An Effective Error Concealment for H.264/AVC

2008307101 이성진

Contents

Introduction

- H.264/AVC is the newest international video coding standard.
- The H.264/MPEG-4 AVC video compression standard promises a significant improvement over all previous video compression standards.
- New standard is expected to provide at least 2x compression improvement over the best previous standards and substantial perceptual quality improvements over both MPEG-2 and MPEG-4.

Motivation

- To transmit video bit stream over low bandwidth such as mobile channel, high bit rate algorithm like H.264 codec is exploited.

- In transmitting high compressed video bit-stream over low bandwidth, Packet loss causes severe degradation in image quality.

- In this paper, a new error concealment algorithm for recovery of missing or erroneous motion vector is proposed.

Error Resiliency Schemes in H.264/AVC

- The error resiliency schemes in H.264/AVC are mainly contained in the VCL.

- Two Methods
  - FMO(Flexible Macroblock Ordering) checker board mode
  - Slice Interleaving mode

Error Resiliency Schemes in H.264/AVC

- FMO(Flexible Macroblock Ordering) checker board mode
  - to scatter possible errors to the whole frame as equally as possible to avoid error accumulation in a limited region.
  - loss rates of up to 10%, the visual impact of the losses can be kept so low that only a trained eye can identify them.

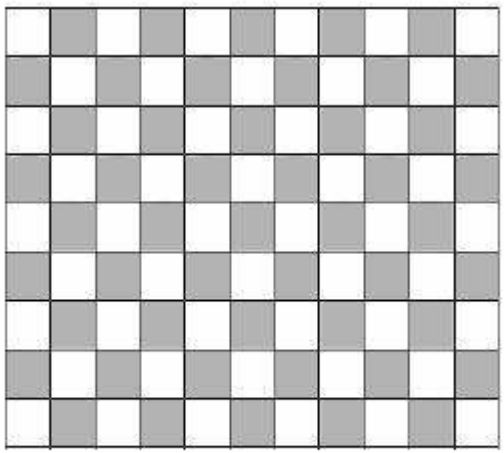


Figure 1. FMO checker board mode

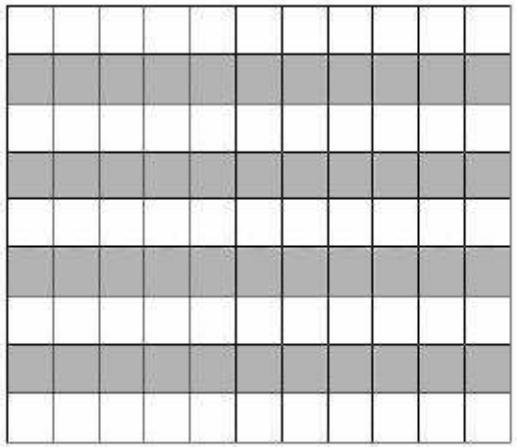


Figure 2. slice interleaving mode

Error Resiliency Schemes in H.264/AVC

- Slice interleaving mode
  - the MTU represents the largest size of a packet that can be transported through networks without being split.

    (MTU : maximum transportation unit)
  - The slice structuring strategy thus aims at avoiding error propagation from a corrupted packet to subsequent packets.

