International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 8 Issue 05 Series. III || May 2019 || PP 42-46

A Review on Motion Estimation Using Frame Rate up Conversion

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Abstract: *With increasing need of technologies like video conferencing, video streaming and video compression plays a vital role in broadcasting. In this video compression is used to compress data redundancy which arises from spatial and temporal correlation between frames. To overcome such temporal redundancies the Motion Estimation technique involved to make more popular video compression standards. Motion Estimation is a technique for computing displacement motion vectors between objects. This Motion Estimation Computing Array (MECA) is used in video encoding applications to calculate the best motion vector between the current frame and reference frames. This paper proposes an optimization framework for motion estimation using technique known Frame Rate Up Conversion (FRUC). The proposed FRUC technique relates low computational complexity and to improves the picture quality.*

Keywords - *Video Coding, Motion Estimation, Block Matching Algorithm, FRUC*

Date of Submission: 05-05-2019 Date of acceptance: 20-05-2019

I. Introduction

1.1. Video Coding

Video coding is currently employed in number of applications used in areas of digital television, video streaming, DVD players and video telephony. In this video coding system, the video data needs to be compressed before storage and transmission in order to eliminate the redundancy. For high quality video streaming over the Internet, H.264 is an important component in video compression standard. In this regard Motion estimation is the technique of finding a suitable Motion Vector (MV) that best describes the movement of a set of pixels from its original position within one frame to its new positions in the subsequent frame [1]. Encoding the motion vector is just for the set of pixels requires significantly less bits than what is required to encode the entire set of pixels, while still retaining enough information to reproduce the original video sequence. The sequence of several scenes is defined as motion picture or well known as a standard movie. A sequence of several seconds of motion picture recorded without interruption is a called as scene. The scene is usually consists of at least three seconds. In general a movie which is a sequence of still images or picture is at rate of 24 frames per second. Similarly, a TV broadcast consists of a transmission of 30 frames per second (NTSC, and some flavors of PAL, such as PAL-M), 25 frames per second (PAL, SECAM) or anything from 5 to 30 frames per second for typical videos in the Internet.

1.2. Compression Techniques

1.2.1. Image resizing

A common technique for compression is resizing, or reducing the resolution. This is because the higher the resolution of a video, the more information that is included in each frame. For example, a 1280×720 video has the potential for 921,600 pixels in each frame. This resizing process is sometimes referred to as scaling.

1.2.2. Interframe

An interframe is a frame in a video compression stream which is expressed in terms of one or more neighbouring frames and refers to use interframe prediction. This kind of prediction tries to take an advantage from temporal redundancy between neighbouring frames enabling higher compression rates.

1.2.3. Video Frame

A group of pictures is known as frames. The compression of frames in a video is known as video frames. There are three major types of video frames namely: Intra coded frame (I-frame), Forward prediction frame (P-frame), Bi-directional prediction frame (B-frame) as shown in "Fig." 1.

1.2.3.1. I-frame

Intracoded frame is video compression method used by Moving Pictures Experts Group (MPEG) standard. In a video sequence an I-frame is a single frame of digital data that compress independent of frames interspersed with P-frames and B-frames. The more I-frames are contained, the better quality of video is existed.

1.2.3.2. P-frame

For motion prediction whenever we use a past frame as reference frame it leads to forward prediction frame or shortly known as predictive frame. P-frames follow I-frames and contain only the data that have changed from the preceding I-frame because of this; P-frames depend on the I-frames to fill the data.

1.2.3.3. B-frame

For motion prediction if we use both forward as well backward prediction then this combination leads to Bi-directional prediction frame. B-frames contain only the data that have changed from the preceding frame or are different from the data in the very next frame. B-frame is also as delta frame.

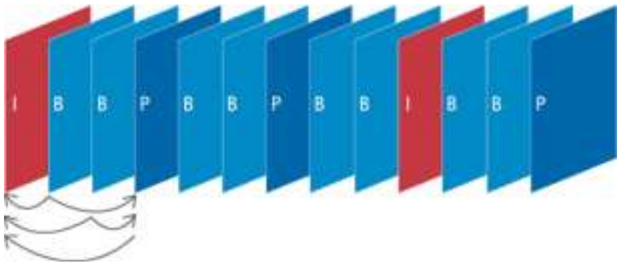

figure1: Frames

II. Motion Estimation

Video coding achieves higher data compression rates compared to analog video without any significant loss in image quality. This video coding applications has led to development of video processing systems having different performance, power consumption, quality, cost and size. Among many coding tools, Motion Estimation (ME) is the most important in exploiting the temporal redundancy occurred between successive frames. Changes between frames are mainly due to the movement of objects. Using a model of the motion of objects between frames, the encoder estimates the motion that occurred between the reference frame and the current frame. This process is called motion estimation (ME) [4]. The encoder then uses this motion model and information to move the contents of the reference frame to provide a better prediction of the current frame. This process is known as motion compensation (MC), and the prediction so produced is called the motion-compensated prediction (MCP). The reference frame employed for ME can occur temporally before or after the current frame.

