Chapter VIII
Semantic-Based Video Transcoding Architectures for Quality of Service Applications in Mobile and Wireless Video Communication

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ABSTRACT

Delivering streaming video over wireless networks is an important component for most interactive multimedia applications running on personal wireless handset devices. Such personal devices have to be inexpensive, compact, and lightweight. Wireless channels have limited bandwidth and a high channel bit error rate and limited bandwidth. Delay variation of packets due to network congestion with the high bit error rate lessens the quality of video at the handheld device. Mobile access to multimedia content requires video transcoding functionality at the edge of the mobile network for interworking with heterogeneous networks and services. Under certain conditions, the bandwidth of a coded video stream needs to be drastically reduced. We present several efficient mechanisms for improving the quality of service (QoS) delivered to the client by deploying content-based transcoding schemes. The proposed approaches are performing the required transcoding based on the video content. Some approaches study the texture and temporal features. Other approaches perform object detection in order to determine the important objects to achieve semantic transcoding. The quality of the reconstructed images is remarkably similar to results that have been processed by the expensive and high performance transcoding approach. Exceptional performance is demonstrated in the experiment results. Extensive experiments have been conducted, and the results of various video clips with different bit rates and frame rates have been provided.

INTRODUCTION

Recent advances in mobile communications and portable client devices enable us to access multimedia content ubiquitously. However, when multimedia content becomes richer, including video and audio, it becomes more difficult for wireless access to communicate due to many practical restrictions. Most important of all, wireless connections usually have a much lower bandwidth compared to wired ones, and communication conditions change dynamically due to the effect of fading. Another practical factor is that portable client devices are equipped with limited computing and display capabilities. Most portable devices are not suitable for high-quality video decoding and displaying.

Concerning the heterogeneity issue, the previous era has seen a variety of developments in the area of multimedia representation and communication. In particular, we are beginning to see delivery of various multimedia data for all types of users and conditions. In a diverse and heterogeneous world, the delivery path for multimedia content to a multimedia terminal is not straightforward, especially in the mobile communication environment. Access networks vary in nature, sometimes limited, and differ in performance. The characteristics of end-user devices vary increasingly in terms of storage, processing capabilities, and display qualities. Finally, users are different by nature, showing dissimilar preferences, special usage, disabilities, and so forth.

However, the major traffic component in multimedia services is undoubtedly due to visual information encoded and delivered either as video frames or visual components.

In order to cope with the current heterogeneous communication infrastructure and the diversity of services and user terminals, different transcoding mechanisms are necessary at Internet working nodes (Han, Bhagwat, LaMaire, Mummert, Perret & Rubas, 1998; Warabino, Ota, Morikawa & Ohashi, 2000).

Whenever a client terminal or its access channel does not comply with the necessary requirements, media transcoding must be triggered to allow interoperability. This is basically an adaptation function operating on coded streams such as MPEG1/2 (ISO/IEC 11 172, 1993; ISO/IEC 13 818, 1995) for matching a set of new constraints, different from those assumed when the signals were originally encoded. Since many multimedia services are not specifically meant for mobile systems, in general the channel bandwidth required for transmission as well as the coded signal format do not match mobile applications (Correia, Faria & Assuncao 2001; Shanableh & Ghanbari, 2000). Because of traffic characteristics such as high bit rate, video will be the dominant traffic in multimedia streams; hence, it needs to be managed efficiently. Obviously, for efficient utilization of network resources, video must be compressed to reduce its bandwidth requirement. Although several compression techniques exist, MPEG (Han et al., 1998; ISO/IEC 13 818, 1995; Warabino et al., 2000) is one of the most widely used compression algorithms for network video applications. A wireless handset device (e.g., personal data assistant) can integrate voice, video, and data into one device. In contrast to solely text information, multimedia data can tolerate a certain level of error and fading. Therefore, although a wireless network has a high bit error rate when compared to a wireline one, it is possible in a cost-effective manner to transmit multimedia over wireless networks with an acceptable quality.

As mentioned earlier, although the constraints imposed by the heterogeneous nature of the communication network are quite different from those arising from the diversity of user terminals and the problem of fading and error in wireless channels, all of them may be dealt with using the so-called transcoding mechanism. In this work, we address the problem of MPEG stream video transcoding where the bandwidth of a coded video stream must be drastically reduced in order to cope with a highly