論文
5-1-13

# Advanced Error Tracking Algorithm for H.263

## H.263에 적합한 개선된 에러 트래킹 알고리즘

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## 요 약

본 논문에서는 피드백 채널을 사용하여 error resilient transmission에 적합한 개선된 에러 트래킹 알고리즘을 제안하였다. 오염된 블록들의 주소는 디코더에 의하여 인코더에게 보고 된다. 제안된 알고리즘을 사용하여 에러 전파를 줄였다. 인코더는 피드백 채널의 negative acknowledgement를 가지고 역방향 움직임 의존도를 조사하여 전파된 에러를 현재 인코딩 되는 프레임 내에서 정확하게 추적한다. 제안된 에러 트래킹 알고리즘을 사용하여 영향을 받은 매크로 블록을 INTRA 코딩함으로 에러 전파효과를 완전히 종식시킬 수 있다.

선택적으로 네 모서리 에러 트래킹 근사를 사용하는 제안된 알고리즘의 에러트래킹 연산량은 전체 픽셀을 사용한 경우의 에러트래킹의 연산량에 비하여 매우 적으나 영상의 질은 동일하게 유지된다.

## Abstract

In this paper, an advanced error tracking algorithm by using feedback channel was proposed for error resilient transmission. Using this proposed algorithm, the propagation of errors were reduced within the decoded data over bit error prone network. The addresses of corrupted blocks are reported to encoder by decoder.

With negative acknowledgments of feedback channel, the encoder can precisely calculate negative acknowledgments and track the propagated errors by examining the backward motion dependency for proper pixel in the current encoding frame. The error-propagation effects can be terminated completely by INTRA refreshing the affected macro-blocks by using proposed error tracking algorithm.

By utilizing the selective four-corner error tracking approximation, the error tracking computations of the proposed algorithm is less than that of the algorithm using full pixel without substantial degradation in video quality. The proposed algorithm can track errors rapidly and accurately.

*Index Terms* : error tracking, error propagation, error concealment, H.263

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논문접수 : 2004. 1. 6.
심사완료 : 2004. 1. 12.

# I. Introduction

H.263[1] is a low bit-rate video coding standard for video conferencing over various networks. H.263 is the most common input format for bit rates below 64kb/s and bit stream syntax of H.263 is based on the hierarchical video multiplex as shown in Fig. 1. This assumption is realistic since the bit stream syntax of H.263 allows resynchronization at the beginning of GOBs. With increasing time, the error inside a particular GOB propagates across the border in a spatial direction and may, in a worst case, spread over the entire frame.

Each MB is processed according to Fig. 3. Significant compression gains can be achieved by using motion estimation and motion compensation, discrete cosine transform(DCT), and variable length coding(VLC). However, this technique is inherently extremely sensitive to the channel disturbances. An error in the H.263 video stream may propagate in both spatial and temporal domains and consequently cause serious quality degradation. Due to the use of VLC, the erroneous compressed data usually cannot be correctly decoded until the next resynchronization point, i.e., when the start of the following group of blocks(GOB) appears. Consequently, all data in the following blocks of the same GOB are usually destroyed in the spatial domain. Moreover, because of the out-of-synchronization between the encoder state and the decoder state, the errors may also propagate in the temporal domain.

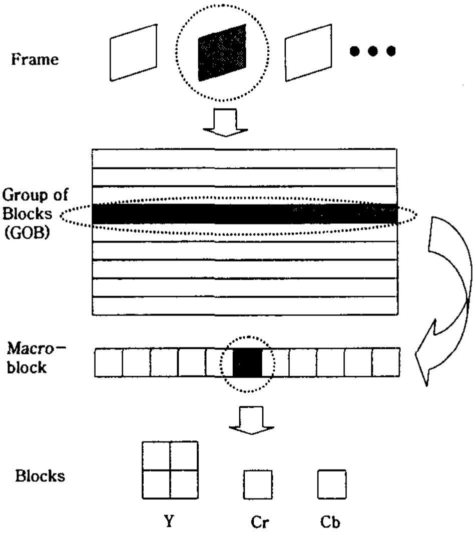


Fig. 1. Video multiplex of H.263 for QCIF.

