)

This is one of the earliest attempts at fast block matching algorithms and dates back to mid 1980s. 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.

B. Diamond Search(DS)

In DS there is no limit on number of search that the algorithm can take. DS uses two different types of fixed patterns, one is Large Diamond Search Pattern (LDSP) and the other is Small
Diamond Search Pattern (SDSP). It is very similar to Four Step Search (4SS) algorithm with only difference in limitless search pattern.

III. BASIC THEORY

Generally, the process of Digital Image Stabilization (DIS) can be divided into the following steps: pretreatment; motion estimate; motion decision; motion compensation. Accordingly images are processed in video coding. Video coding standards such as MPEG-1/2 and H.261/263 exploits motion estimation block by block so that each dead space can be traced. The matching in the previous frame is then used as a predictor for the block in the current frame. Then motion vector is calculated by comparing relative position of current frame with previous frame. In video compression major work is motion compensation prediction which can be done by motion estimation. In block matching current frame is divided into matrix of macro blocks that are then compared with corresponding blocks of previous frame and its adjacent neighbors in the previous frame to find the dead blocks. The movement calculated for all the macro blocks comprising a frame, constitutes the motion estimated in current frame Ref.[2].PSNR stated below given by equation-1 is for motion compensated image created by motion vectors.

$$PSNR = 10\log_{10}[\frac{(PeakValueOfOriginalData)^2}{MSE}] \quad (1)$$

Where
MSE=Mean Squared Error

Data transmission bandwidth can be controlled effectively by analyzing temporal redundancy. Pixels in two video frames that have the same values in the same location is generally referred as temporal redundancy. Exploiting temporal redundancy is one of the primary techniques used in video compression.

The most computationally expensive and resource hungry operation in the entire compression process is motion estimation. Hence, this field has seen the highest activity and research interest in the past two decades. This paper implements and evaluates the fundamental block matching
algorithms from the mid-1980s up to the recent fast block matching algorithms of year 2002. It also presents a literature
review of few papers from the last 3 years. The algorithms that have been implemented are Exhaustive Search (ES), Three Step Search (TSS), New Three Step Search (NTSS), Simple
and Efficient TSS (SES), Four Step Search (4SS), Diamond
Search (DS), and Adaptive Rood Pattern Search (ARPS). Section II explains block matching in general and then the above algorithms in detail. Section III compares them and presents some simulation results. Section IV is a literature survey of the more recent algorithms, followed by summary
and references.

IV. DETERMINATION OF DEAD SPACE

A. Problem Definition

For synchronized transmission of video and audio considerable research effort has been taken in video compression. The most popular algorithm known in video compression is Three Step Search(3SS/TSS).However 3SS and recently proposed OSA uses uniformly allocated searching points in their first step which becomes insufficient for the estimation of small motions since it gets trapped to local minimum. To take control over the issue we modified the 3SS technique.

Next to 3SS an efficient algorithm termed as DS, very similar to 4SS utilizes a search pattern which gives PSNR close to that of ES combined with the existing modified 3SS technique, so that each dead space can be manipulated.

B. Proposed Technique

In this proposed algorithm, we use concept of modified 3SS combined with diamond search. Without compromising bit budget and quality, the proposed algorithm tries to find optimally the local as well as global minima.

Algorithm:

{

First Step: Step taken from modified 3SS.

Second Step: Three cases arises

Case-1

If minimum cost is at centre then search with step size =1(figure-2).
Best possible search.
No third step required.

Case-2

If minimum cost is at any of the corners, then search with step size=2 (Figure-4).Then go to step-3

Case-3
If minimum cost is at any of the axis, then go for Diamond Search (DS) where two sub-cases arises.(Figure-3).
Sub-case-1
If minimum cost is at corner of the diamond then search with step size 1.
Sub-case-2
If minimum cost is at the axis of the diamond then search with step size 1.

Third Step: It is for getting the local minima from Second step by searching with step size=1.
}

In first step we use a modified 3SS technique with step size=3 in all corners and with step size=4 in axis so as to cover a maximum area which helps to get global optimum solution.

In second step we again focus on global optimum solution by searching in three different ways (case-1, case-2, case-3).

In third step we search for local optimum solution of second step.

