EVALUATATION OF THE EFFICACY OF SSIMWAVE SOLUTION TO AUTOMATICALLY ASSESS THE PRESERVATION OF CREATIVE INTENT OF VIDEO CONTENT DELIVERED TO CONSUMERS

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Motion Imaging Technology Council
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1 Background

With the explosive growth of streaming media services, video content producers now have a number of choices to deliver their content to consumers, from traditional cinemas, broadcast cable TV and satellite TV to Internet-based OTT and fiber services. Massive video distribution is a costly process, and video distributors are attempting to reduce the cost by lowering the bandwidth of the video streams being delivered using strong lossy video compression technologies. With the increasing production of 4K and Ultra HD (UHD), high dynamic range (HDR), and wide color gamut (WCG) video content, and the fast penetration of UHD, HDR and WCG TVs into the consumer market, the bandwidth demand has been growing rapidly. Thus an increasing trend in the video delivery industry is to use even stronger video compression configurations. In addition, "smart" pre-processing and post-processing techniques have started to be used to alter the video streams before and after transmission, so as to "ease" the compression process. This has been raising major concerns among content producers because these processes often lead to more data loss, and the preservation of the original creative intent of cinematographers and directors is even more at risk. This is occurring at the very time when the capabilities of consumer displays with HDR and WCG are more capable than ever before of preserving and displaying imagery that closely matches that original artistic intent, if only such content can be faithfully delivered.

What is really missing is a mechanism that can be used to control the quality of the video distribution process. For this purpose, an automatic measurement and scoring tool that can be used to assess instantly the fidelity of the video streams being received at the consumer display devices against the Master video streams coming out of post-production studios is highly desirable. Such a tool not only can be used to compare and select video distributors, but can also help them improve their services and use their resources most efficiently. The broad usage of such a tool in the video distribution industry is of great interest to The American Society of Cinematographers (ASC).

The SSIMWave Inc. Quality-of-Experience (QoE) Measurement software – currently used by cable distributors and networks to judge delivered video quality as perceived by end users – is being upgraded to handle HDR, WCG, and higher resolution image data streams in real time. SSIMWave is willing to help members of the ASC to evaluate and provide input into the efficacy of the upgraded quality measurement software from the point of view of the image creators, rather than downstream distributors or consumers. SSIMWave's new QoE measurement solution is the next generation of the Structural SIMilarity (SSIM) perceptual image/video quality metric, which was

invented by Dr. Zhou Wang, the Chief Scientist of SSIMWave and a winner of 2015's Primetime Engineering Emmy Award for his SSIM work. The new SSIMWave QoE measurement software has many advantages over SSIM, and can automate the process of evaluating the perceived QoE of video signals from the point of view of both a "typical" and an "expert" observer modes. It also produces in real-time a highly detailed quality map that indicates the perceptual distortions up to pixel level. Such quality measure and maps of potential image alteration/degradation may also be valuable to creatives during color grading and even during production, predicting how their content will be perceived by end users on various devices and delivery mechanisms. SSIMWave's video QoE monitoring (SQM) software possesses several exclusive features which facilitate the current test and future deployment process, including (1) accurate and straightforward scores from 0 to 100 that is easy to be understood and used; (2) real-time calculation for 4K/UHD resolution videos with scalable report; (3) display device adaptation; (4) fidelity measure between source and test video irrespective different resolution, frame rate, and dynamic range; (5) detailed quality maps allowing pixel level+ inspection.

The ASC Technology Committee has formed a Working Group to evaluate the efficacy of SSIMWave's solution as an automatic tool to assess the preservation of cinematographers' creative intent of video content delivered to consumers.

2 Objectives

The purpose of this ASC Technology Committee Working Group is to assess, evaluate, and improve the preservation of the original creative intent of UHD, 4K and HDR/WCG video imagery during its distribution and delivery, from grading suite to consumers.

The specific objectives are as follows:

1. Establish a testbed environment by working with industry partners that allows cinematographers to evaluate delivered quality of distribution content, and the efficacy of SSIMWave perceptual quality metric;
2. Establish the process and evaluate the efficacy of using automatic QoE measurement software to monitor the preservation of cinematographer's and director's original creative intent along the video delivery chain;
3. Evaluate the degree to which SSIMWave's automated perceptual quality metric, as applied to 4K/UHD and HDR/WCG content, matches the judgment of professional cinematographers and colorists who create such visual imagery;
4. Make suggestions where necessary to improve both the quality assurance process of the video distribution and the SSIMWave QoE metric, to ensure that preservation of creative intent – as judged by the content creators – becomes the standard with which HDR/WCG content distribution is evaluated.

3 Tasks

There are four major tasks of the Working Group:

3.1 Preparation of Test Materials

The ASC will provide pristine-quality test video materials that cover a wide range of content types, in a format as viewed by a cinematographer and colorist in a professional color grading suite. . The materials would be 4K or UHD resolution and HDR/WCG content of at least the digital cinema DCI P3 colour space or larger and at least digital cinema standard dynamic range or greater. This pristine-quality source imagery will represent the visual creative intent of the cinematographer, before any modifications are made for distribution of that imagery. Copyright issues should be cleared and permissions should be obtained for free use of the materials by the Working Group, for testing, reporting, and/or public demonstration purposes.

Ideally, the compression configuration details, which are used during content delivery over networks, would be pursued from industrial video distribution partners. The pristine-quality video materials will then be encoded by SSIMWave to those specifications for use in this evaluation. If for any reason it proves impractical for SSIMWave to accurately duplicate those transcoding and compression steps, or if the evaluation might inaccurately represent a particular distributor's delivery process, or to ensure that the encoding/encryption accurately reflects what is actually being done, content distributors will be asked to use their internal pipeline processes on the standard source material for this evaluation.

