Chapter 3
Multiple Description Coding for Multipath Video Streaming

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ABSTRACT

This Chapter addresses robust video coding and adaptation of compressed streams in multipath communications environments, using Multiple Description Coding (MDC). A review of Multiple Description (MD) video coding is presented, covering different video coding approaches. Different path diversity topologies and MDC networking applications are described, including MD video adaptation schemes to operate at network edges, for robust video streaming. A multi-loop architecture for Advanced Video Coding (AVC) to prevent drift distortion accumulation is also described. A simulation study of MDC for AVC is presented to evaluate the coding efficiency, the effects of distortion propagation and streaming performance in lossy networks. These research findings extend the current state-of-the-art MDC methods by developing new networking capabilities in different application scenarios maintaining coding efficiency, and increasing error robustness, when subject to transmission losses.

INTRODUCTION

In the current heterogeneous communication environments, the great variety of multimedia communications combined with fast evolution of networking architectures and topologies, give rise to new problems related to the various elements of the communication chain. In media networks, wireless LAN or last generation wireless access channels, different levels of quality of service due to bandwidth constraints, delay, jitter and packet loss, require increased error robustness to guarantee acceptable user experience. Moreover, different terminal capabilities and convergence between traditional TV sets, Internet TV and

mobile video streaming, also pose challenges in content adaptation and technology constraints, such as those resulting from limited processing capacity, memory, display size and power autonomy. New emerging video streaming services and applications using both centralized Content Delivery Networks (CDN) (Pathan, Buyya, & Vakali, 2008) and distributed infrastructures, such as Peer-to- Peer (P2P) Networks (Lua et al., 2005) have been developed in recent years. In this context, path diversity is seen as an efficient transmission scheme capable of providing high adaptability to network reconfiguration, and also error robustness and load balancing. In CDN schemes, a high number of access users leads to adoption of streaming schemes using server diversity. On the other hand, P2P networks have to deal with problems related to network management and configuration, because a user may act simultaneously as network receiver and network node to another peer. Also, each node can join/leave the network at any instant, forcing dynamic network reconfigurations. Furthermore, taking into account the network dynamics, the massive dissemination of high quality multimedia content combined with the access ubiquity poses new challenges to video coding methods in terms of efficiency, error resilience and quality of service.

This Chapter addresses robust video coding and adaptation of compressed streams in multipath communications environments, using *Multiple Description Coding* (MDC). A review of Multiple Description (MD) video coding is presented, covering different video coding approaches. Different path diversity topologies and MDC networking applications are described, including MD video adaptation schemes to operate at network edges, for robust video streaming. A multi-loop architecture *for Advanced Video Coding* (AVC) to prevent drift distortion accumulation is also described. A simulation study of MDC for AVC is presented to evaluate the coding efficiency, the effects of distortion propagation and streaming performance in lossy networks. These research findings extend the current state-of-the-art MDC methods by developing new networking capabilities in different application scenarios maintaining coding efficiency, and increasing error robustness, when subject to transmission losses.

Multiple Description Coding (MDC) has recently been given particular attention by the research community, as a promising approach to improve the quality of multimedia streaming over error-prone networks with path diversity. In MDC, a video signal is typically encoded into several independent descriptions, i.e., compressed streams, where each one can be delivered over a separate channel making use of available paths. If joint decoding of all descriptions is done at the receiver, then the quality of the reconstructed signal is higher than that obtained from individual decoding of any single description.

Figure 1 shows an MDC application scenario using two descriptions transmitted over different paths. Streaming server feeds the client with two logical paths. Each path is defined over distinct network branches between client and server, passing through intermediate network nodes. Usually, each branch is characterized by the available bandwidth, delay and packet loss rates. These interesting features of MDC are accomplished at the cost of higher coding rate, i.e., redundancy, when compared to classic single description coding (SDC). This is essentially driven by networks with multiple available paths from the sender to the receiver (e.g., mesh and overlay networks) and multiple source coding representations (i.e., MDC) that go beyond the classical paradigm of SDC, where one source is encoded into one single representation. The use of MDC in path diversity video networking is a competitive alternative with other network-adaptation schemes, such as scalable video coding (SVC) (Schwarz, Marpe, & Wiegand, 2007) for robust streaming over time-varying networking conditions. In general, the main difference between SVC and MDC lies in the inter-dependency of SVC layers in contrast with independent MDC descriptions. MDC is also an interesting approach whenever retransmission schemes are not a viable

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