A Framework to Measure and Estimate Video Quality in SVC Real-Time Adaptive Systems

Alberto Álvarez, Informatics Department, University of Oviedo, Gijón, Spain
Laura Pozueco, Informatics Department, University of Oviedo, Gijón, Spain
Sergio Cabrero, Informatics Department, University of Oviedo, Gijón, Spain
Xabiel G. Pañeda, Informatics Department, University of Oviedo, Gijón, Spain
Roberto García, Informatics Department, University of Oviedo, Gijón, Spain
David Melendi, Informatics Department, University of Oviedo, Gijón, Spain
Gabriel Díaz, Electrical and Computing Department, Spanish University for Distance Education (U.N.E.D), Madrid, Spain

ABSTRACT

Effectively adapting the content to network conditions in real-time is an important matter in best-effort networks like the Internet. Scalable Video Coding (SVC) is an interesting alternative to implement such systems. However, some problems of the performance evaluation of SVC based adaptive systems have not been solved. The authors review the main efforts directed to measure video quality on SVC related systems and discuss the limitations of each one. This paper elaborates a framework to measure video quality metrics in real adaptive SVC based streams. An estimation method for full reference video quality metrics is proposed. This method reduces reference information required and it is able to provide real-time accurate results simply using metadata regarding the video quality of the reference layers. The video quality of several streams that have been generated using a real-time adaptive system is first measured with the elaborated framework and then estimated with the proposed method.

Keywords: Adaptive Streaming, Emulation, Framework, Full-Reference Estimation, QoE, Scalable Video Coding, Video Quality

DOI: 10.4018/ijbdcn.2014010103
INTRODUCTION

New developments in video coding and networking technologies have helped the proliferation of new systems offering multimedia content on the Internet. New services range from high quality on-demand services to Internet TV. Apart from services, new presentation environments are being defined, extending computer displays to larger TV screens and more eager viewers, seeking an optimum experience. For these environments better qualities such as content size and details, are demanded and service managers have to ensure the quality of the service (Pañeda et al., 2007). However, with the increased quality of contents comes the drawback of resource constraints leading to network congestion, jitter and packet losses which harmfully affect video quality.

Nowadays, Scalable Video Coding (SVC) is considered one of the most advanced video coding technologies. With its distinctiveness, SVC is allowed to provide an efficient layered representation of a video within a single stream. Layers offer different qualities, in terms of temporal and spatial resolution or quality space. Layers in a single stream can be added or removed to obtain higher or lower quality streams. SVC standard has originated numerous novel ideas in the field of video communication. It has been seen as a very flexible technology for diverse multimedia applications. The layered approach has proved appropriate for a growing market in differentiated services targeted for specific environments. The same coded sequence can easily be adapted for different screen sizes or different qualities when, for example, constrained on processing power of a target device.

A variety of SVC adaptive systems have been proposed leveraging the potential of layered encoding. The combination of SVC technology, or any other scalable codec (Azni et al., 2009), with network congestion estimation algorithms permits to build adaptive systems which are able to suit the media content to network conditions at each moment. This technique helps to avoid most of the harmful packet losses. Some solutions use client feedback to estimate network congestion and act on the server (Pozueco et al., 2013); others implement network proxies that perform the adaptation (Kuschnig et al., 2008). As a result, the end-to-end quality is potentially improved.

As happens with any new developed codec and transmission technology, its benefits need to be assessed in different ways. Both coding and transmission processes impose distortion on the resulting video. Video Quality (VQ) metrics are the most useful metrics to quantify video distortion. VQ metrics are related to Quality of Experience (QoE), as they are entitled to measure the video quality including the user’s assessment of distortion. Most useful VQ metrics include objective measures that provide an estimation of the expected subjective quality. Full Reference (FR) metrics are thought to be the most reliable metrics. On the negative side, these metrics require access to the original unimpaired sequence, which in real-time/live services is complicated. Peak Signal to Noise Ratio (PSNR) and Structural Similarity Index (SSIM) are examples of objective full reference metrics focused on evaluating image quality that have also been extensively used to assess video quality. More advanced metrics such as MOVIE (Seshadrinathan & Bovik, 2010) introduce temporal and spatial considerations. Therefore, it is thought to be more accurate for video sequences than the metrics merely inherited from image quality assessment, such as PSNR.

Nevertheless, the usage of full reference metrics with SVC adaptive systems is not straightforward. Besides regular error concealment problems, temporal and spatial adaptations need to be compensated before extracting VQ metrics. SVC VQ assessment in literature is basically restricted to analyze independently the quality of different layers or their cross-combination. Other works seek to emulate adaptive behavior or use trace-based analysis. Measuring VQ in real adaptive streams comprising both losses due to transmission errors and dynamic layer variation according to network conditions is a key feature to evaluate.
Dual-Hop and Multi-Hop Cooperative Spectrum Sensing with an Improved Energy Detector and Multiple Antennae-Based Secondary Users

Is Regulation a Roadblock on the Information Highway?
www.igi-global.com/chapter/regulation-roadblock-information-highway/21655?camid=4v1a