Mosaicing Videos to Stream Over Multiple Independent Channels

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- Practical MDC to create independent sub-streams
- Illustrate scalable quality and compression overhead
Motivation - MDC

- Multiple Description Coding (MDC): Split stream into independent sub-streams
  - No sub-stream is critical
  - Final quality depends on the number of sub-streams available
- Compare with Layered encoding
  - Enhancement layers require base layer
  - E.g., P and B frames require I frame
Motivation - Applications

• Some users fail to receive some streams

Losing links gracefully degrades quality
Motivation - Applications

- Some users fail to receive some streams

Internet/P2P ....

Losing links gracefully degrades quality
Our approach

Original Stream

Sub-Stream 1

Sub-Stream 2

Sub-Stream 3

Sub-Stream 4

Encode

Encode

Encode

Encode

Transmit

Sub-Stream 1

Sub-Stream 2

Sub-Stream 3

Sub-Stream 4

SD encoder (e.g., H.264)

Decide

Recombine

Received Stream

Split into sub-streams
Approach: Stream splitting

- **Spatial**
  - Neighboring pixels sent to different sub-streams
  - Reconstructed using pixel averaging
  - Retain some temporal redundancy for H.264
Approach: Stream splitting

- **Temporal**
  - Neighboring frames sent to different sub-streams
  - Retain some spatial redundancy for H.264
Approach: Stream splitting

- Quadrant based
  - Split frame into equal quadrants
  - Retain some spatial and temporal redundancy
  - Sub-streams may not be equal size
Transmission Error Resiliency

Our Approach

- enhancement layers (P or B)
- base layer (I)

SD Transmission

Staggered I frames
Evaluation Dataset

- **NDSet**
  - Plain background, little movement
  - CVRL data acquisition

- **MotorcycleSet**
  - Heavy motion
  - [www.motorcycle.com/mo/mcvideos/videos.html](http://www.motorcycle.com/mo/mcvideos/videos.html)
Experiments

• Resiliency to stream loss
  ▶ PSNR - Original vs Recombined stream
    □ With and without data loss
    ▶ Prefer: graceful degradation

• Sub-stream characteristics
  ▶ Encoding parameters for each sub-stream
  ▶ Discussed in paper

• Peak stream requirement
  ▶ Prefer: uniform rather than spiky
    □ E.g., Tavarua used multiple cellular links
Results - Data Loss

- Worst case data loss: initial 1500 bytes of I-frames zero’d
- Traditional Method: 1500 bytes per I-frame
- Sub-stream methods
  - experimented with 1, 2, 3 and all streams
    - 1500 byte per stream or four times data loss
Results: ND – Zero’d all I-frames

Conventional SD (H.264)
Results: Motorcycle - Zero’d all I-frames
Results: ND - frame size

Sub-streams smoother
Less demand on each link
Temporal - I frame ~ Traditional
Spatial - I frame ~ Quadrant

Frame Number

Size

0 2000 4000 6000 8000 10000 12000 14000 16000 18000

1 5 9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69 73 77 81 85 89 93 97

Traditional  Quadrant
Results: Motorcycle - frame size

Sub-streams smoother
Less demand on each link
Temporal - I frame ~ Traditional
Spatial - I frame ~ Quadrant
Conclusions

- MDC functionality using SD encoders
  - Sub-stream independently encoded
    - MDC higher overhead versus SD coding
- Temporal: Bursty transmission
  - I frame ~ original
- Spatial: fault tolerant
  - high overhead (lost spatial redundancy)
- Quadrant: low compression overhead
  - fault tolerant: iff lost quadrant was unimportant
Future Work

- Adaptive sub-stream compression parameters
- Generate sub-streams in compression domain
- Versatile sub-stream creation (not just four)
Results: ND- half I-frame
Results: Motorcycle- half I-frame