

Motion Estimation using new blocks based on the Frame Difference for Frame Rate-up Conversion

Tong-Ill Kwak Jong-Ho Yun, Hwa-Hyun Cho, Myung-Ryul Choi

Dept. of EECL, Hanyang Univ., 1271, Sa 3-dong, Sangnok-gu, Ansan, Gyunggi-do, 425-791, Korea

TEL:82-31-400-4036, e-mail: unitetong@asic.hanyang.ac.kr.

Keywords : Motion Estimation, Frame Difference, Frame Rate up Conversion

Abstract

In this paper, we propose a Motion Estimation (ME) using new blocks based on the Frame Difference (FD) between two adjacent frames for Frame Rate-up Conversion (FRC). The proposed algorithm decides the shape of blocks by the FD. The experimental results show that the proposed method has better performance than conventional methods

1. Introduction

Various Frame Rate up Conversion (FRC) algorithms are applied to reduce motion blur that is occurred by keeping pixel value from current to next frame in the hold- type display such as Liquid Crystal Display (LCD) [1]. FRC refers to the technique that performs frame interpolation to shorten frame intervals by increasing frame rates.

Frame repetition, linear temporal interpolation and motion estimation-motion compensated interpolation (ME-MCI) have been proposed for FRC. Among various FRC methods, the ME-MCI has been developed, because it has better performance than others [2]. The motion estimation finds motion vectors between two sequential frames, and the motion compensation interpolates new frames using the motion vectors [3-4]. In ME-MCI, because accuracy of motion vector has an effect on quality of interpolated frame, ME is important process.

To find the accurate motion vectors, in this paper, we propose motion estimation using new blocks based on frame difference. The proposed algorithm can find accurate motion vector by new block which is constructed adaptively expanded block with neighborhood block.

Section 2 presents the full search motion estimation. The proposed algorithm is provided in section 3. In section 4, experimental results are given and discussed. Finally, section 5 concludes this paper.

2. Full Search Motion Estimation

The basic idea in the Full Search Motion Estimation (FSME) is to divide the current frame in the video sequence into blocks, and for each block to search for a best matched block within a search range in an available previous frame. The motion estimation starts with assuming that motion has inertia, and blocks are smaller than objects. As cost-function, the Sum of Absolute Difference (SAD) is used. The SAD is given as

$$SAD(x,t) = \sum_{i=search\ range} \sum_{k=block} |f(x+k,t) - f(i-x+k,t-1)| \quad (1)$$

where x and t are the spatial and temporal indices, k and i are the pixel of the calculated blocks and calculated indices in the previous frame. The distance between current position and reference position of lowest value in SAD is motion vector. Fig.1 shows how motion estimation performs to find motion vectors. The block size is $M \times N$ and search range is pre-defined in Fig.1 [4].

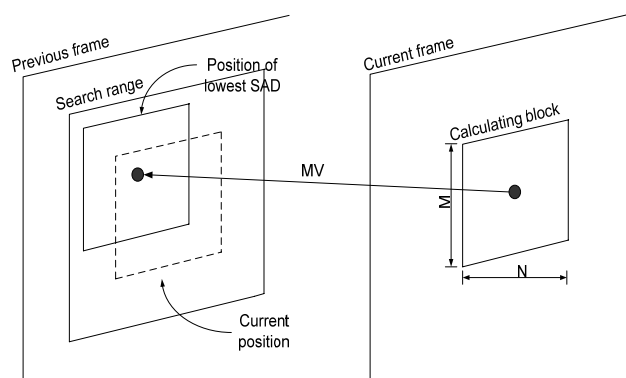


Fig.1 Full Search Motion Estimation

3. The Proposed method

The major issue of proposed algorithm is to extract the accurate motion vector. To achieve the efficient ME, in proposed algorithm, Frame Difference (FD) is used as pre-processing. Using the FD, we can define new blocks that consist of neighborhood blocks of current block. Finally, ME is performed by new block. Fig. 2 shows the flowchart of proposed algorithm.

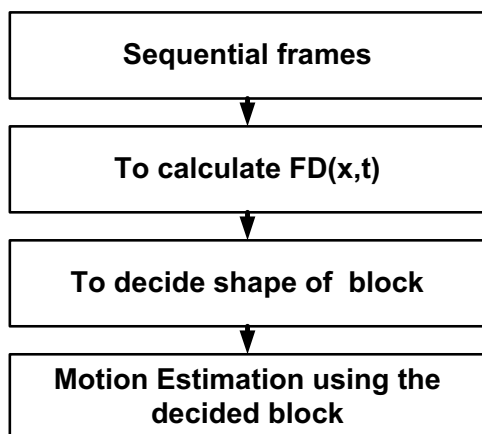


Fig 2. The flow chart of the proposed algorithm

FD is represented by difference of pixel value from current and previous frame. FD is defined as

$$FD(x, n) = |f(x, n) - f(x, n-1)| \quad (1)$$

where (x, n) denotes the position of the calculated pixel and frame number, and $FD(x, n)$ is the pixel value in FD. The block correlated to moving objects should be detected by FD.

