ITU Kaleidoscope 2014

Living in a Converged World – Impossible without Standards?

SQUALES: A QT-based Application for Full-Reference Objective Video Quality Measurement

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Outline

Introduction

- The methodology applied in subjective experiments for video quality assessment are described in Recommendations ITU-T P.910 and ITU-R BT.500-13
- Successful full-reference objective algorithms were developed for 2D video quality assessment (ITU-T J.144)
- Stereoscopic video signals present new parameters and hardware requirements that need to be considered in the design of the objective algorithms and future standards, such as: bandwidth, bit-rate, storage space, power consumption and depth
- A platform independent application that uses a graphical user interface (GUI) for objective stereoscopic VQA, was developed
- It is called SQUALES (Stereoscopic video QUALity Evaluation Software)

Introduction

- The stereoscopic video signals supported are based on a two-view model, such as the H.264/AVC standard with Multiview Video Coding (MVC), and several spatial resolutions are made available
- Numerical results corresponding to the performance of the objective measurements acquired using the proposed application are presented
- The ultimate goal is that the application contributes, as an open-source tool to be used by academia and industry, for standardization and development of objective algorithms and evaluation of impairments in stereoscopic video signals

Objective Algorithms

- Perceptual Weighting Structural Similarity Index

$$|\vec{\nabla} f| = \left| \frac{\partial f}{\partial x} \hat{a}_x + \frac{\partial f}{\partial y} \hat{a}_y \right|$$

$$\mathrm{SI}(f_j) = \sqrt{\frac{1}{K-1} \sum_{k=1}^{K} (\mu_j - |\nabla f_j(k)|)^2}$$

$$\text{PW–SSIM}(f,h) = \frac{\sum_{j=1}^{J} \mathrm{SSIM}(f_j,h_j) \cdot \mathrm{SI}(f_j)}{\sum_{j=1}^{J} \mathrm{SI}(f_j)}$$

Objective Algorithms

- Disparity Weighting

$$D(F(x,y,n)) = |f_L(x,y,n) - f_R(x,y,n)|, \ \forall \ (x,y,n)$$

$$\mathrm{DMSE}_L(F,H) = \frac{\sum_{n=1}^{N}\sum_{y=1}^{Y}\sum_{x=1}^{X}[f_L(x,y,n) - h_L(x,y,n)]^2 \cdot D(F(x,y,n))}{\sum_{n=1}^{N}\sum_{y=1}^{Y}\sum_{x=1}^{X} D(F(x,y,n))}$$

$$\mathrm{DPSNR}_L(F,H) = 20 \cdot \log_{10}\left[\frac{MAX}{\sqrt{\mathrm{DMSE}_L(F,H)}}\right] \quad [\mathrm{dB}]$$

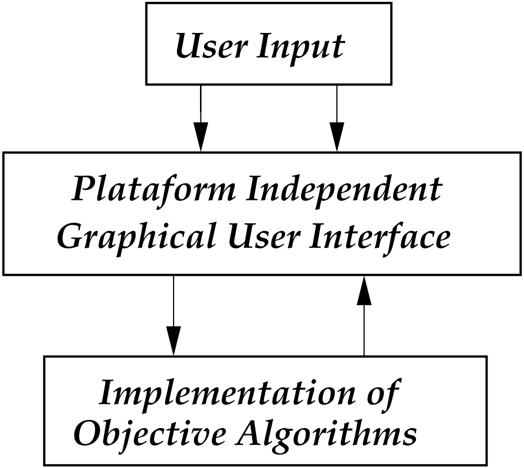
Objective Algorithms

- Disparity Weighting

$$\text{DSSIM}(F,H) = \frac{\sum_{j=1}^{J} \text{SSIM}(F_j,H_j)\cdot D(F_j)}{\sum_{j=1}^{J} D(F_j)}$$

