Quality of Experience Assessment of Video-Based Applications – Introduction to Research

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Abstract—Most telecommunication operators are moving cautiously with their video-based services rollouts because of video service assurance concerns. Competition between providers is fierce and the key to success is to provide a service with the highest possible level of user satisfaction (QoE – Quality of Experience) to some extent related to network transmission parameters (commonly referred to as QoS – Quality of Service) and to the quality of communicated video data. Providers, of course, can't afford the risk of going to market with a sub-standard TV offer and need to resolve their video quality problems.

I. INTRODUCTION TO THE RESEARCH

The goal of this paper is to present research plans and the current state of the research for Piotr Romaniak PhD thesis. The proposed research aims at a development of a technology and tools to be used by service providers in a user feedback to continuously monitor the overall quality of video based services, offering mutual and measurable benefits. In the scope of the research, video streams quality, in terms of user’s satisfaction level, will be analyzed. Research efforts towards the assessment of end-user perceived quality will be based on the integrated network provider and user approaches, that is hoped to be a significant innovation [2].

II. CURRENT STATE OF THE RESEARCH

In this section preliminary results of ongoing research efforts towards video quality assessment are presented. Firstly, quality metrics operating on decompressed video stream (frames level) for seven isolated distortion aspect are described. Secondly, two types of subjective tests architecture are presented.

A. Algorithms for Isolated Image Distortion Aspects Assessment

The main idea of the work presented in this section is to elaborate a set of the algorithms for independent assessment of selected video distortions being resilient to cross-distortion influence. Algorithms metrics for the following seven distortion types are presented: contrast distortion, blur, granularity, geometry distortion, noise, color distortion and gamma distortion. All the algorithms are Full-Reference type (based on quality comparison between original and reconstructed video stream) and are implemented in MATLAB environment, with a use of Simulink and Image Processing Toolbox.

Contrast distortion algorithm operates on a single frame histogram. Comparison of original and reconstructed frame histogram stretch is a distortion indicator. Assessment of another type of distortion, blur, is based on edge detection method as the amount of edges is an excellent blur indicator. Granularity distortion refers to effective resolution of reconstructed video stream in comparison with effective resolution of original sequence. Geometry distortion algorithm is based on motion vectors, applied methodology is similar to motion estimation used in video compression in the MPEG standard applications. Another type of distortion is noise, evaluated using the Hosaka plots [4]. Hosaka plots allow for evaluation of a noise level and original video stream reconstruction inaccuracy. The quality evaluation is based on quad-tree frame decomposition and is evaluated in square pixel blocks divided into a couple of classes. Color distortion algorithm incorporates Hue component representation in HSV (Hue-Saturation-Value) color space. The color distortion measure is considered as the average of Hue difference histogram for original and reconstructed video frames. The last one, gamma distortion, is based on numeric method of reconstructed video frames gamma estimation. The method consist of several steps. If we assume distortions ranging from 0 do 1, 8 steps allow to assess gamma with an accuracy equal to 0.02 in the worst case.
B. Subjective Tests Architectures

In the scope of the research two types of subjective tests architecture were proposed. Both allow to introduce some certain modifications (distortions) for transmitted video by adjusting QoS transmission parameters. This step is required to generate test set material used in subjective tests.

An overview of the first proposed architecture is presented in Fig. 1. This approach is not a very complex solution and its emulation capabilities are limited. In order to assure diverse transmission parameters Netem software was used. It enables the following QoS parameters to be applied: variable delay, PLR, duplication and re-ordering. Transmitted video stream will be distorted according to the QoS parameters on the fly. Quality of distorted video sequences will be judged by testers during objective tests. Results will serve as a base to train objective algorithms of video quality assessment and to build a model (transition function) [1], [3].

An architecture of the second approach is only a bit more complex, however, its capabilities to emulate any network infrastructure are almost unlimited. Any type of a network architecture can be emulated in ns-2 software. QoS parameters assured by Netem software will be continuously modified according to the information included in a network trace from ns-2. Such a solution allows to modify video stream in a similar way as it was transmitted through the real network of any architecture. Since the video stream is distorted, the scenario becomes analogical to the first one.

For subjective tests purpose existing and standardized methodologies or modifications of existing ones will be considered. The most wide-spread methodology examples are DSIS (Double Stimulus Impairment Scale), DSCQS (Double Stimulus Continuous Quality Scale) and SS (Single Stimulus) [5], [6].

III. Future Work and Open Issues

Assessment of any distortion of video stream quality is not a very challenging research issue, when single distorted sequences are considered (only one type of distortion); however, the task becomes much more complex when one stream is multi-distorted (e.g. both noised and blurred). In order to overcome this problem, a number of compensations will be designed and implemented. Compensations allow to eliminate harmful influence of some distortions, based on improvement of reconstructed (can by applied for fully reversible distortion) or distortion of reference video sequence (for irreversible distortions).

Another step includes transformation of the presented algorithms for isolated image distortion aspects into quality metrics. To achieve this goal, the algorithms have to be trained and verified upon results obtained in subjective tests [1].

Most of the quality metrics commonly used by providers are Full-Reference, examples are PEVQ (Perceptual Evaluation of Video Quality) and VQM (Video Quality Metric) [7], [8]. Quality measuring according to MPQM (Moving Pictures Quality Metric) is referred to as No-Reference, however, it uses only network parameters to assess service quality. To make a conclusion to the above, the most appealing research issues at the time seems to be a design of a No-Reference quality metric that uses quality parameters directly from decompressed video stream.

REFERENCES