The Frame Difference Block (FDB) is used as the block shape decision. It is defined as the value of the summed pixels of a block in FDM, which is given by

$$FDB(x, n) = \sum_{i \in block} FD(x+i, n) \quad (2)$$

where i and x denotes the index in block and block index, respectively, and $FDB(x, n)$ is the total sum of pixels in the block. The proposed algorithm uses the adaptive block as the ME-block as this block contains more information which can be used to extract the exact motion vector. The adaptive block is decided by the follow condition. When the FDB value of neighborhood block is higher than the threshold which is predefined by experiments, the block is combined

For($i=0; i < \text{candidate block}; i++$)
 if($FDB_i < P_{TH}$)
 adding the block into ME-block;

the new blocks to extracts the motion. The proposed algorithm uses the adaptive block for ME-block contained more information which is useful to exact motion vector.

1	3	3
4	Calculated block	5
6	7	8

Fig 3. Example of new block

In Fig. 3, yellowish blocks represent new block which the FDB value is larger than the threshold in neighborhood blocks. In the proposed algorithm, the chosen new block is used to find the motion vectors by a Modified Sum of Absolute Difference (MSAD) which is defined as

$$MSAD(x, t) = \sum_{i=\text{search range}} \sum_{l=\text{new block}} |f(x+l, t) - f(i-x+l, t-1)| \quad (6)$$

where *new block* denotes the expanded ME-block. The pixels of new block provide useful information for finding the true motion vector, because expanded block involves the neighborhood block that is selected to make the optimal new block by the FDB.

4. Experimental

In order to measure the quantitative evaluation, we adopt the peak signal to noise ratio (PSNR) for compensated frames. We calculate the PSNR by using mean square error between the original image and the interpolated image. PSNR results are given in Fig .4. Even though the proposed algorithm had a lower value than the value of FSME, the result of the proposed algorithm showed a reliable PSNR.

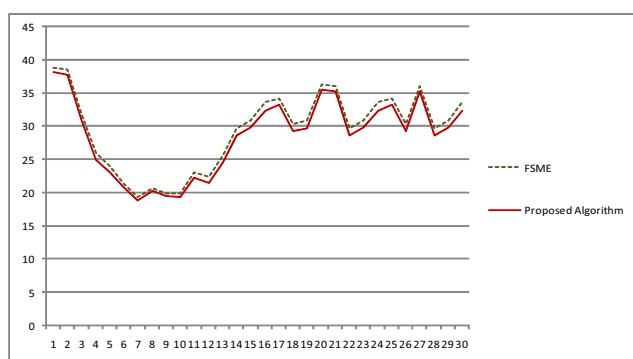


Fig. 4. Susie PSNR of conventional and proposed algorithm

To demonstrate the subjective evaluation of proposed algorithm, we compared the various results with the Full Search Motion Estimation (FSME) and the proposed algorithm. Fig. 5 shows the comparison of the results for Susie sequence. The frame size of Susie is 704x480 and the size of calculated block is 16x16. In simulation of FSME, block artifacts are occurred around the right eye and nose. However, the result of proposed algorithm, are removed the block artifacts significantly.

4. Conclusion

Motion estimation has been widely used in various video processing for FRC. However, motion estimation often extracts incorrect motion vectors. In this paper, we proposed the motion estimation using new blocks based on frame difference. The proposed method extracts correct motion by the adaptive block which is decided by a frame difference. The experimental results show that the proposed algorithm gives better results than conventional method in the image quality. Therefore, the proposed algorithm might be very suitable for Flat Panel Display (FPD) such as LCD.

5. Acknowledgements

This work was supported by BK21

6. References

1. A.A.S.Sluyterman, "What is needed in LCD panels to achieve CRT-like motion portrayal?", Journal of the SID 14/8, pp681-686, 2006



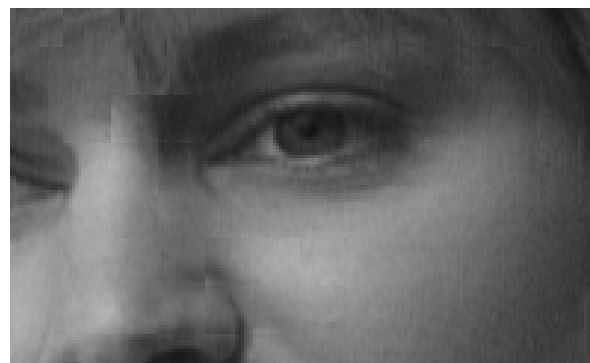
(a)



(b)



(c)



(d)

Fig 5. Test sequence Susie (a) a result of FSME, (b) a result of proposed method, (c) Expand of a, (d) Expand of b

2. Suk Ju Kang, Young Hwan Kim, "Performance Comparison of Motion Estimation Method for Frame Rate Up-Conversion", IDW'06 DESp-6, pp1633-1636, 2006
3. Kuhn, Peter, "Algorithms, Complexity Analysis and Vlsi Architectures for Mpeg-4 Motion Estimation", Kluwer Academic Pub, 1999
4. Kun-Min Yang, Ming-Ting Sun, "A Family of VLSI Designs for the Motion Compensation Block-Matching Algorithm", IEEE Trans. pp1317-1325, 1989
5. Sung-Hee Lee, Ohjae Kwon, Rea-Hong Park, "Motion Vector Correction Based on the Pattern-Like Image Analysis", IEEE Trans. pp479-484, 2003