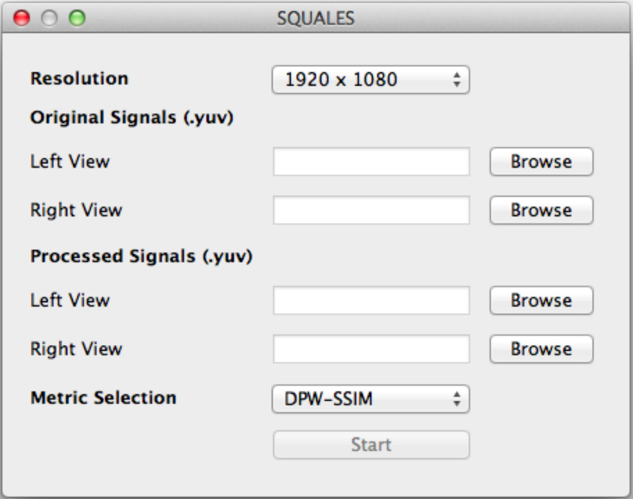
$$\text{DPW-SSIM}(F,H) = \frac{\sum_{j=1}^{J} \text{SSIM}(F_j,H_j)\cdot \text{SI}(F_j)\cdot D(F_j)}{\sum_{j=1}^{J} [\text{SI}(F_j)\cdot D(F_j)]}$$

Proposed Scheme



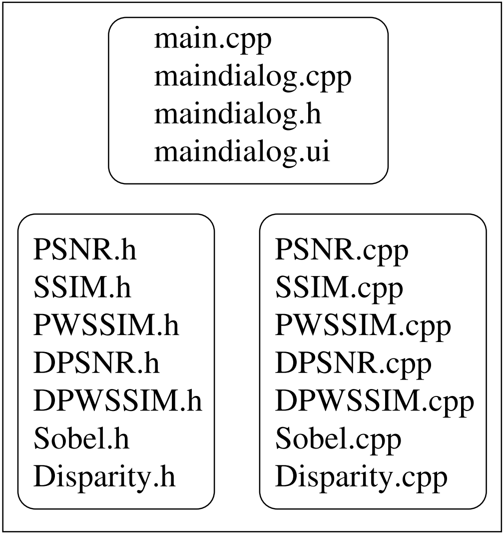
Proposed Scheme

- QT-based Application



Proposed Scheme

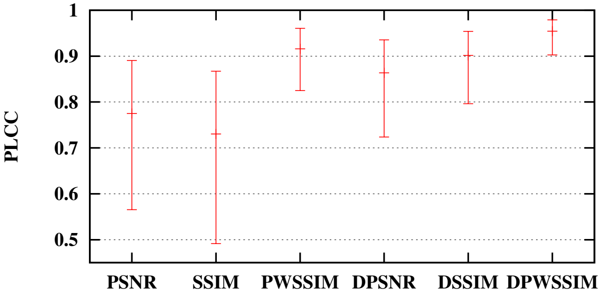
- QT-based Application



Numerical Results

Table : Performance measures for H.264 scenario

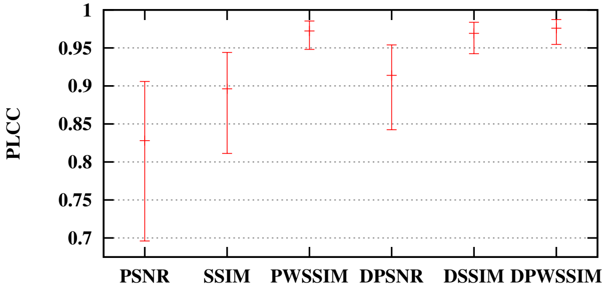
Algorithm	PLCC	SROCC	KROCC	RMSE
PSNR	0.774946	0.721424	0.533869	0.689299
SSIM	0.730523	0.716222	0.555117	0.744770
PW–SSIM	**0.915983**	**0.906776**	**0.756978**	**0.437573**
DPSNR	0.863640	0.838604	0.640111	0.549789
DSSIM	0.901635	0.892266	0.746354	0.471688
DPW–SSIM	**0.954403**	**0.937166**	**0.815412**	**0.325572**