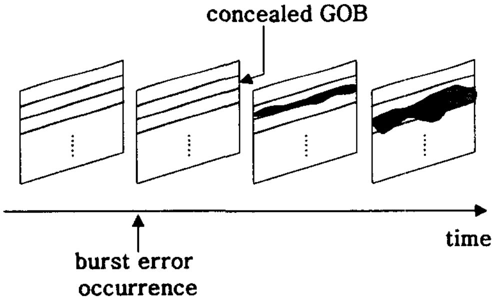


Fig. 2. Spatial-temporal error propagation

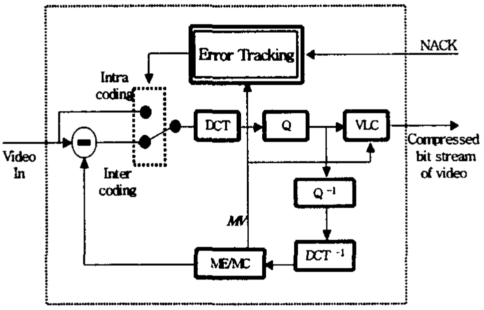


Fig. 3 Block diagram of H.263 encoder with error tracking.

In general, errors existing in the decoded bit stream are hardly perceived by the encoder. Thus, at the decoder a macroblock(MB) may be over written by the damaged area pointed by the received motion vector(MV).

Consequently, the reconstructed video quality is deteriorated and the error-propagation continues. Several techniques, such as unequal error protection[2], ARQ[3], and error concealment[4]-[6], have been proposed to limit the effects of error propagation, The first two techniques, however, require bitstream syntax modifications and are not compatible with the standard. The error-concealment techniques at the receiver have been proved their ability to effectively reduce the error damage. Most of the error-concealment techniques utilize the information from neighbors in one or more domains to estimate the erroneous blocks. Unfortunately, although these concealment techniques can substantially improve the video quality, they hardly avoid or even terminate the temporal error propagation completely.

A different approach to avoiding error accumulation is to INTRA code the video with the penalty of rate increase. The H.263 standard requires that each MB in P-pictures shall be coded in INTRA mode at least once for each 132 frames. A sequential INTRA update generates a smooth bandwidth profile, but it takes long time to recover from errors.

Steinbach et al. proposed an error-compensation strategy based on a feedback channel[5]. With the analysis of temporal dependencies of MBs in successive frames, this feedback approach leads to rapid quality recovery by reconstructing the error propagation effects at the encoder and by selecting seriously affected regions to be INTRA refreshed. However, in such an algorithm, the assumption that errors distribute uniformly within each MB results in over-estimation of error-propagated areas. Besides, the forward dependency trees may also span too widely and grow to unnecessarily large sizes, especially for those MBs with large MVs and the networks with long round-trip delays.

The Precise and Fast error tracking proposed by Pao-Chi Chang et al., is based on the pre-stored MVs only and traces the motion dependency for each pixel backward to the unsuccessfully decoded frame. The encoder can thus exactly evaluate how seriously each MB in the current encoding frame is affected. At last, all or parts of the contaminated MBs can be selected to refresh by INTRA-mode coding. It is important to note that this algorithm is able to track the actual error propagation and effectively terminate it. In fact, precise error recovery can also achieved by re-encoding the last frames after a feedback acknowledgment arrives. However, the computational complexity is much higher. The fast algorithm to further reduce the computation complexity and to decrease the memory requirement by utilizing the approximation of MBs corner tracking and the assumption of constant-velocity motion model. But This algorithm cannot find exact error region. In addition to, need to assumption of constant-velocity motion model.

In this letter, The proposed strategy is like fundamental direction with precise and fast error tracking proposed by Pao-Chi Chang. When the encoder evaluate how seriously each MB in the current encoding frame is affected with back tracking scheme, we proposed accurate and fast algorithm by utilizing the selective four-corner tracking approximation. The proposed algorithm is able to track the actual error propagation and effectively terminate it and can also achieved by re-encoding the last frames after a feedback acknowledgment arrives and further can reduce the computation complexity and to decrease the memory requirement.

## II. Accurate and Fast Error-Tracking Algorithm

The coding scheme of the H.263 encoder with the error tracking control is shown in Fig. 3. Negative acknowledgments(NACKs) with the information on unsuccessfully decoded image blocks are sent back to the encoder via a feedback channel. Once a NACK is received, the encoder performs error tracking to determine whether the current encoding MB is contaminated by the erroneous MBs in the past frames. If this happens, this MB becomes a candidate for INTRA-refresh coding.

The dependencies of MBs in successive frames are essential to the error tracking. The MV of the MB produced in the motion estimation indeed provides adequate information for accurately tracing error propagation in the encoder.

Fig. 4 illustrates how to execute the PET for pixels *K, P*, and *M* by employing the backward motion dependencies for a QCIF format video with 99MBs. Any pixels motion dependency can be found by tracing back the MV of the MB it belongs to.

