CATT Media Research

- Katherine Isbister
  - New gaming projects at Poly
- Yao Wang
  - Perceptual Quality Assessment for Compressed Video
- Yong Liu
  - Live P2P video: viewing-uploading decoupling
- Keith Ross
  - Live P2P video: layered streaming & incentives
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Social Game Lab

- Gaming research facility
  - Console games, pc-hookup, large display, video monitoring and digital mixing and recording facilities
- Internal launch Nov. 15 after all-day 3D Game Engine workshop
Social Game Lab

- Allows for rich analysis of game play and user experience
Gesture and Emotion project

- Analyzing gesture design in commercial games
- Creating a design pattern language
- Innovating new gestural strategies for games and other applications that enhance social and emotional experience
Gesture and Emotion project

- Effects of interest
  - Physical feedback loop
  - Emotional contagion
  - Increasing trust & liking through shared movement & mimicry
Gesture and Emotion project

- Enhance social & emotional ties in non-game digital environments.
Games for Learning Institute

- Multi-institution 3-year grant from Microsoft:
  - Research effective design for learning through games.
  - NYU, Columbia, Dartmouth, CUNY, Parsons The New School, Rochester Institute of Technology

- NYU-Poly faculty:
  - Katherine Isbister, Digital Media
  - Carl Skelton, Digital Media
  - Joel Wein, Computer Science

- Games will focus on STEM subjects.
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Motivation

• To deliver video to low-bandwidth users, should we code video at high frame rate, large frame size but low quality per frame, or vice versa?
• To deliver the same video to users with diverse downlink bandwidth, how to meet different users’ capability?
  • Code the video into a scalable stream that can be accessed at different spatial, temporal, and amplitude resolutions.
  • Which combination is the best for a particular bandwidth?
• Should maximize the perceptual quality?
• How to measure the perceptual quality?
• Prior research focuses on videos of fixed frame rate and frame size.
• This work investigates the impact of frame rate and quantization.
Subjective Quality Assessment

- Testing Sequence Pool
  - Four original video in CIF (352x288) resolutions, 30 frames/sec (fps), each 8 seconds long
  - Each original video is coded following the H.264 scalable video coding (SVC) standard [JSVM912] and decoded at different frame rates (30, 15, 7.5, 2.75 fps) and quality levels (QP=28, 32, 36, 40), yielding 64 test sequences

- 20 viewer ratings for each processed video sequence
Proposed Quality Metric

\[ VQMTQ(f, PSNR) = Q(PSNR)TCF(f) \]

- \( Q(PSNR) \) models the quality at the highest frame rate:

\[ Q(PSNR) = \hat{Q}_{\text{max}} \left(1 - \frac{1}{1 + e^{p(PSNR-s)}}\right) \]

- Temporal Correction Factor (TCF) characterizes the quality drop with frame rate reduction:

\[ TCF = \frac{1 - e^{-b \frac{f}{f_{\text{max}}}}}{1 - e^{-b}} \]
Predicted vs. Measured Quality At the Highest Frame Rate

\[ Q(PSNR) = \hat{Q}_{\text{max}} \left( 1 - \frac{1}{1 + e^{p(PSNR-s)}} \right) \]
TCF vs. normalized MOS

\[ TCF = \frac{1 - e^{-b \frac{f}{f_{\text{max}}}}}{1 - e^{-b}} \]
Quality Model vs. Measured
Conclusion and Future Work

• **Conclusion**
  • Proposed model fits the subjective ratings accurately
  • Degradation of the perceptual quality due to quantization and frame-rate reduction are captured by two functions separately (sigmoidal function and inverted falling exponential).
  • Each function has a single parameter that is video-content dependent.

• **Future Work**
  • Investigate the correlation between model parameters and video content.
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Peer-to-Peer Video Streaming

- Peer-to-Peer Video Streaming
  - peers help each other retrieve video
  - exploit peer uploading/buffering capacity
  - low infrastructure cost

- Large scale deployments on Internet
  - thousands of live/on-demand channels
  - millions of world-wide users daily

- P2P streaming at poly
  - measurement, analysis, design, prototyping, security
  - two demos today
Multi-Channel System: Traditional Isolated Channel Design

P2P Sharing Rule: peers upload to each other only if they watch same channel

Channel 1

Channel 2
Multi-Channel System: Traditional Isolated Channel Design

**Drawback:** distribution systems disrupted when peers switch channels

after channel switching
New Design: View-Upload Decoupling

distribution swarms

viewers

Channel 1

Channel 2
View-Upload Decoupling

Channel 1

channel1 substream1
channel1 substream2

Channel 2

channel2 substream1
channel2 substream2

after channel switching

distribution swarms

viewers

substream1
substream2
VUD vs. ISO

- Robust against frequently peer channel switching
- Balance bandwidth resource cross channels
  - take care of long-tail channels
- Largely improved streaming delay performance
  - switching delay, playback delay
“View-Upload Decoupling: A Redesign of Multi-Channel P2P Video Systems”
Di Wu, Chao Liang, Yong Liu and Keith Ross,
Polytechnic Technical Report, August 2008

“Queuing Network Models for Multi-Channel P2P Live Streaming Systems”
Di Wu, Yong Liu and Keith Ross,
Polytechnic Technical Report, August 2008
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Goal: create incentives to contribute

- Incentive principle:
  - The more you upload, the better the video quality.
- Approach:
  - Layered coding
  - Trading layered chunks
- Aggregate bandwidth plentiful:
  - Everyone gets excellent quality
- Aggregate bandwidth scarce:
  - You get what you give
Deployment

- Tracker, server, and client
  - More than 10,000 lines of C++ code
  - Linux platform
Evaluation: underloaded; no free-riding

- 100+ PlanetLab Nodes;
- Video rate =630kbps (VBR), layers =300, 200, 130
Evaluation: overloaded; 15% free-rider

- Peers that upload more receive better video quality
- Free-riders receive a poor video quality
Demo Downstairs!

- Media server
- Tracker

Map showing locations of Stanford, UCSD, Chicago, Purdue, UIUC, JHU, Poly, and Brown.
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Thank You!!!