Motion Estimation using Block Matching Algorithm

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Abstract— With the recent advances in video technology, there is an increasing need for a more reliable, efficient and robust generic framework for video processing and its analysis. In this regard the Motion estimation has for many years demanding area of research because of its diversity of use in real-time applications. Motion estimation using block matching algorithm is used in many applications in video processing. This paper presents a review of motion estimation based on block matching algorithm and also includes analytical study of fixed and variable block matching algorithms

Keywords— Block Matching Algorithm, FSBMA, Motion Compensation, Motion Estimation, VSBMA.

I.   INTRODUCTION

Video signal processing plays a vital role in many research areas, industry and computer science such as online monitoring of processing systems, robot navigation, medical treatment, multimedia broadcasting, remote sensing, and military. In video processing it is very difficult to analyze the motion of natural moving objects in a scene. To overcome this problem the Motion Estimation (ME) determines the motion vectors used to detect the transformation from one sequence to another. ME have many applications and have been proven essential for video coding and compression [4], [2]. Motion Estimation is a popular technique for computing the displacement vectors between objects or attributes between images captured at subsequent time stamps. Block matching is a well known technique of motion estimation that has been successfully applied to several applications such as video coding, compression and object tracking. This technique exploits the unwanted redundancies and achieves video compression [1]. Motion Estimation using block matching techniques is the most widely used method to find motion vector (MV).

II.   MOTION ESTIMATION

Motion estimation has been the most key role on video processing. It is usually applied to block matching algorithm for choosing the best motion vector. The two adjacent images are searched to find the displacement of the same object in the video image. Motion estimation techniques aim at deducing displacement vectors for objects or image attributes between two consecutive frames. In a model of the object motion between the frames, "the motion that occurred between the reference frame and the current frame" can be estimated by the encoder. This method is known as the motion estimation (ME). For the better current frame prediction, the encoder used the information that move between the reference frame contents and motion model. This process is called the motion compensation (MC).

III.   BLOCK MATCHING ALGORITHM

In video coding the most commonly used motion estimation technique i.e., block matching algorithm used for simplicity and good performance. The main purpose of this technique is to determine the displacements of each block of pixels between two successive frames. The displacement between these matching blocks is called a motion vector (MV) [4] as shown in "Fig.1". The important aspect in block matching is the use of intelligent search strategies to reduce the computational time [2]. There are two distinct phases of block matching method: block partitioning and block searching. The block partitioning scheme is concerned with dividing the original image frame into non-overlapping regions and it performs by using the fixed size or variable size methods. The block search mechanism is the process of locating the block in the destination frame that best matches the block in the frame using a specific matching criterion. Different distortion measures are used to find the best match for a desired macro block in the entire motion estimation process. Mean absolute error (MAE), mean squared error (MSE), and sum of absolute differences (SAD) are commonly used to measure the efficiency of algorithms [1].
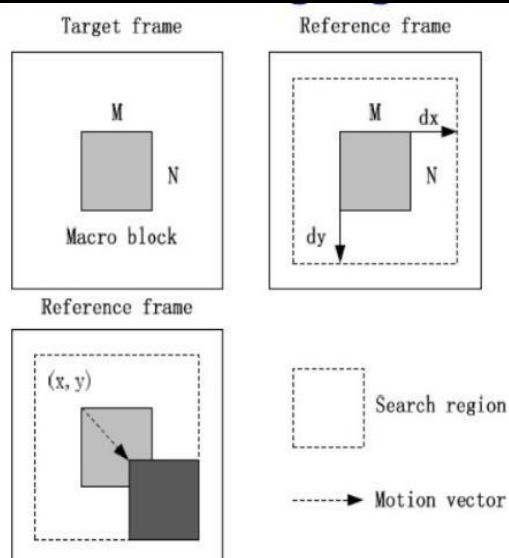
Fig.1: Block Matching Algorithm

Block matching is a standard technique of encoding motion in video compression applications. There exist two forms of block matching. The first is Fixed Size Block Matching Algorithm (FSBMA) and the other is Variable Size Block Matching Algorithm (VSBMA). In fixed size block matching, an image is subdivided into blocks of uniform size, whereas in variable size block matching small block cover areas of complex motion, while regions of uniform motion are spanned by large blocks.

3.1. Fixed Size Block Matching Algorithm

In the fixed block matching algorithm, blocks are defined as non overlapping square parts in an image frame as shown in "Fig.2". Each block of the current frame is matched to a block in the next frame specified within a search window [6] [7].

Fig.2: FSBMA displacement vector

This technique is easy to implement, and thus widely adopted. Each image frame is divided into a fixed number of usually square blocks. For each block in the frame, a search is made in the reference frame over an area of the image that allows for the maximum translation that the coder can use [6]. The search is for the best matching block, to give the least prediction error, usually minimizing either mean square difference, or mean absolute difference which is easier to compute. Fixed block matching schemes are well known for their simplicity and compactness. However, the model suffers from certain limitations which include:

a) Determining the optimal number of blocks that best estimates the motion of objects

b) Issue of time complexity when estimating motion in a complex scene and

c) Introduction of block artifacts which occur when a block covers an area where two or more types of motion are present [8], [9].

3.2. Variable Size Block Matching Algorithm

A variable-size block-matching scheme uses multi-resolution or multi-grid approaches to compute the displacement vector between frames [11]. These hierarchical schemes give reliable and locally adapted motion estimated by operating at different resolutions in a top down manner [12]. The application of such top-down methods may generate block structures for an image that match real moving objects, but it seems that an approach which more directly seeks out areas of uniform motion might be more effective[10]. We developed a VSBM technique that detects areas of common motion grouping them into variable sized blocks with a coding strategy based on the use of quad trees [8]. Use of a quad-tree obviates the need to describe the size and position of each block explicitly, only the tree description is needed.

Variable-size block matching algorithms can be distinguished from each other by the technique of multi-resolution and splitting criterion as shown in "Fig.3". Some of the most common methods of variable size block matching procedures include: quad tree approach, polygon approximation [8] and binary partition trees [9]. The quad tree multiresolution approach splits an image frame into four partitions each time based on splitting criteria. In contrast, the polygon approximation approach use content based information of approximate different regions on an image containing polygons.

Fig.3: Variable BMA displacement vector

IV.   CONCLUSION

This paper consists of an overview on motion estimation and block matching algorithm which are more applicable for video coding application. The Block matching techniques is the most popular and efficient of the various motion estimation techniques. This paper first describes the general block matching algorithm and the motion vectors resulting from FSBM. The FSBM technique is easy to implement, and thus widely adopted. Unfortunately, this is a conflicting requirement, particularly with fixed-size block matching (FSBM), where the size of all the blocks is the same. In FSBM, increasing the block size is the only way to reduce the number of motion vectors. In variable-size block matching (VSBM) smaller blocks can be used to describe complex motion while larger blocks can be used in areas where the image content is stationary or undergoing uniform motion. However, its success depends on an appropriate selection of blocks.

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