Quality of Experience estimation for adaptive HTTP/TCP video streaming using H.264/AVC

Kamal Deep Singh, Yassine Hadjadj-Aoul and Gerardo Rubino
IRISA,
INRIA, Dionysos Team-project
Agenda

• Background
  – QoE
  – Adaptive HTTP streaming

• QoE Estimation
  – PSQA approach
  – Proposed QoE Estimation module for Adaptive HTTP streaming

• Results

• Conclusion
What is QoE (Quality of Experience)?

- QoE is defined by ITU as “the overall acceptability of an application or service, as perceived subjectively by the end user”.

- Perceived video quality is a subjective concept.

- Perceived quality can be measured using humans.
  - However, it is costly and cannot be done automatically.
Adpative HTTP Streaming

- HTTP/TCP tends to replace RTP/UDP for video delivery
  - Adaptive traffic represents 17% of the internet traffic today\(^1\)
    - Up to 60% of the US traffic\(^2\)
      - Netflix takes up to 32.7% of the bandwidth
  - Expected grow at an average 77% a year\(^1\)
    - 51% of internet video in 2015

\(^1\) http://tdgresearch.com/
\(^2\) http://tdgresearch.com/
Motivations behind the adoption of Adaptive HTTP Streaming

• **HTTP Streaming** has become **very popular** on the internet
  • Various different bitrates of the video are available on the server
    • One can choose the optimal version to load
  • **Segments** video file into chunks of same duration
    • Client downloads the next chunk depending on available bandwidth
      • Better QoE
• Easy to use with **existing CDN**
  • No streaming server is necessary
• **No NAT/Firewall issues** due to HTTP
Other motivations

• **Several commercial content/service providers** use it
  • Netflix

• **Several players** support it
  • Microsoft Smooth Streaming Player
  • Netflix Player
  • Adobe OSMF/Zeri Player
  • Apple Player

• **Standard in preparation**
Why QoE for Adaptive HTTP?

• QoE may play a key role for optimizing video delivery of adaptive HTTP services
  • Detecting and debugging failures
  • Managing streaming performance
  • Enabling intelligent client adaptation
    • QoE-aware adaptation
Adaptive HTTP Streaming

- Degradation of quality due to:
  - Bitrate switching
  - Playout interruptions
    - Playout interruptions are rare with simple scenarios of Adaptive HTTP streaming
    - However they can occur when using P2P technology where chunk retrieval is unreliable
How to estimate QoE?

• Objective Quality metrics like PSNR
  – Easy to implement
  – However, do not resemble the quality as perceived by real users

• Subjective quality assessment methods
  – Based on the quality perceived by real users
  – Time consuming and costly
QoE Estimation: PSQA approach

• Pseudo Subjective Quality Assessment
  – Context dependent

[Diagram Image]

Training

Set of Network Parameters

Real Time Usage

Real Network

Mean Opinion Score

Trained RNN
QoE Estimation: Input parameters

- QoE parameters for HTTP/TCP video
  - Encoding quality
    - QP (Quantization Parameter): average value of QP for the video
  - Playout interruptions
    - D_{avg}: average duration of interruptions
    - D_{max}: duration of the interruption that was longest or Alpha: 1 - D_{avg}/D_{max}
    - N: number of interruptions
QoE Estimation

- Videos used for Subjective tests (100 videos were used for the learning phase and 18 for the validation phase)
- Resolution: 720p
- FPS: 30
Building QoE estimation tool

• RNN training to capture the way humans react to a video flow.
Results

MOS vs QP and Dmax

MOS vs N and Dmax
Results ...

MOS vs Dmax and alpha

- **RMSE: 0.35** on MOS scale 1-5
- RMSE of the human panel: **0.61**
Results …

- Comparison with freeze distortion model [Watanabe 2006]
  - Considers only playout interruptions/freezes and not QP
- We consider QP in our model and hence mean square error is low for different bitrates/QP of video
Conclusions

- An automatic no-reference QoE estimation module for HTTP video streaming using TCP and H.264 video Codec

- QoE feedback can be used to take some corrective measures, in case the quality drops, to bring back QoE to satisfactory level.

- Other metrics will be considered in the near future:
  - Resolution
  - Qp pattern