Systematic Lossy Error Protection based on H.264/AVC Redundant Slices

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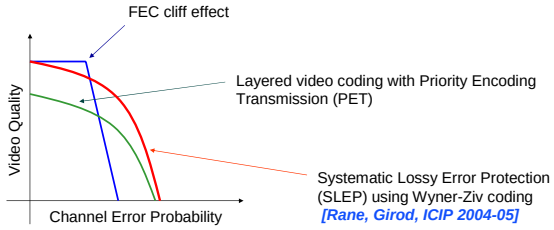
Error-Resilient Video Transmission

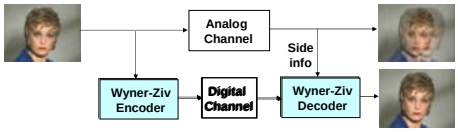


Construct Wyner-Ziv codec using H.264/AVC redundant slices

Outline

- Systematic lossy source/channel coding
- SLEP implementation based on H.264/AVC redundant slices
- Simulation results

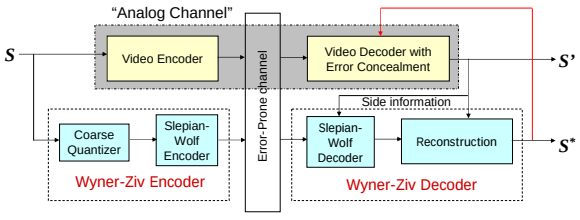
Systematic Lossy Source/Channel Coding



[Shamai, Verdú, Zamir, 1998]

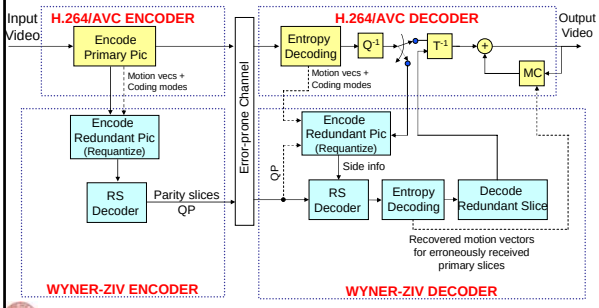
- Enhancing analog image transmission using digital side information
  [Pradhan, Ramchandran, 2001]
- Error-resilient distributed video compression schemes
  [Sehgal, Ahuja, 2003-04], [Xu, Xiong, 2004]
- Systematic lossy source-channel coding of video waveforms
  [Aaron, Rane, Girod, 2003-04-05]

SLEP for Video Transmission

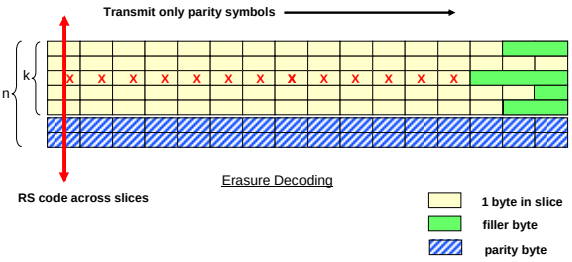


- Analogous to systematic source/channel coding
- Error corrected up to a distortion introduced by coarse WZ quantizer, hence lossy protection *[Rane, Aaron, Girod, ICIP 2003]*

SLEP using H.264/AVC Redundant Slices



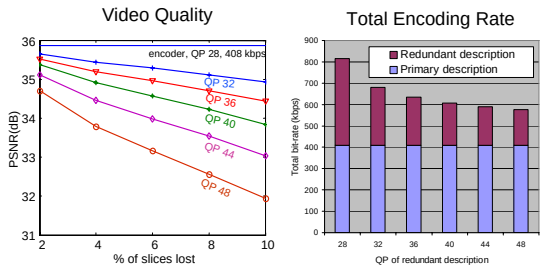
Reed-Solomon Coding Across Video Slices



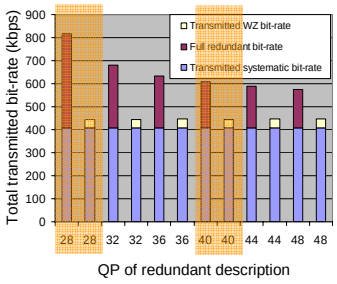
Experimental Setup

- Systematic Transmission → H.264/AVC primary coded bitstream
- WZ Codec → Redundant slices + Reed-Solomon Slepian-Wolf codec
- Same slice boundaries for primary and redundant slices
- GOP structure : *I-B-P-B-P-…*
- Unequal WZ protection for B and P frames
- Previous frame concealment

Resilience using Redundant Slices



SLEP based on Redundant Slices (*Foreman*)

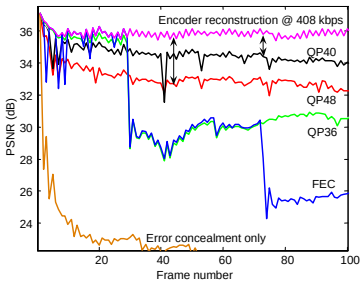


- Transmit WZ coded version of the video signal
- WZ bit-rate ~ 10% of bit-rate of the primary description
- Coarser redundant description has stronger error-resilience but greater quantization mismatch

Primary (systematic) description @ 408 kbps with QP 28.

SLEP based on Redundant Slices (*Foreman*)

Video quality for various redundant descriptions
Symbol error probability = 5 x 10^{-4}



Systematic bit-rate 408 kbps, WZ bit-rate ~ 40 kbps
Symbol error probability = 5 x 10^{-4}

Error-free
35.7 dB

SLEP with redundant QP = 40
28.9 dB

Summary

- SLEP based on H.264/AVC redundant slices support
- Trade-off between error resilience and quantization mismatch introduced by redundant description
- Graceful degradation of received video quality compared to FEC

- Recent work
  - H.264/AVC rate control to modulate QP of redundant description
  - SLEP on region-of-interest using Flexible Macroblock Ordering (FMO)