In general we can consider the blocks can be divided into 16x16, 8x8 or 4x4 in the current frame as shown in below “Fig.” 2(b). From the reference frame as shown in “Fig.” 2(a), a search area is defined for each block in the current frame. The search area is typically sized at 2 to 3 times the macro block size (16x16). Using the fact that the motion between consecutive frames is statistically small, the search range is confined to this area. After the search process, a ‘best’ match will be found within the area. The ‘best’ matching usually means having lowest distance formed by subtracting the candidate block in search region from the current block located in current frame. The process of finding best match block by block is called block-based motion estimation which can be also called as Block Matching Motion Estimation (BMMA). After finding the best match, the motion vectors and distance between the current block and reference block are computed.

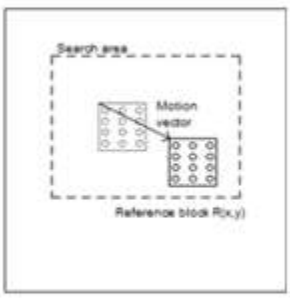

figure 2(a): Reference frame

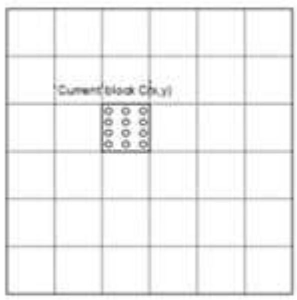

figure 2(b): Current frame

2.1. Motion Vectors

In motion estimation the most important characteristic is a Motion Vector (MV) which is used to find the relative displacement between the current candidate block and the best matching block within the search window in the reference frame. The maximum value of motion vector is determined by the search range. If the search range is more, the more bits needed to code the motion vector. For predicting this motion vector there are two types of prediction called as forward prediction motion estimation and backward prediction motion estimation.

2.2. Forward Prediction Motion Estimation

The motion estimation generally considered as forward motion estimation, since the current frame is considered as the candidate frame and the reference frame on which motion vectors are searched is a future frame, i.e., the search is forward as shown "Fig." 3.1.

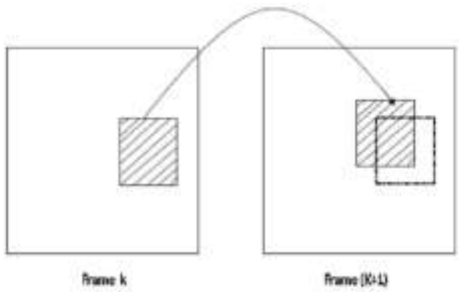

figure 3.1: Forward Prediction Motion Estimation

2.3. Backward Prediction Motion Estimation

The motion estimation generally considered as backward motion estimation, since the current frame is considered as the candidate frame and the reference frame on which motion vectors are searched is a past frame, i.e., the search is backward as shown "Fig." 3.2.

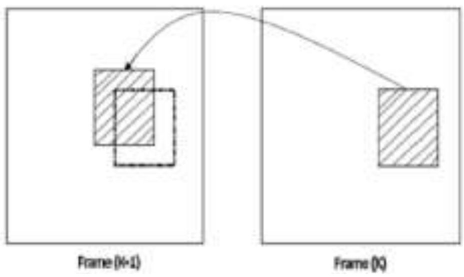

figure 3.2: backward Prediction Motion Estimation

III. Block Matching Motion Estimation

The most commonly used Motion Estimation method is the block-matching motion estimation (BMME) algorithm. Block matching motion estimation is process of locating matching macro blocks in a sequence of digital video frames for purpose of motion estimation [5]. The main objective of block matching technique is to find a candidate block in a search area for best matched to a source block. In the block-matching technique, each current frame is divided into equal-size blocks, called source blocks as shown in "Fig."4. The candidate block is block from reference frame & source block is from current frame.