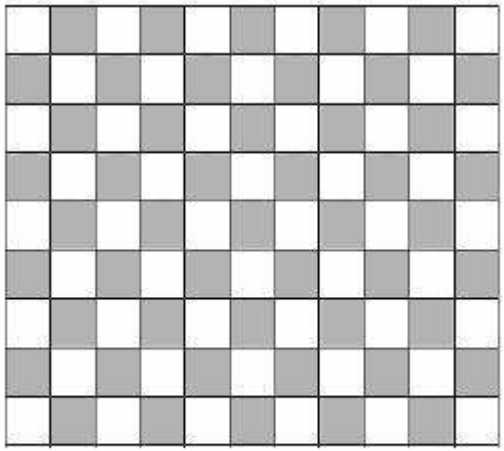


Figure 1. FMO checker board mode

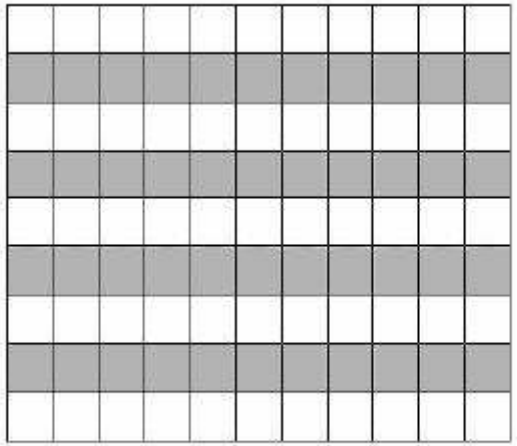


Figure 2. slice interleaving mode

Error Concealment for H.264/AVC

- The H.264/AVC reference software supplied by the JVT committee(Joint Video Team of ISO/IEC MPEG and ITU-T VCEG) implements state-of-the-art concealment algorithms.

- The JVT algorithm treats differently Inter and Intra images.

- Three Methods
  - Spatial Error Concealment for Intra-frame
  - Temporal Error Concealment for Inter-frame
  - Error Concealment Considering Direction of MV set

Error Concealment for H.264/AVC

- Spatial Error Concealment for Intra-frame
  - In Intra frames, the JVT algorithm uses information from surrounding blocks to reconstruct the missing data.
  - The already concealed blocks can be used for the interpolation of the remaining damaged blocks.

- Temporal Error Concealment for Inter-frame
  - JVT concealment for Inter images performs a 4motion estimation for temporal prediction in order to reconstruct the missing data.
  - The algorithm tries to estimate the motion vector associated to the damaged or lost blocks from the vectors in the spatially adjacent blocks.

Error Concealment for H.264/AVC

- Error Concealment Considering Direction of MV set
  - the direction of MV is grouped into eight directions by dividing the gradient at 45° intervals from 0° to 360°.

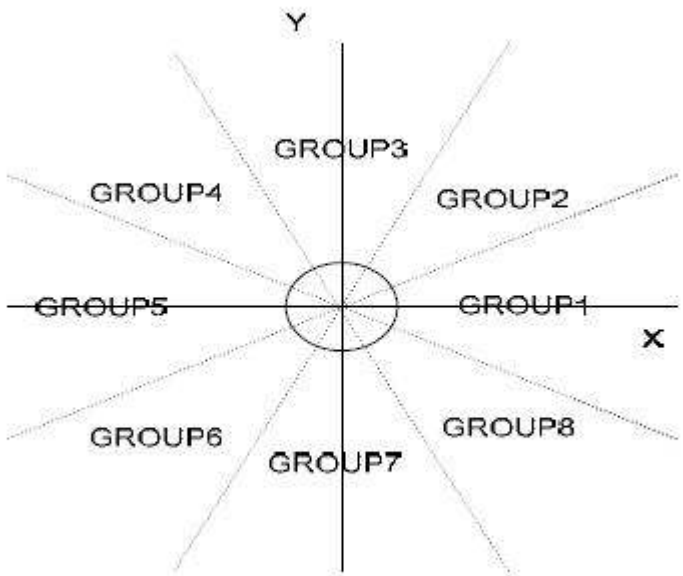


Figure 3. The direction of MVs[3]

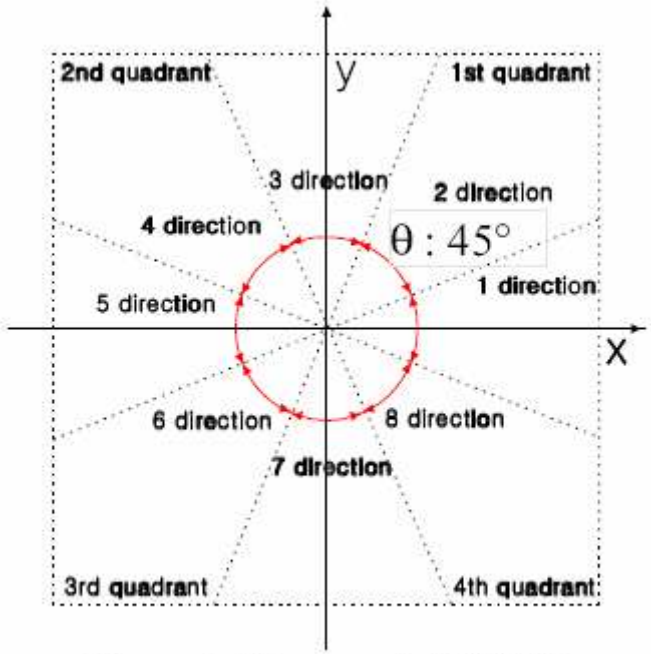


Figure 1. The aspect of MV[6]

Error Concealment for H.264/AVC

- Error Concealment Considering Direction of MV set
  - MV is grouped into 9 directions.

