Performance Evaluation of Existing Quality Models and ITU Standards on Video Gaming Quality Estimation

VQEG Meeting - Mountain View, California, USA, 2018

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CLOUD GAMING

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

Cloud (Server)

Game Engine

Video Encoder

Game Input Device

Video Decoder

Display System

Game Engine

Client

Player

Network Characteristic

Transmission Delay

Limited bandwidth

High performance GPU buffer capture
NvFBC, NvIFR

Dilemma
Low Latency
High Quality

Hardware encoding setting
NvENC

Limited bandwidth

High performance
High Quality
Low Latency
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, ...
HW VS SW ENCODING
NVENC vs x264

Video Encode Performance

Quality comparable to x264

Taken from https://developer.nvidia.com/nvidia-video-codec-sdk

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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>Delay Sensitivity</th>
<th>Encoding Complexity</th>
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</table>

| Encoding Parameter | Bit Rate (BR) | Resolution (Res) | Key Frame Interval (KFI) | Frame Rate (FR) |

| Network Parameter  | Packet Loss (PL) | Delay (D) |

Quality Features

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

Predicted Gaming QoE

- Q_max
- Overall Gaming Quality (MOS)
- Acceptance

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VIDEO QUALITY MODELS

Standardization activities

- **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
G.1071 ON VIDEO GAMES
Planning Video Gaming Model

GamingVideoDataset

KUGVD

Performance evaluation of existing quality models and ITU standards on video gaming quality estimation
Planning Video Gaming Model

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<table>
<thead>
<tr>
<th>GamingVideoDataSet</th>
<th>KUGVD</th>
<th>CGVDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>RMSE</td>
<td>Correlation</td>
</tr>
<tr>
<td>0.68</td>
<td>1.1</td>
<td>0.74</td>
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</table>
P.1201 ON VIDEO GAMES

Observation

- P.1201 did not perform well with our dataset
- Possible reasons:
  - Not trained well enough for gaming content
  - Diversity of video complexity of selected video sequences
  - Usage of GPU encoding

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11/11/2018
**RESULTS OF P.1203**

Parametric bitstream-based quality assessment of progressive download and adaptive audiovisual streaming services over reliable transport

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<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>
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## RESULTS OF P.1203

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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 coefficients changed dramatically

- The change of performance after fitting with 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>
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<tbody>
<tr>
<td>a_{1V}</td>
<td>51.28</td>
<td>→ 65.74</td>
</tr>
<tr>
<td>a_{2V}</td>
<td>-22.00</td>
<td>→ -15.68</td>
</tr>
<tr>
<td>a_{3V}</td>
<td>6.00</td>
<td>→ 7.42</td>
</tr>
<tr>
<td>a_{4V}</td>
<td>6.21</td>
<td>→ 12.46</td>
</tr>
<tr>
<td>a_{31}</td>
<td>3.92</td>
<td>→ -4.88</td>
</tr>
<tr>
<td>a_{32}</td>
<td>-27.54</td>
<td>→ -16.70</td>
</tr>
<tr>
<td>a_{33}</td>
<td>0.26</td>
<td>→ 1.18</td>
</tr>
<tr>
<td>c_{1V}</td>
<td>17.73</td>
<td>→ 21.97</td>
</tr>
<tr>
<td>c_{2V}</td>
<td>123.08</td>
<td>→ 0.047</td>
</tr>
<tr>
<td>c_{21}</td>
<td>80.61</td>
<td>→ 198.88</td>
</tr>
<tr>
<td>c_{22}</td>
<td>0.00046</td>
<td>→ 0.00046</td>
</tr>
<tr>
<td>c_{23}</td>
<td>0.00147</td>
<td>→ 0.00070</td>
</tr>
<tr>
<td>q_{1}</td>
<td>0.018</td>
<td>→ 0.0000069</td>
</tr>
<tr>
<td>q_{2}</td>
<td>0.04</td>
<td>→ 0.10</td>
</tr>
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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 process and especially high complex video games as they might be much more complex than non-gaming videos
Thank you for your attention!

Visit www.qu.tu-berlin.de for more information.