Complexity Scalable Motion Compensated Temporal Filtering

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ABSTRACT

Computer networks and the internet have taken an important role in modern society. Together with their development, the need for digital video transmission over these networks has grown. To cope with the user demands and limitations of the network, compression of the video material has become an important issue. Additionally, many video-applications require flexibility in terms of scalability and complexity (e.g. HD/SD-TV, video-surveillance). Current ITU-T and ISO/IEC video compression standards (MPEG-x, H.26-x) lack efficient support for these types of scalability. Wavelet-based compression techniques have been proposed to tackle this problem, of which the Motion Compensated Temporal Filtering (MCTF)-based architectures couple state-of-the-art performance with full (quality, resolution, and frame-rate) scalability. However, a significant drawback of these architectures is their high complexity.
The computational and memory complexity of both spatial domain (SD) MCTF and in-band (IB) MCTF video codec instantiations are examined in this study. Comparisons in terms of complexity versus performance are presented for both types of codecs. The paper indicates how complexity scalability can be achieved in such video-codecs, and analyses some of the trade-offs between complexity and coding performance. Finally, guidelines on how to implement a fully scalable video-codec that incorporates quality, temporal, resolution and complexity scalability are proposed.

Keywords: Scalable video-coding, complexity scalability, motion compensated temporal filtering, memory complexity, MPEG-21.

1. INTRODUCTION

Transmission of multimedia and video in particular over a variety of networks has become a part of today's society. In order to cope with the bandwidth limitations and bandwidth variations over the channels, scalable video codecs that adapt the source to the channel conditions have been proposed in the past and are currently under investigation within MPEG-21[1, 2]. These codecs do not only adapt the transmitted data to the channel conditions, but also allow for meeting a variety of user preferences regarding the quality, resolution and frame-rate of the received video material. From a complementary perspective, more and more mobile devices such as GSM, PDA, … find their place in the market and together with them, the variety of applications operating on these devices keeps on growing. Encoding/decoding video sequences on mobile devices requires scalable coding systems that are adapted to their limited computational capabilities[3]. Moreover, the encoding/decoding requirements may vary over time, as for instance when the battery condition drops, low-power usage becomes a higher priority. This emphasizes another type of scalability that has to be considered in scalable video coding, namely, complexity scalability.
Various scalable video compression systems have been proposed in the recent past, of which wavelet-based architectures based on motion compensated temporal filtering (MCTF) are the most promising. These codecs couple coding performance competitive to that of state-of-the-art non-scalable H.264 codec, with support for quality, resolution and frame-rate scalability[2]. This paper focuses on the complexity analysis of two scalable MCTF-based video codecs,

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