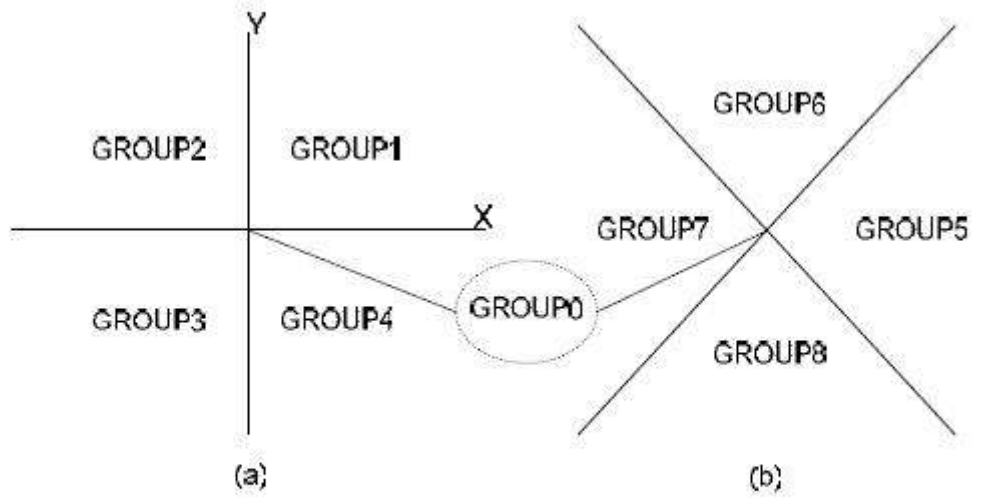


Figure 4. MVs are grouped into 9 different groups[14]

Proposed Algorithm

- Calculation of MV
- Grouping
- Decision of MV for Missing MB

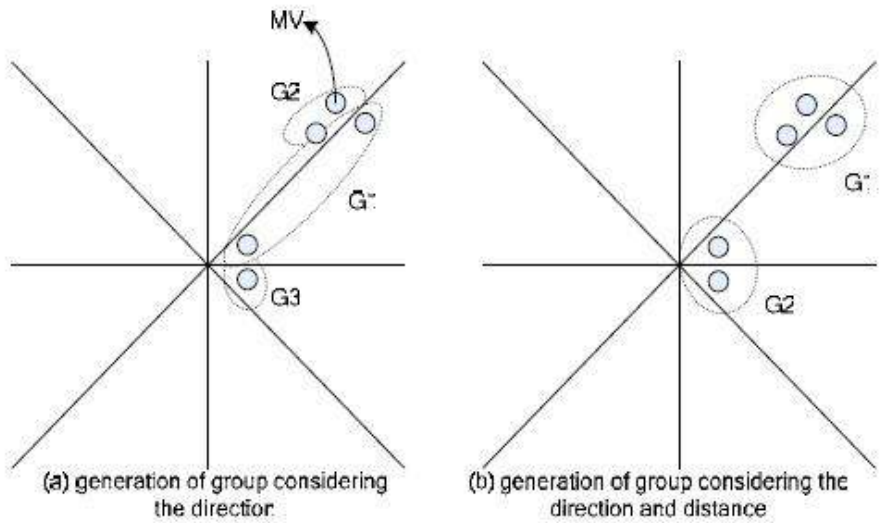


Figure 5. A generation of groups considering distance and direction of MV

Calculation of MV

- Motion vectors of neighboring block are grouped according to ALA (average linkage algorithm) as like figure 6.

