Abstract

Video streaming applications are becoming more and more popular in consumer electronic devices with the advancement of video coding and wireless communication technologies in recent years. As end viewers always prefer to watch a consistent visual quality[1] stream under strict bandwidth constraints, delivering such a constant quality media under the constraint of a given target bitrate and provides a unique challenge for the video service providers. In this context, two novel rate control mechanisms are proposed for bandwidth constrained video streaming applications by employing hierarchical coding structures in multi-pass and single-pass encoding mechanisms. To achieve the target bitrate with the best quality, the initial quantization parameter is determined by the average spatio-temporal complexity of the sequence, its resolution and the target bitrate. The proposed multi-pass rate control mechanism uses the statistics collected in the first-pass to derive an optimal quantization parameter for encoding the frames in the second-pass while the single-pass rate control mechanism periodically estimates the number of bits that would be necessary to encode a frame for a given spatio-temporal complexity and quantization parameter. Simple linear estimation models are further employed to update the frame quantization parameter values in an adaptive manner, resulting in a smoother variation among these values and a better visual quality. The experimental results demonstrate that the proposed rate control mechanisms outperform the traditional rate control scheme in the reference software in terms of peak signal-to-noise ratio and consistent perceptual visual quality while meeting the bitrate constraint. Finally, the proposed rate control mechanisms are validated through implementation on a miniature wireless test-bed.

Accurate assessment of video quality has become a crucial concern for the video service providers with the increasing demand for video streaming applications. The video service providers are always interested in evaluating the quality of a video from an end viewers' perspective since reliable assessment of video quality plays an important role

[1] an objective measure of perceived video degradation compared to the pristine video

in meeting the agreed quality of service and in improving the end viewers' quality of experience. Consequently, video quality assessment models which evaluate the perceptual quality of a video as perceived by human observers have increased in importance. In this context, two no reference video quality assessment models, namely, feature extraction based predicted video quality measure and feature extraction based predicted video quality measure with encoding dimension adaptation are proposed for predicting the quality scores of a distorted video before the adaptation of its encoding dimensions and after the dimensions adaptation respectively. For video quality evaluation, both of the models extract all the spatio-temporal distortions and content characteristics from the video to quantify the initial frame level quality scores. A multi-stage temporal pooling mechanism thereafter transforms the frame level quality scores of a video into video level quality scores corresponding to each of the distortions in a modular way to account for both viewers sensitivity to quality degradation and saturation effects. Finally, a trained neuro-fuzzy model outputs the predicted video quality score according to the pooled frame level quality scores. The performance evaluation of the proposed models with regard to their efficacy in predicting the video quality scores tested on publicly available video quality databases have shown a strong correlation with the subjective scores.

A quality of experience driven rate adaptation approach is proposed for adaptive video streaming which jointly considers both bandwidth savings and video quality adaptation for the rate adjustment, beneficial to both video service providers and subscribers. At each decision epoch, the adaptation algorithm accumulates the time varying quality of experience of a viewer by accounting for all the impairments, namely, initial delay, quality transitions and playback interruptions, which commonly occur during the playback of a video in adaptive video streaming. Based on the possible bandwidth savings and resulting quality of experience variations, the algorithm decides on to adapt the bit rate dynamically and accordingly maximizes the viewer's quality of experience. Since the proposed adaptation algorithm constructs an optimal path across the segments for adaptation, it also achieves quality of experience fairness among multiple clients in shared bandwidth environments. The experimental evaluation carried out over real-world wireless network environments demonstrate that the proposed adaptation approach can maximize end viewers quality of experience in adaptive streaming, especially, under highly variable throughput conditions.

Keywords: Video Streaming, Spatio-Temporal Complexity, Video Adaptation, Video Quality Assessment, Adaptation Algorithm, Quality of Experience