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An adaptive motion compensation method using superimposed inter-frame signals

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Abstract In theory, multi-hypothesis motion compensation prediction (MHMCP) can enhance the prediction quality of motion compensation prediction. Traditional MHMCP methods use fixed weightings for the linear combination of the multiple signal sources which may not be optimum. Moreover, MHMCP requires the transmission of more than one motion vector, which will increase the side information to be transmitted. We discovered that using estimated distortion ratio, a weighting pair can be estimated adaptively for the linear combination of two signal blocks to form a prediction block with a lower distortion. The proposed MCP method does not require the transmission of additional side information yet has a better prediction accuracy than conventional motion compensation prediction. In addition, the proposed method has relatively low algorithmic decision overhead. It can be implemented in hardware easily to support the realization of real time high-quality video coding.

Keywords Video coding · Real time · Motion compensation prediction · Multi-hypothesis · Motion estimation

1 Introduction

By the Multi-Hypothesis MCP (MHMCP) theory, arbitrary number of prediction signals can be linearly combined to improve the performance of MCP [1, 2]. Bi-directional prediction for B-frames is one of the applications of MHMCP in which two prediction signals, one from the reference frame before and the other from the reference frame after the B-frame, are superimposed to form a prediction signal with better prediction quality. MHMCP requires the estimation of multiple motion vectors. The best prediction performance can be obtained when all the motion vectors are jointly estimated but this requires very high computation complexity. Suboptimal solutions can speed up the process [3]. In [4], it is reported that MHMCP can work together with variable block size MCP and multiple-reference frame MCP to enhance the efficiency of a rate-constrained coding scheme. Experimental results in [4] show that two jointly estimated prediction signals can achieve up to 30 % bit-rate reduction in coding. In [5], two-hypothesis MCP is used to boost the error resiliency in an error-prone environment. In [6], three-hypothesis MCP is used to reduce the error propagation as well as achieving rate-distortion gain.

In [4], the weighting coefficients applied to the multiple signal sources converge to $1/n$, where n is the number of signal sources. That means an averaging is applied to the multiple signal sources. The same averaging is also used for the linear combination of the multiple signals found by template matching in [7]. In both [6] and [8], fixed optimum weighting combinations for the multiple signal sources are found by empirical methods. However, we are not sure whether fixed weightings can obtain optimum prediction performance for MHMCP because the characteristics and conditions of the signal sources can differ a lot. The second problem of MHMCP is that it requires the transmission of more than one motion vector. As the residual data of MCP are nowadays getting smaller and smaller due to the advance in MCP technology, the increase in the number of motion vectors is very unfavorable. Moreover, most MHMCP methods proposed have very high computational complexity, which is unfavorable, especially for real time video coding applications.

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