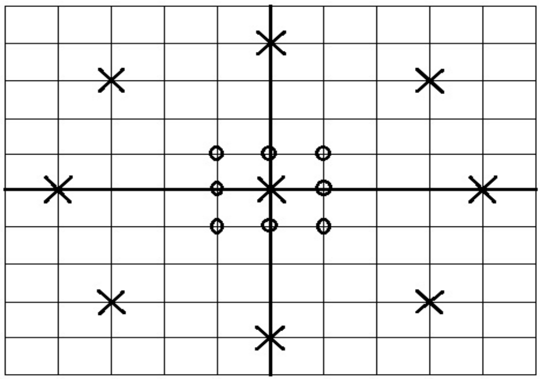

Figure 2:case-1

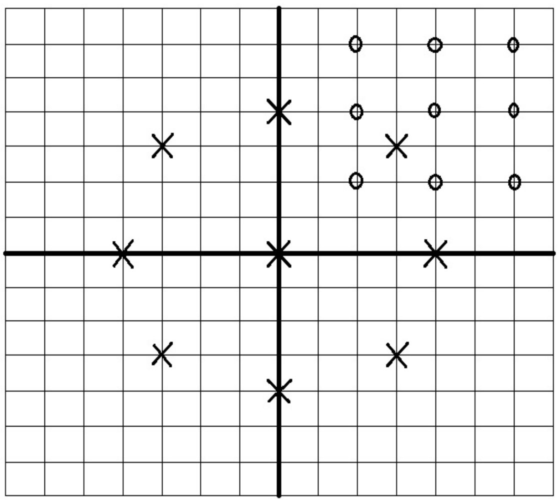

Figure 3:case-2

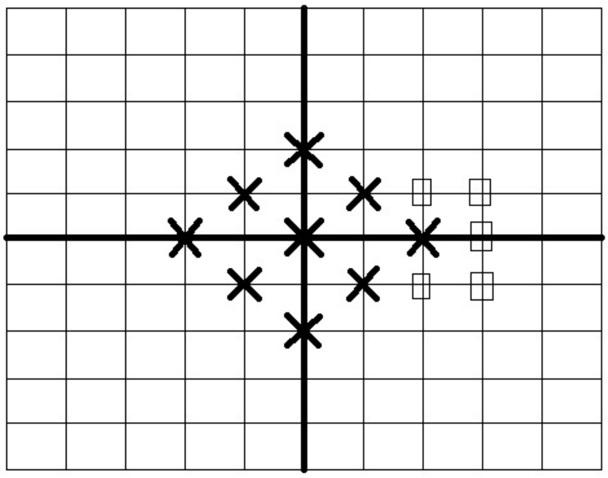

Figure 4:case-3(Sub-case-1)

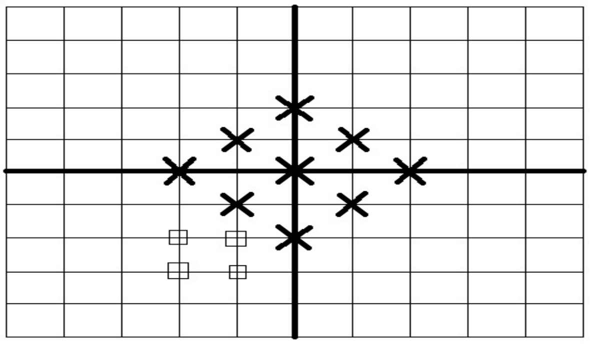

Figure 5:case-3(Sub-case-2)

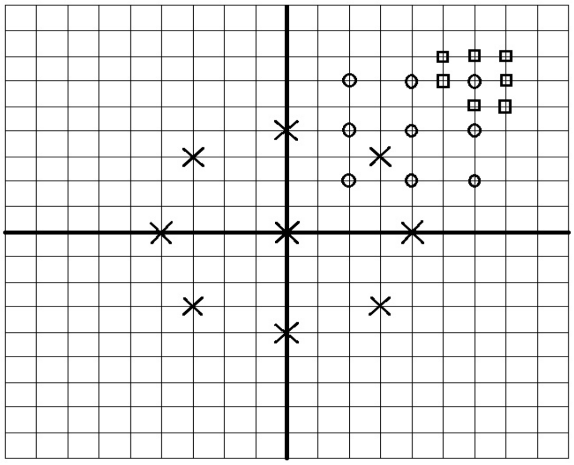

Figure 6:Step-3

V. SIMULATION RESULTS

Table 1: Results for Miss America Frame

S. N	Block Matching Algorithms	PSNR	COMPUTATIO N(sec)
1	NTSS	30.02	22.72
2	DS	25.35	29.74
3	ES	25.60	204.28
4	4SS	25.39	25.09
5	3SS	25.53	23.92
6	Proposed Algorithm	**25.60**	**18.02**

Table 2: Results for Foreman Frames

S. N	Block Matching Algorithms	PSNR	COMPUTATIO N(sec)
1	NTSS	14.63	21.82
2	DS	14.02	30.22
3	ES	14.29	204.2
4	4SS	14.07	25.26
5	3SS	14.20	23.87
6	Proposed Algorithm	**14.46**	**17.60**

Table 3: Results for Mother Daughter Frame

S. N	Block Matching Algorithms	PSNR	COMPUTATIO N(sec)
1	NTSS	21.22	21.79
2	DS	17.71	29.66
3	ES	17.84	204.28
4	4SS	17.71	24.931
5	3SS	17.77	23.80
6	Proposed Algorithm	**18.20**	**17.80**

VI. CONCLUSION

In this paper, the new modified block matching algorithm is tested for its efficiency in terms of computation time and PSNR. The strength of the algorithm lies in giving acceptable results (with improvement) in terms of (PSNR) Quality and reduced the computation time drastically. The results are better than all other well known algorithms proposed. Summing up the proposed algorithm is a better replacement of the entire group of compared algorithm in terms of reduced complexity, reduced computation time and acceptable indeed better PSNR of the reconstructed picture. Efficiency of the algorithm can be best realizable when more number of dead spaces comes into action.

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