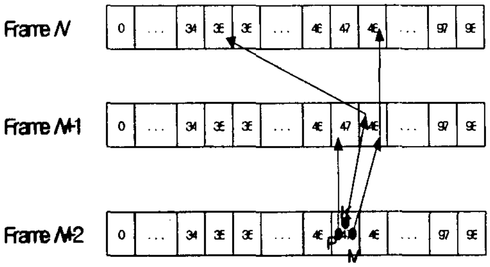
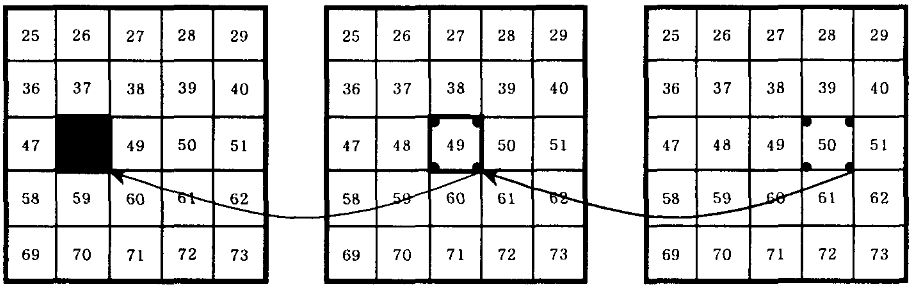


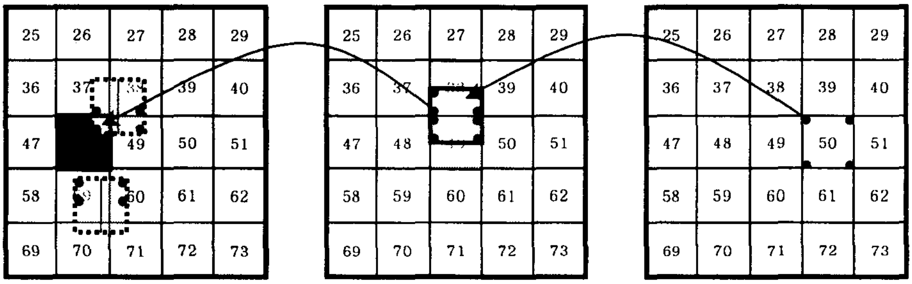
Fig. 4 Illustration of pixel-based backward motion dependency tracking

Assuming that, in Fig. 4, the prediction of MB 47 in frame *N*+2 is obtained from MB 47 and 48 in frame *N*+1. MB 48 of frame *N*+1 refers to MB 35, 36, 48, and 49 in frame *N*+2 The encoder receives a NACK that indicates an error occurred at MB 35 of frame *N* while working on frame *N*+2 Thus, we can backward trace every single pixel in MB 47 of frame *N*+2 along the corresponding paths, i.e., the corresponding MVs, to see if it refers to the erroneous area, i.e., MB 35 of frame *N*. Based upon the illustration, pixel K in Fig. 4 is then determined to be a contaminated pixel while pixel P is not. Likewise, the backward motion dependency structure for each pixel is built as in Fig. 4 and the error tracking procedure is performed for all pixels in frame *N*+2

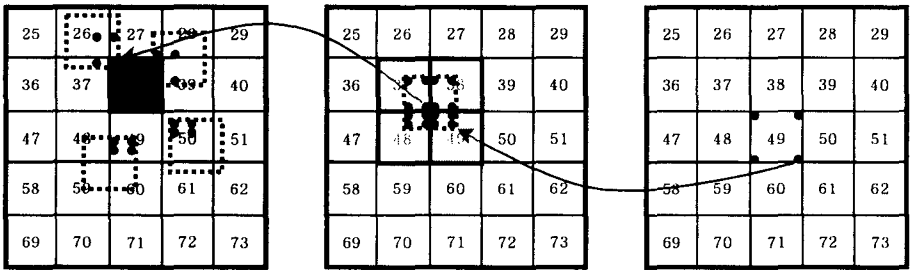
The backward motion dependencies, i.e., the paths shown in Fig. 4, can be mathematically designated as reference paper[10].