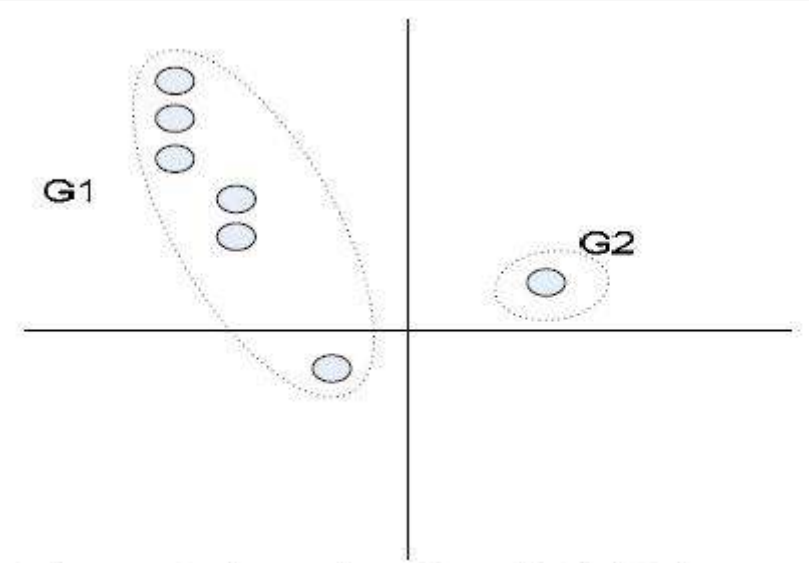


Figure 6. A results of applied ALA

Calculation of MV

- Equation shows that the distance(D) corresponding to MV (x_n , y_n) and its neighboring MV(x_{n-1}, y_{n-1}) where x_n and y_n are coordinates of MV.

$$D = \sqrt{|x_{n-1} - x_n|^2 + |y_{n-1} - y_n|^2}, (n \geq 2)$$

Grouping

- ALA is incorrectly grouped the candidate MV set because it is not considered the between MVs.
- Therefore we proposed that a group divided into the groups considering distance of MVs as like figure 7.

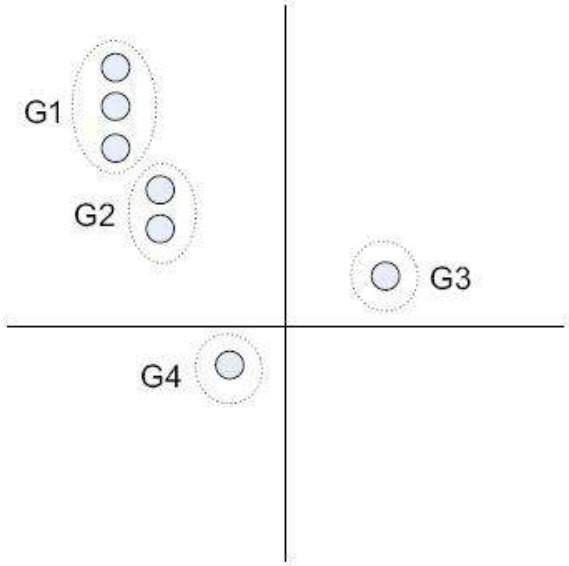


Figure 7. Proposed Scheme

Decision of MV for Missing MB

- a representative value which is median value for each group is determined to obtain the candidate motion vector sets[c][d].

- After distortions are computed for each MV in the candidate MV set

- the one in candidate MV set with minimum SMD (side matching distortion) is selected to be the recovered vector.

Experimental Results

- compare the performance of our algorithm to that of the reference method for interleave and FMO type 1 slices.

- Table 1
  - Proposed algorithm by FMO type.
  - In the numbers of candidate MV, proposed algorithm is superior to BMA and [16] because of decreasing in 6,415 and 2,358 respectively.

- Table 2
  - Proposed algorithm by interleave type.
  - In the numbers of candidate MV, proposed algorithm is superior to BMA and [16] because of decreasing in 2,358 and 131 respectively.

