Content-based scalable video streaming in video sensor networks

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In recent years, sensor networks research has emerged as a promising research field and is poised to dwarf previous milestones in the information revolution. These networks consist of many tiny, low-power and inexpensive wireless sensors that are usually mission driven and application specific. Thus they must operate under a set of unique constraints and requirements. One of the most interesting and yet challenging applications of sensor networks is real-time video streaming. The delay-constrained video signal, inherent infrastructure unreliability, frequent variations in the link conditions, low data rates, and the limited amount of energy available to wireless sensor are among the factors that make video communication in such environments particularly challenging. Scalable video coding is considered an attractive coding technique for such environments due to its highly flexible nature and competitive performance to single layer coding of the latest standard H.264/AVC.

Efficient bit stream adaptation and resilience to packet losses are two critical requirements in scalable video coding for transmission over packet-lossy networks. These requirements possess a greater significance in scalable H.264/AVC video bitstreams since missing refinement information in a layer propagates to all lower layers in the prediction hierarchy and causes substantial degradation in video quality. We describe an algorithm to accurately estimate the overall distortion of decoder reconstructed frames due to enhancement layer truncation, drift/error propagation, and error concealment in the scalable H.264/AVC video. The method recursively computes the total decoder expected distortion at the picture-level for each layer in the prediction hierarchy. This ensures low computational cost since it bypasses highly complex pixel-level motion compensation operations. The application of the algorithm to both single- and multi-hop scenarios is considered.

We also present a content-aware scheduling and resource allocation scheme for streaming video to multiple nodes. It uses a gradient-based scheduling framework in conjunction with scalable video coding techniques to provide multiple high quality video streams over a range of operating conditions. A main component of this work is to show that by appropriately ordering the data in a scalable coded bitstream, it can be made more amenable to efficient content-aware gradient-based scheduling and resource allocation techniques.

Experimental results will be presented demonstrating the efficacy of the developed algorithms. A number of the research challenges and opportunities will be discussed.