(a) In the case of examining four corners



(b) In the case of examining eight corners



(c) In the case of examining sixteen corners

Fig. 5 Each case of examine pixels

The PET algorithm proposed by Pao-chin chang et al.[10] examines all pixels. After all, PET algorithm bring about overhead of computation complexity and, in the same paper, FET algorithm decrease Accuracy. In according to, we propose AFET algorithm that operate backward error tracking with selective pixel, not all pixel. When we do backward error tracking, it is unlikely that all four corners refer to error-free(EF) area. while the inner pixels in a MB refer to contaminated area. Hence backward motion dependencies are examined for only four corners of a MB, instead of each pixel, to speed up the tracking process. The follow, it is examined for four, eight, sixteen corners of a MB according to each case. Each case is shown in Fig 5. The Fig.5(a) depict the case of four corners. The case of Fig. 5(a) bring unlikely. This case will isnt most variation of motion. Fig. 5(b) depicts the case of four corner and Fig. 5(c) depicts the case of sixteen corner. In This case is general case. Others case is included the Fig. 5(c). This pixel-based error tracking strategy following each case can be operated backward error tracking without accuracy loss and also, can be speed up backward error tracking.

In summary, the AFET procedures for each encoding frame can be listed as follows:

```
INT i;
Initialize MB in current frame;
Examine for only four corners in error block;
 While(until detect the frame which incurred
 error) {
      For(i = 0 ; i < number of MBs in
      frame N ; i++) {
If(In case of four corners) {
       examines pixels of the four corner;
     If(contaminated MB) {
       do intra-coding of contaminated MB;
             }
}
Else If(In case of eight corners) {
examines pixels of the eight corner;
If(contaminated MB) {
 do intra-coding of contaminated MB;
               }
}
Else {//In case of remains
examines pixels of the sixteen corner
If(contaminated MB) {
do intra-coding of contaminated MB;
               }
}
}//end of   for()
  }//end of   while()
```

In spite of the fact that this algorithm requires tracing the motion dependency for each case, it actually exhibits very low complexity because only simple comparison sentence are needed and reduce number of examined pixel.

Briefly speaking, this AFEF algorithm has the advantages of no extra memory requirement for storing MVs and a very low computation complexity.

## III. ANALYSIS and EVALUATION

In our analysis and evaluation, the following scenarios are compared:

1) AFET_Best
2) AFET_Worst
3) AFET_Average
4) PET
5) FET

In the scenarios, AFET_Best has the best case in the AFET algorithm, AFET_Worst has the worst case in the AFET algorithm, and AFET_Average has the average of an account of the each other case with the weight.

In the Fig. 6, we can show the AFET_Best is the same as the FET case, In spite of Worst case of AFET is less than number of examining pixel PET. Therefore, The AFET algorithm improved about 75% computation complexity more than PET. As compared AFET with FET, we can find excellent performance of the AFET algorithm. In addition to, In spite of not examining all pixels, the accuracy of AFET is 100 percentage. AFET has the round trip time lower than PET and similar to FET. The AFET algorithm can protect the actual error propagation and reduce considerable computation complexity.

Therefore, An AFET algorithm is robust strategies in error-prone environment.

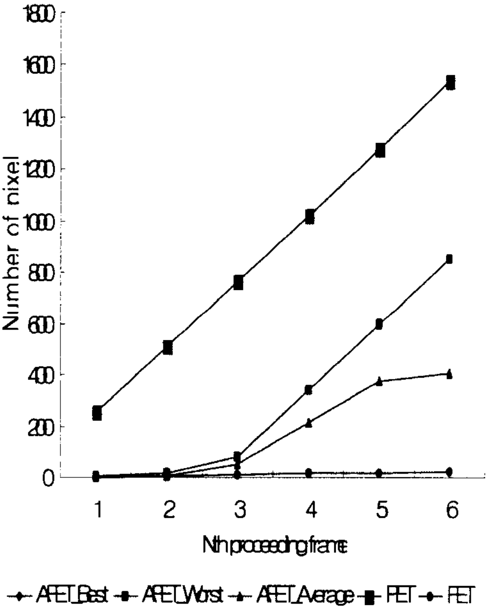


Fig 6. Number of pixel of *N*th proceeding frames that is each case.

## IV. CONCLUSION

To protect the error-propagation effects, accurate error tracking is needed in the INTRA refreshing method. We have presented an accurate and fast error-tracking coding scheme with a feedback channel for the H.263 video transmission. By utilizing the MVs generated in the regular encoding process and by tracing the backward motion dependency for the proper pixel which is placed the border among MBs, contaminated MBs are accurately tracked and the error propagation is terminated through INTRA coding the affected MBs. This approach can achieve rapid error recovery. In addition, the proposed accurate and fast error-tracking algorithm approximates the actual error propagation and saves considerable calculations. In short, due to its low memory requirement and computation complexity, the accurate and fast error tracking technique is especially suitable for real-time implementation.

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