Real-Time Prototype of a Zero-Reference Video Quality Algorithm

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***Abstract*—This paper presents a real-time implementation of a previously described video quality monitoring solution which does not require access to the original video. The prototype is intended to be used in real video network scenarios, for video quality monitoring as well as real-time system enhancement.**

I. INTRODUCTION

Video quality evaluation is an important problem in audiovisual communications. The need for perceptually meaningful objective metrics is broadly recognized, and such measures have the dual role of understanding signal quality in completed algorithm designs and providing an in-the-loop metric for real-time algorithm steering. Content owners as well as content distributors stand to benefit from rapid objective measurements that correlate well with subjective assessments, and further, do not depend on the availability of the original *reference* video.

Our prior work has included a study of the utility and prediction of a functional measure of video quality: mean time between (noticeable) failures, *MTBF* [1-3], and a relation between this intuitive metric and the more traditional five-point scale of video quality (*MOS*). A new video quality metric termed the Automatic Video Quality metric (AVQ) was also introduced as a *no-reference* that had a high correlation of 0.93 with subjective scores of *MTBF* [1, 4].

In this paper, we demonstrate a real-time prototype of this algorithm as applied to QCIF, CIF, SD and HD video formats.

II. VIDEO QUALITY SCALES: *MTBF* AND *MOS*

For assessing video quality, subjective testing is the ideal approach, since it involves real viewers evaluating the end output. Although objective testing for video is more practical, accurate subjective scores need to be collected over an extensive test database in order to observe the effectiveness of objective metrics and to perform additional fine tuning of their algorithms.

Our research recommends a functional quality metric called Mean Time Between Failures (*MTBF*) where failure refers to video artifacts deemed to be perceptually noticeable. This metric is seen to have a direct and predictable relationship with Mean Opinion Scores (*MOS*) (Fig. 1), and they both are observed to have similar standard deviations [1].

The AVQ real-time prototype is being developed by VQ Tech, a startup effort at Georgia Tech

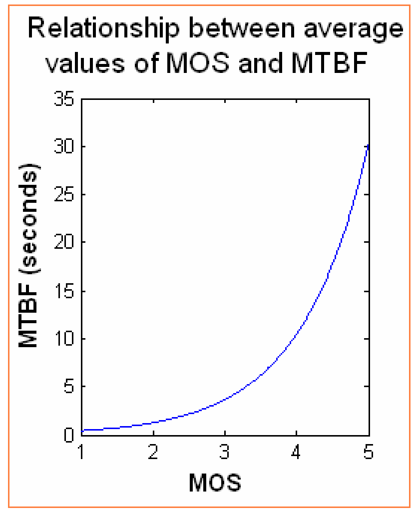

Fig. 1: Relationship between *MOS* and *MTBF*

While both *MOS* and *MTBF* are global metrics, *MTBF* values can be computed over controlled subsets of the test database. This makes *MTBF* a more desirable metric, since the correlations between subjective and objective scores can be measured over different samples of video content. The strengths and weaknesses of an objective metric can be isolated in a systematic manner, so as to fine tune it to be robust to a broad range of video content.

III. VIDEO QUALITY PREDICTION IN NO-REFERENCE METRICS

Significant research exists in the literature in the field of *no-reference* video quality metrics. For instance, parameters from an MPEG-2 bit-stream are used to estimate the mean square error in the received video, and based on the visibility of packet losses randomly injected into the MPEG-2 slices, a classifier algorithm is used to find the visibility of a packet loss based on certain stream parameters [5]. There are some commercial *no-reference* implementations as well [6-8].

Automatic Video Quality metric (AVQ) is a *no-reference* metric that is being developed at Georgia Tech with new spatio-temporal algorithms based on the characteristics of the various kinds of artifacts observed in video transmission systems, and the knowledge of the Human Visual System. A comprehensive understanding of existing objective metrics and their strengths and weaknesses of these metrics has also helped in making AVQ efficient and subjectively relevant.