Eventually, a video database will be established that contains diverse video content and both pristine and compressed digital versions at different levels and stages.

3.2 Objective Evaluation

SSIMWave will assess all of the compressed videos in the database against the original source material using its SQM software. The results should not only include per-frame and per-video quality scores, but also pixel-precision quality maps that indicate local quality variations across space and time, that can be verified by human expert testing.

3.3 Establishment of the Testbed and Subjective Test by Experts

In general, the subjective test will involve participants performing a comparison of the original material as it would be viewed in a professional color grading suite with the same material after it has been subjected to the encoding, encryption, decryption, and decoding performed during distribution and delivery to consumer devices. Simultaneously, information from SSIMWave software would reflect that software's automated evaluation of the visible differences between the original imagery and corresponding imagery as delivered to a consumer display. Based on direct side-by-side comparison of original vs. as-delivered imagery, participants would rate the effectiveness of the SSIMWave Quality-of-Experience software in matching their professional evaluation of the differences, with the goal of establishing the degree to which the imagery "as delivered" is an adequate representation of the original creative intent.[1]

[1] NB.: This ASC working group is not performing an evaluation of consumer High Dynamic Range or Wide Color Gamut displays. This evaluation will be limited to examining the visibly noticeable alterations to the video signal data during its commercial distribution and delivery to such devices.

ASC and SSIMWave will work together with industrial partners to establish the testbed environment to perform this subjective test. This includes the monitors/displays to be used in the test, the viewing condition setups, and the testing protocols, which will be described in a separate document.

In return, industry partners will (a) obtain both objective and subjective evaluations of the overall changes to image quality caused by delivery pipelines; (b) gain understanding of which artifacts of the end-to-end encoding and encryption of HDR, WCG material are most noticeable and which aspects are best preserved during distribution; (c) explore and evaluate the usefulness of visual quality-of-experience metrics such as SSIMWave from the point of view of the content creators; (d) have a chance to know the opinions from other colleagues in terms of video QoE; and (e) be able to optimize their video delivery chain to better preserve the creative intent of content creators.

ASC will help organize experienced image quality professionals (cinematographers, colorists, etc.) to evaluate/score the test materials using the testbed. For each test video, three types of expert opinions should be recorded:

1) A score on the level of preservation of creative intent of the test video;
2) A score on SSIMWave software's accuracy in predicting the preservation of creative intent;
3) Additional information and/or comment on how/why the scores are given.

Depending on the scale of the test and the availability of the test environment, the expert test may be divided into multiple phases. For example, Phase 1 may be dedicated to 4K/UHD and HDR/WCG content with P3 color space and Dolby PQ (SMPTE ST 2084) encoding, and Phase 2 to 4K/UHD and HDR/WCG content with REC2020 color space and both PQ and HLG encoding.[2]

3.4 Analysis and Report

The Working Group will analyze the test results together, and work on a detailed report that should include the following conclusions.

1) The appropriateness of using video QoE software tool in monitoring the preservation of creative intent in video distribution, and how the control should be done, including the testing point in the delivery chain and recommended quality scores that should be achieved at each point;
2) The appropriateness and usefulness of SSIMWave software tool in evaluating and monitoring the preservation of creative intent in video distribution;
3) If possible, a list of recommendations that can be used to improve the quality assurance process of video distribution and the refinement of SSIMWave's solution.

4 Organization

The Working Group will be composed of five groups of participants.

1) Representatives of the ASC Technology Committee, including Curtis Clark, ASC, Chair of the ASC Technology Committee, and Thomas Wall, who will coordinate the project. ASC Technology Committee will oversee all aspects and control the progress of the Working Group;

[2] NB.: The limitations on color and dynamic range imposed by REC709, BT.1886 video are well recognized. This evaluation will be concerned with high dynamic range (HDR) and wider color gamut (WCG) material only.

2) The SSIMWave technical team, including Dr. Abdul Rehman, CEO of SSIMWave, Dr. Zhou Wang, Chief Scientist of SSIMWave, and Dr. Kai Zeng. SSIMWave will provide the QoE software tool for testing, and participates in the objective evaluation of the test materials, the establishment of the testbed, and the analyzing and reporting processes;
3) Industrial partners who provide the facilities to host the evaluations;
4) Industrial video distribution partners who provide encoding and compression configurations or actually create the test materials that mimic the quality degradations in the video delivery chain;
5) Video quality experts who may be cinematographers and colorists, or other industrial "golden eyes", who are invited to participate by the ASC in the subjective testing and provide expert opinions on the preservation of creative intent.

5 Timeline

The following is a rough estimated timeline, to be used as a roadmap for execution of the evaluation. Actual schedule is dependent upon factors such as cooperation and coordination of and with third-party industry partners, availability of detailed information from network distributors concerning their internal processing pipelines and the ability of SSIMWave to duplicate those pipelines, time required for SSIMWave to execute the Objective evaluation of test material, availability of equipment and facilities for hosting of the subjective evaluations, availability of sufficient numbers of professional cinematographers and colorists to participate in the evaluation, etc. Note also that schedule items are not necessarily strictly serial in nature; tasks may overlap and will be performed in parallel whenever possible.

01/2016	Forming the Working Group
01-02/2016	Obtain industry partner cooperation to provide testbed for evaluation(s)
02-03/2016	Detailed definition of testbed requirements and evaluation process.
02-03/2016	Obtain cooperation of content distributors re. their internal encoding and encryption processes for HDR, WCG, 4K/UHD material.
03/2016	Preparation of the test materials (including source content and compressed videos)
04/2016	Objective assessment
05/2016	Testbed setup
05-06/2016	Subjective expert evaluation
06/2016	Analysis, report, and making recommendations