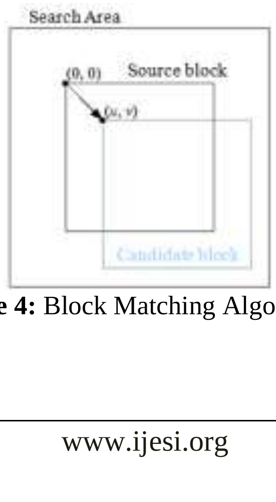

figure 4: Block Matching Algorithm

3.1. Block Size

Another important parameter of the block matching algorithm is the block size. If the block size is smaller, it achieves better prediction quality. This is due to a number of reasons. A smaller block size reduces the effect of the accuracy problem. In other words, with a smaller block size, there is less possibility that the block will contain different objects moving in different directions. In addition, a smaller block size provides a better piecewise translational approximation to non-translational motion. Since a smaller block size means that there are more blocks per frame, this improved prediction quality comes at the expense of a larger motion overhead. Most video coding standards use a block size of and on a Macro Block (MB) basis of 16x16. The block-matching algorithm (BMA) is widely used for motion estimation as it is simple to implement. BMA divides an image into blocks and detects the movement of those blocks. Two kinds of Motion Estimation are primarily used for BMA: unilateral motion estimation and bilateral motion estimation. The Frame Rate Up Conversion (FRUC) technique using unilateral motion estimation have been proposed as shown in “Fig.” 5.1, motion vector’s obtained using unilateral motion estimation pass in one direction through an interpolated frame, which results in overlaps and holes.

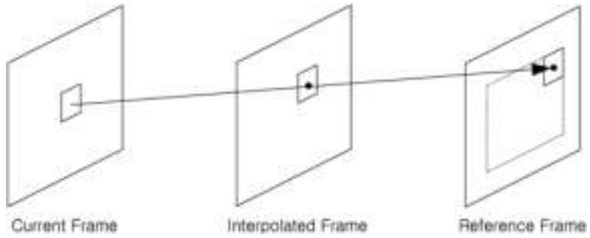

figure 5.1: Unilateral motion estimation

To overcome overlaps, simple FRUC technique merely involves averaging and overwriting the overlapped pixels. Moreover, holes are covered by the pixel values from a reference or a current frame in However, this technique result in blocking artifacts. As shown in “Fig.” 5.2, bilateral motion estimation is another solution that can be used to avoid the problems caused by overlaps and holes. Bilateral motion estimation obtains motion vector’s passing through a block in the intermediate frame using the temporal symmetry between blocks of the reference and current frames. As a result, it does not generate overlaps and holes.

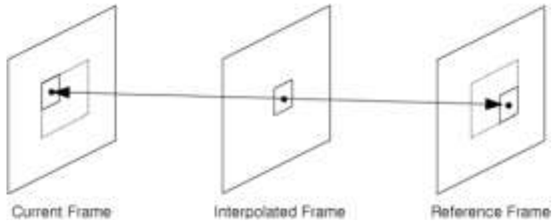

figure 5.2: Bilateral motion estimation

IV. Methodology

4.1. Frame Rate Up Conversion

Frame Rate Up Conversion (FRUC) is a technique to convert lower frame rate video to higher frame rate. It is applied in low bandwidth applications, where half of the frames are dropped in the encoding stage. In this paper presents a motion compensated frame rate up-conversion algorithm that uses the expanded range of the adaptive bilateral motion estimation to enhance the accuracy of motion vectors. The linear approach, referred to as motion compensated frame rate up-conversion (MC-FRUC), reconstructs better quality of intermediate frames than the nonlinear one by taking into account the motion of individual objects. MC-FRUC consists of motion estimation (ME) and motion compensated interpolation (MCI). Motion Estimation is the process of determining motion vectors (MV) of the neighboring frames, and the MVs are employed in interpolating a new frame by MCI. Among existing ME algorithms, the block matching algorithm (BMA) is the most popular one because it can be easily designed with low computational complexity. However, BMA suffers from block artifacts such as compensation area overlap and the gap that cannot be compensated. Recently, bilateral motion estimation [3] is proposed as a way to avoid these BMA artifacts.

V. Conclusion

This paper consists of a overview on motion estimation and block matching algorithm which are more applicable for video coding application. In order to employ effect in a limit transmission bandwidth, to convey the most, high quality user information it is necessary to have more advanced compression method in image / video and data. Also in this paper, a novel block matching algorithm based on FRUC technique is also discussed to estimate the motion vectors. The proposed method enhanced the image quality by additional adaptive parameter.

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