Correlations between objective scores and subjective scores for different test conditions of compression and network artifacts have also been evaluated, and the Automatic Video

Quality metric (AVQ) has been shown to have excellent subjective attributes. In the example of this paper (fig. 2), the *no-reference* AVQ metric shows a correlation of 0.93 with *MTBF*, exceeding the correlations of *full-reference* metrics PSNR and JND [9] (with respective correlations of 0.69 and 0.88) and the *reduced-reference* Spatial-Temporal Join Metric (STJM [10]) (with a correlation of 0.87 with *MTBF*).

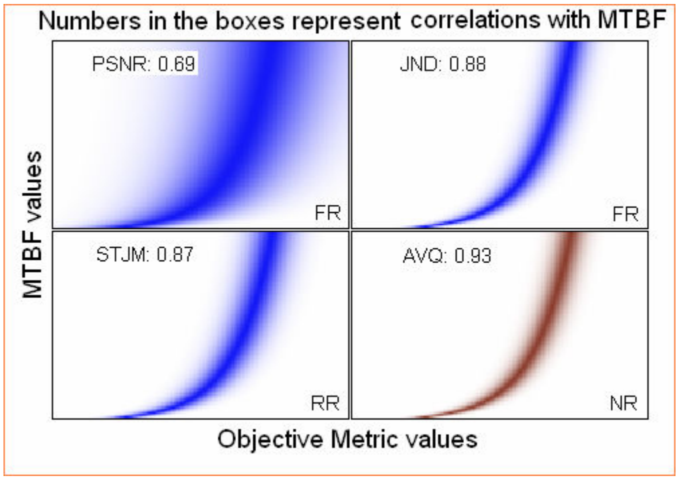

Fig. 2: Scatter plots of *MTBF* and specific versions of objective metrics that were available to us in the *full-*, *reduced-* and *no- reference* cases

IV. Real-Time Prototype

AVQ has been implemented as a real-time prototype that can currently playback an MPEG-2 stream and simultaneously display its quality in intuitive terms, such as *MTBF*. The AVQ metric is also diagnostic in nature, in the sense that it indicates the relative annoyance of compression and network artifacts.

The AVQ prototype has been implemented as a platform independent library written in ANSI C. This AVQ library is currently integrated in the VideoLAN Client (VLC) media Player [11]. The prototype provides a visual feedback of the video quality and the identification of Compression Artifacts (CA) and Network Artifacts (NA) using a Yahoo! Widget as shown in Fig 3.

A screenshot of the AVQ prototype is shown in Fig. 3. Varying resolutions such as QCIF, CIF, SD and HD are allowed as inputs. It has been observed in literature [12] that current video quality metrics are not well suited for newer compression standards such as H.264. Work is in progress to make the AVQ functional and effective for other H.264 coding as well. The AVQ prototype is designed to help in the measurement and enhancement of video in cable, wireless and telco scenarios, complementing existing tools as appropriate.

Demonstration

We plan to demonstrate the real-time AVQ prototype at the conference. We plan to illustrate its capacity with video clips having a wide range of resolutions and quality settings.

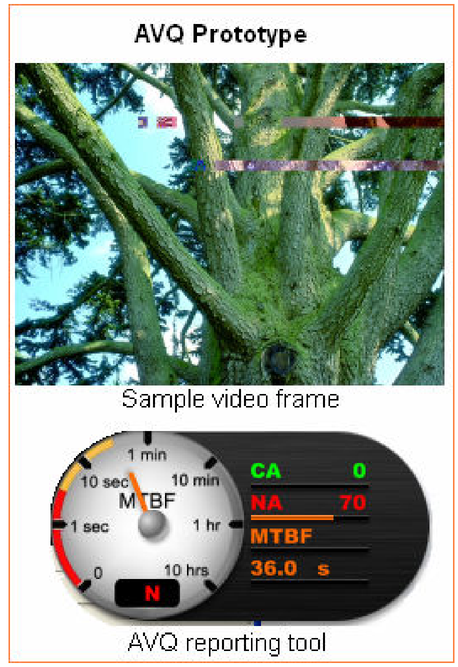

Fig. 3: Video monitoring prototype displaying the instantaneous quality of a video sequence. The absence of compression artifacts is indicated as CA=0, while the occurrence of a network artifact is indicated by NA=70. Numbers for CA and NA range from 0 to 100. The MTBF reading, averaged over the last few Group-of-Frames is 36 seconds

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