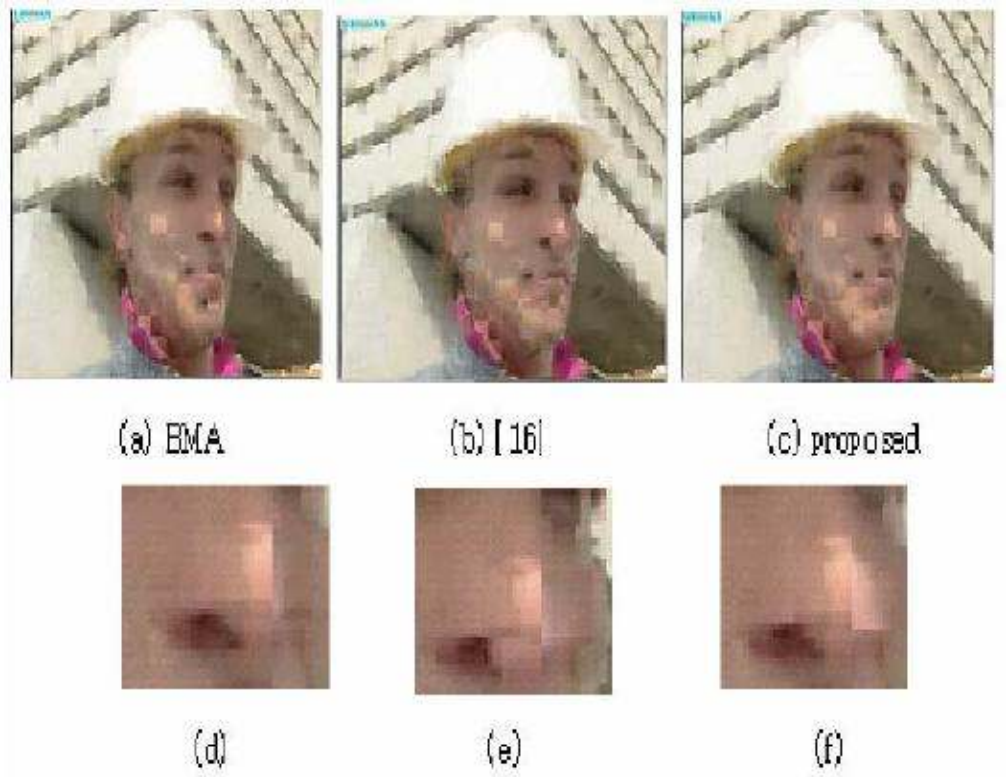
Experimental Results

Proposed algorithm by FMO type.

Sequences	Comparison of performance	BMA	[16]	proposed
FOREMAN	The Number of candidate MV set	12,294	6,801	1,499
	Complexity time(sec)	20.00	19.70	19.56
	PSNR	33.18	33.25	33.87
SUZIE	The Number of candidate MV set	512	324	227
	Complexity time(sec)	12.313	12.18	12.04
	PSNR	36.07	36.10	36.11
MOBILE	The Number of candidate MV set	4,320	2,018	1,099
	Complexity time(sec)	21.53	21.42	20.92
	PSNR	29.81	29.69	29.63
TABLE TENNIS	The Number of candidate MV set	4,139	2,634	1,540
	Complexity time(sec)	18.22	16.67	13.73
	PSNR	30.30	29.95	30.00
STEFAN	The Number of candidate MV set	21,570	10,772	6,395
	Complexity time(sec)	20.64	21.35	19.06
	PSNR	30.43	30.05	30.09

Experimental Results

- the FOREMAN sequence with a FMO type.
- It shows that the proposed algorithm has better performance compared with BMA and [16] in terms of both subjective and objective image quality.



Experimental Results

Proposed algorithm by interleave type.

Sequences	Comparison of performance	BMA	[16]	proposed
FOREMAN	The Number of candidate MV set	2 504	1 429	961
	Complexity time(sec)	30 17	26 92	25 87
	PSNR	33 08	33 06	33 04
SUZIE	The Number of candidate MV set	347	16[illegible]	82
	Complexity time(sec)	18 64	12 23	16 75
	PSNR	35 94	35 97	35 99
MOBILE	The Number of candidate MV set	1 437	2 018	415
	Complexity time(sec)	22 45	21 42	18 20
	PSNR	29 50	29 69	29 47
TABLE TENNIS	The Number of candidate MV set	1 706	534	20[illegible]
	Complexity time(sec)	25 82	21 7[illegible]	17 11
	PSNR	29 03	29 04	29 04
STEFAN	The Number of candidate MV set	11 840	2 634	4 304
	Complexity time(sec)	27 54	16 67	17 29
	PSNR	29 06	29 95	29 27

Conclusion

- An error concealment algorithm which recovers the corrupted MV by extracting the homogeneous motion area is proposed.
- Missing block has almost the same motion vector with the blocks in the homogeneous motion area.
- By using motion vectors of the homogeneous motion area, a more exact recovery of motion vectors is possible
- Experimental results showed that the proposed algorithm exhibits better performance

The End