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Error concealment for SNR scalable video coding

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Abstract

This paper proposes an efficient error concealment method for SNR scalable coded video. The algorithm adaptively selects a proper concealment candidate from the base or the enhanced pictures to conceal the artifact of a lost enhancement block. To determine the best concealment candidate, we propose a trial process in which the concealment candidates are examined based on two criteria: (1) picture continuity at the border of concealed macroblocks, and (2) to satisfy the coding distortion bound of the base layer coefficients when they are available. For the latter, requantization of the concealed picture with the base layer quantizer step size and its dequantized pixels should result in zero distortion. We have implemented the method on a proposed SNR scalable H.264 video codec and compared the decoded video quality against just copying the base layer pixels into the enhanced picture. Simulation results show that the proposed method can achieve a considerable improvement by up to 3 dB especially in situations where the enhancement layer contains a large portion of the picture information. This will make scalable video transmission more successful over unreliable channels.

Keywords: Error/loss concealment; SNR scalability

1. Introduction

In video transmission over a variety of communication channels, receiving all the video data is not guaranteed and parts of these data may be lost or some bits may be received in error. To address this problem several efforts have been considered to make video bitstreams robust to channel errors. Scalable coding is one of the successful methods of delivering video contents over heterogeneous channels and provides a robust error protection tool [5,3,14].

A scalable video coder provides a base layer that contains a decodable video with low quality and one or more enhancement layers that contain additional data necessary to improve video quality. It has been shown that if the base layer is better protected than the enhancement layers, a more successful video transmission will be

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achieved [14,6,7]. However, there is still a significant probability that video contents are lost, hence effective error concealment methods should be applied in the decoder to visually minimize the impairments of the lost parts of each picture. In nonscalable codecs, in an intraframe, the correctly received neighboring macroblocks (MBs) are used to conceal a lost MB, and in an interframe, typically the MBs of the previous frames are used [11,12,2,10].

In a scalable codec when an enhancement MB is missed, the concealment candidates can be among the blocks from the previous enhanced frame or the current frame of the base layer. The straightforward method is to replace the enhanced block with the corresponding base layer reconstructed block. We call this *upward* method. Since the base layer is often more protected and so is more reliable than the enhancement layer, selecting the concealment pixels from the enhanced pictures might even increase the distortion. However, if the enhanced reference frame is received correctly it can generate a better concealment block. In [4] the loss concealment is carried out from the previous enhanced picture only if it is received correctly, otherwise, the current reconstructed picture is used. In [13,1] by assuming that the base layer data are error free, the enhanced concealment block is calculated from the base and the enhanced pixels. The concealment method of [8] also uses the texture data of both layers, but does not efficiently exploit the available motion vectors (MVs).

In this paper we propose a more efficient error concealment method for the enhancement layer. Firstly, if the enhancement layer MB is correctly received but in the absence of the base data, instead of ignoring the enhancement data, we use them as efficiently as possible. Secondly, to conceal a lost MB in the enhancement layer, the available data of both base and enhancement layers are examined and the best one is selected. We propose an efficient trial process in which the loss concealment candidates among the base and enhancement motion compensated pixel blocks are examined based on two criteria: (1) picture continuity around the concealed block borders, and (2) compatibility of coefficients with the base layer. Simulation results show that this method of error concealment has a significant improvement over the conventional concealment methods. The proposed method has the advantage that it considers the possible losses in the base layer as well as the enhancement layer and also adaptively uses all the available data for concealment in all circumstances.

The remainder of this paper is organized as follows. Section 2 describes the employed base layer error concealment which is the basis of our enhancement error concealment. Section 3 describes how the correctly received enhancement data are used in the absence of the lost base data as well as classifying the different error situations and their corresponding loss concealment candidates. In Section 4 the proposed error concealment trial process to select the best candidate is described. Finally, Section 5 provides the simulation results followed by a conclusion in Section 6.

2. Error concealment in the base layer

As mentioned earlier, the base layer of an SNR scalable coded video is exactly a standard nonscalable bitstream. Therefore, for its error concealment we employed the proposed algorithm of [10], in which the motion compensated blocks with all the surrounding MVs of a lost MB are examined. The neighboring MV that results in a minimum edge discontinuity [9] would be selected as the recovered MV and its motion compensated block is chosen as an estimate of the lost MB. As Fig. 1 shows the edge discontinuity can be

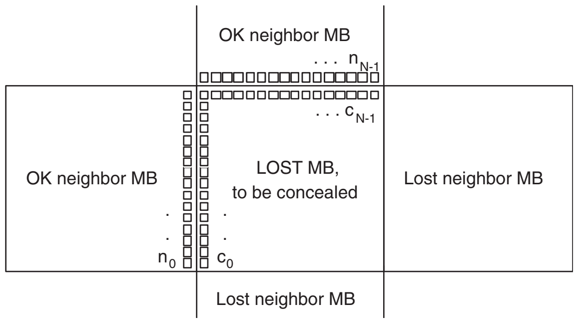

Fig. 1. Edge discontinuity, the center MB is lost and left and upper neighbors are correctly received.