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

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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

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

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

\[ \text{PW–SSIM}(f, h) = \frac{\sum_{j=1}^{J} \text{SSIM}(f_j, h_j) \cdot \text{SI}(f_j)}{\sum_{j=1}^{J} \text{SI}(f_j)} \]
Objective Algorithms

- Disparity Weighting

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

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

\[
DPSNR_L(F, H) = 20 \cdot \log_{10} \left[ \frac{\text{MAX}}{\sqrt{DMSE_L(F, H)}} \right] \quad [\text{dB}]
\]
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

User Input

Platform Independent
Graphical User Interface

Implementation of
Objective Algorithms
Proposed Scheme

- QT-based Application
Proposed Scheme

- QT-based Application

### Files
- main.cpp
- maindialog.cpp
- maindialog.h
- maindialog.ui
- PWSSIM.h
- SSIM.h
- PSNR.h
- DPSNR.h
- DPWSSIM.h
- Sobel.h
- Disparity.h

### Source Code
- PWSSIM.cpp
- SSIM.cpp
- PSNR.cpp
- DPSNR.cpp
- DPWSSIM.cpp
- Sobel.cpp
- Disparity.cpp
Numerical Results

Table: Performance measures for H.264 scenario

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>PLCC</th>
<th>SROCC</th>
<th>KROCC</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSNR</td>
<td>0.774946</td>
<td>0.721424</td>
<td>0.533869</td>
<td>0.689299</td>
</tr>
<tr>
<td>SSIM</td>
<td>0.730523</td>
<td>0.716222</td>
<td>0.555117</td>
<td>0.744770</td>
</tr>
<tr>
<td>PW-SSIM</td>
<td>0.915983</td>
<td>0.906776</td>
<td>0.756978</td>
<td>0.437573</td>
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<tr>
<td>DPSNR</td>
<td>0.863640</td>
<td>0.838604</td>
<td>0.640111</td>
<td>0.549789</td>
</tr>
<tr>
<td>DSSIM</td>
<td>0.901635</td>
<td>0.892266</td>
<td>0.746354</td>
<td>0.471688</td>
</tr>
<tr>
<td>DPW-SSIM</td>
<td>0.954403</td>
<td>0.937166</td>
<td>0.815412</td>
<td>0.325572</td>
</tr>
</tbody>
</table>

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Numerical Results

Table: Performance measures for JPEG2000 scenario

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>PLCC</th>
<th>SROCC</th>
<th>KROCC</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSNR</td>
<td>0.828049</td>
<td>0.825865</td>
<td>0.662380</td>
<td>0.734844</td>
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<tr>
<td>SSIM</td>
<td>0.896314</td>
<td>0.907419</td>
<td>0.750010</td>
<td>0.581185</td>
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<tr>
<td>PW–SSIM</td>
<td>0.972477</td>
<td>0.965980</td>
<td>0.860836</td>
<td>0.305388</td>
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<tr>
<td>DPSNR</td>
<td>0.914034</td>
<td>0.927596</td>
<td>0.770629</td>
<td>0.531663</td>
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<tr>
<td>DSSIM</td>
<td>0.969310</td>
<td>0.962132</td>
<td>0.853104</td>
<td>0.322222</td>
</tr>
<tr>
<td>DPW–SSIM</td>
<td>0.975911</td>
<td>0.971048</td>
<td>0.865991</td>
<td>0.285951</td>
</tr>
</tbody>
</table>

Graph showing performance measures for different algorithms.

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Numerical Results

Table: Performance measures for Joint scenario

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>PLCC</th>
<th>SROCC</th>
<th>KROCC</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSNR</td>
<td>0.790152</td>
<td>0.766721</td>
<td>0.588923</td>
<td>0.750780</td>
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<td>SSIM</td>
<td>0.832476</td>
<td>0.841566</td>
<td>0.658728</td>
<td>0.678694</td>
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<tr>
<td>PW–SSIM</td>
<td>0.951992</td>
<td>0.943427</td>
<td>0.800988</td>
<td>0.374981</td>
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<td>DPSNR</td>
<td>0.875461</td>
<td>0.858578</td>
<td>0.678167</td>
<td>0.592001</td>
</tr>
<tr>
<td>DSSIM</td>
<td>0.944039</td>
<td>0.942530</td>
<td>0.801872</td>
<td>0.404026</td>
</tr>
<tr>
<td>DPW–SSIM</td>
<td>0.967001</td>
<td>0.955609</td>
<td>0.830147</td>
<td>0.312082</td>
</tr>
</tbody>
</table>

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Numerical Results

![Graph 1: PSNR vs DMOS](image1)

![Graph 2: DPSNR vs DMOS](image2)

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Numerical Results

![Numerical Results Diagram]

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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

Just work hard...jointly.