Numerical Results

Table : Performance measures for JPEG2000 scenario

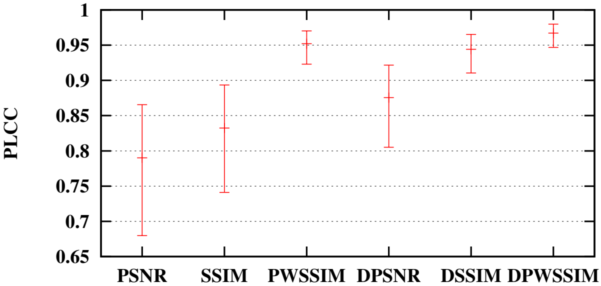
Algorithm	PLCC	SROCC	KROCC	RMSE
PSNR	0.828049	0.825865	0.662380	0.734844
SSIM	0.896314	0.907419	0.750010	0.581185
PW–SSIM	**0.972477**	**0.965980**	**0.860836**	**0.305388**
DPSNR	0.914034	0.927596	0.770629	0.531663
DSSIM	0.969310	0.962132	0.853104	0.322222
DPW–SSIM	**0.975911**	**0.971048**	**0.865991**	**0.285951**



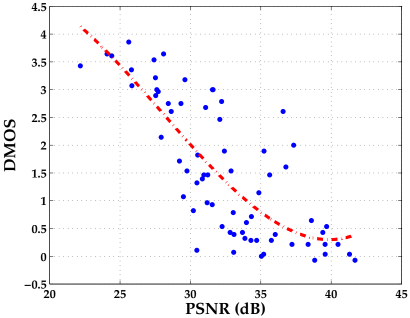
Numerical Results

Table : Performance measures for Joint scenario

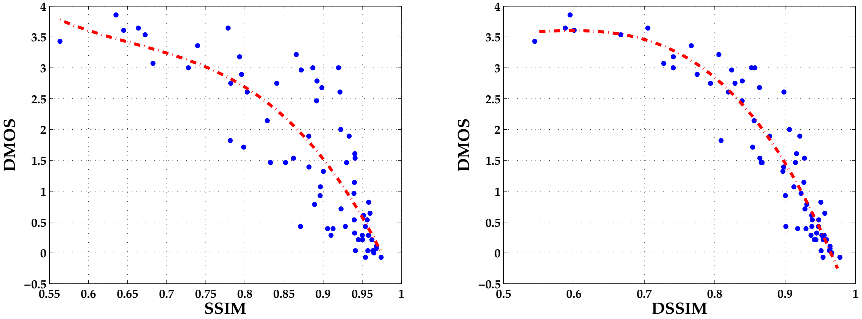
Algorithm	PLCC	SROCC	KROCC	RMSE
PSNR	0.790152	0.766721	0.588923	0.750780
SSIM	0.832476	0.841566	0.658728	0.678694
PW–SSIM	**0.951992**	**0.943427**	0.800988	**0.374981**
DPSNR	0.875461	0.858578	0.678167	0.592001
DSSIM	0.944039	0.942530	**0.801872**	0.404026
DPW–SSIM	**0.967001**	**0.955609**	**0.830147**	**0.312082**



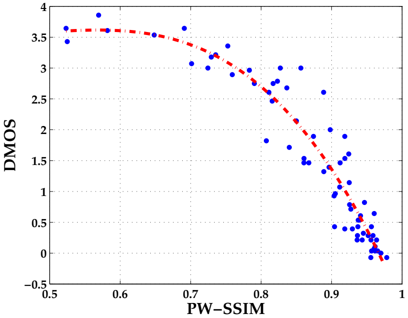
Numerical Results

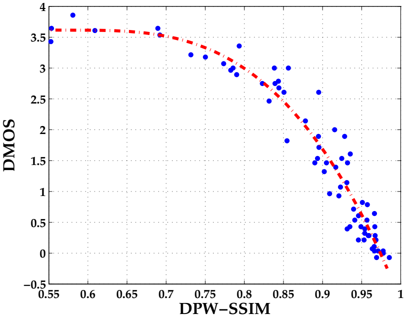


Numerical Results



Numerical Results





Conclusion

- An application that computes the video quality plays an important role in the development and standardization of new objective video quality prediction models
- The application produces stereoscopic video quality assessment, is platform independent, quickly computes the video quality, because the C++ programming language was used in the implementation presents a user-friendly GUI and is not based on closed-source architectures
- The figure of merit used to validate the performance of the objective algorithms evidences the outstanding performance of the algorithms that use the disparity weighting technique, suggesting that SQUALES is a useful tool to be used by the academia, by the industry and also by standards organizations
- The authors will develop a statistical analysis tool and add it to SQUALES

Acknowledgments

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Just work hard...jointly.