PERFORMANCE EVALUATION OF EXISTING QUALITY MODELS AND ITU STANDARDS ON VIDEO GAMING QUALITY ESTIMATION

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VQEG Meeting - Mountain View, California, USA, 2018
CLOUD GAMING

Special encoding and network protocol

- **Latency**
  - Capturing RGB data from frame buffer (front buffer) without any involvement from OpenGL/Direct3D
  - Using GPU hardware accelerator engines for video encoding/decoding
  - Fixed macroblock size for fast encoding

- **Packet loss (concealment)**
  - Designing task-specific network protocol such as reliable UDP

- **Encoding setting**
  - CBR, short GoP, ...
Performance evaluation of existing quality models and ITU standards on video gaming quality estimation

Dilemma
Low Latency
High Quality

Cloud Gaming

Performance evaluation of existing quality models and ITU standards on video gaming quality estimation

Cloud (Server)

Video Encoder

Game Engine

Display System

Video Decoder

Game Engine

Game Input Device

Client

Network Characteristic

Transmission Delay

Limited bandwidth

High performance GPU buffer capture
NvFBC, NvIFR

Hardware encoding setting
NvENC

Player

Low Latency
High Quality

Cloud Gaming

Telekom Innovation Laboratories

11/16/2018
HW VS SW ENCODING

Video Encode Performance

<table>
<thead>
<tr>
<th>FPS</th>
<th>x264</th>
<th>NVENC</th>
</tr>
</thead>
<tbody>
<tr>
<td>720p streaming (llsfast)</td>
<td>800</td>
<td>900</td>
</tr>
<tr>
<td>720p high quality (hqsslow)</td>
<td>700</td>
<td>800</td>
</tr>
<tr>
<td>1080p streaming (llsfast)</td>
<td>600</td>
<td>700</td>
</tr>
<tr>
<td>1080p high quality (hqsslow)</td>
<td>500</td>
<td>600</td>
</tr>
</tbody>
</table>

Quality comparable to x264

<table>
<thead>
<tr>
<th>PSNR (dB)</th>
<th>x264</th>
<th>NVENC</th>
</tr>
</thead>
<tbody>
<tr>
<td>720p streaming (llsfast)</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>720p high quality (hqsslow)</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>1080p streaming (llsfast)</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>1080p high quality (hqsslow)</td>
<td>39</td>
<td>39</td>
</tr>
</tbody>
</table>

Taken from https://developer.nvidia.com/nvidia-video-codec-sdk
The result for a complex video game: Nier Automata
Medium preset of x264 performs quite similar to llhq preset of NvENC
G.OMG MODEL
Opinion model for gaming

Influencing Factors

<table>
<thead>
<tr>
<th>Game Type</th>
<th>Encoding Parameter</th>
<th>Network Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay Sensitivity</td>
<td>Bit Rate (BR)</td>
<td>Packet Loss (PL)</td>
</tr>
<tr>
<td>Encoding Complexity</td>
<td>Resolution (Res)</td>
<td>Delay (D)</td>
</tr>
<tr>
<td>Key Frame Interval (KFI)</td>
<td>Frame Rate (FR)</td>
<td></td>
</tr>
</tbody>
</table>

Quality Features

- Spatial Video Quality
- Temporal Video Quality
- Responsiveness Feedback
- Controllability

Predicted Gaming QoE

- Video Quality
- Interaction Quality
- Overall Gaming Quality (MOS)
- Acceptance

Performance evaluation of existing quality models and ITU standards on video gaming quality estimation
PLANNED ACTIVITIES
Modeling Gaming QoE

- **Planning model**
  - G.1071: Opinion model for network planning of video and audio streaming applications

- **Monitoring models**
  - P.1201: Parametric non-intrusive assessment of audiovisual media streaming quality
  - P.1203: Parametric bitstream-based quality assessment of progressive download and adaptive audiovisual streaming services over reliable transport
Performance evaluation of existing quality models and ITU standards on video gaming quality estimation.
G.1071 ON VIDEO GAMES
Planning Video Gaming Model

Performance evaluation of existing quality models and ITU standards on video gaming quality estimation

<table>
<thead>
<tr>
<th>GamingVideoDataSet</th>
<th>KUGVD</th>
<th>CGVDS</th>
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</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>0.68</td>
<td>0.74</td>
</tr>
<tr>
<td>RMSE</td>
<td>1.1</td>
<td>0.99</td>
</tr>
</tbody>
</table>

R: Linear ≈ 0.422
Parametric bitstream-based quality assessment of progressive download and adaptive audiovisual streaming services over reliable transport

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<tr>
<td>0</td>
<td>Encrypted media payload and media frame headers</td>
<td>Meta-data</td>
<td>Low</td>
</tr>
<tr>
<td>1</td>
<td>Encrypted media payload</td>
<td>Meta-data and frame size/type information</td>
<td>Low</td>
</tr>
<tr>
<td>2</td>
<td>No encryption</td>
<td>Meta-data and up-to 2% of the media stream</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
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<td>Meta-data and any information from the video stream</td>
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Results of P.1203

Performance evaluation of existing quality models and ITU standards on video gaming quality estimation
Parametric bitstream-based quality assessment of progressive download and adaptive audiovisual streaming services over reliable transport

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G. OMG VIDEO QUALITY
Updating G.1071 based on gaming content

- Fit the model again based on our dataset
  - Only a few coefficient changed dramatically

- The change of performance based on the new dataset
  - SRCC: 0.63 → 0.735
  - RMSE: 1.05 → 0.754

<table>
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<tr>
<th>Coefficient</th>
<th>old</th>
<th>new</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_{3V}$</td>
<td>51.28</td>
<td>283.88</td>
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<tr>
<td>$a_{2V}$</td>
<td>-22.00</td>
<td>-21.85</td>
</tr>
<tr>
<td>$a_{3V}$</td>
<td>6.00</td>
<td>20.93</td>
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<tr>
<td>$a_{4V}$</td>
<td>6.21</td>
<td>4.84</td>
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<tr>
<td>$a_{31}$</td>
<td>3.92</td>
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<td>$a_{32}$</td>
<td>-27.54</td>
<td>-23.34</td>
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<tr>
<td>$c_{1V}$</td>
<td>17.73</td>
<td>62.85</td>
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<tr>
<td>$c_{2V}$</td>
<td>123.08</td>
<td>1399.50</td>
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<tr>
<td>$c_{21}$</td>
<td>80.61</td>
<td>49.78</td>
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<tr>
<td>$c_{22}$</td>
<td>0.00046</td>
<td>0.00046</td>
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<tr>
<td>$c_{23}$</td>
<td>0.00147</td>
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<tr>
<td>$q_{1}$</td>
<td>0.018</td>
<td>0.204</td>
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<tr>
<td>$q_{2}$</td>
<td>0.04000</td>
<td>0.00025</td>
</tr>
</tbody>
</table>
CONCLUSION

- Gaming content is diverse in terms of video complexity
  - A video game classification is required in order to obtain an accurate video game model

- G.OMG
  - Updating G.1071 for gaming content might be a candidate for video quality module
  - We plan to extend our dataset to cover wide range parameters

- P.1203 phase 2
  - Recommend to use gaming content in training and especially high complex video games as they might be much more complex than non-gaming videos
Thank you for your attention!

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