Systematic Lossy Error Protection Versus Layered Coding with Unequal Error Protection

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Outline
- Systematic source-channel coding
- Systematic Lossy Error Protection (SLEP) using Wyner-Ziv coding
- SLEP versus Layered Coding with Unequal Error Protection

Systematic Source-Channel Coding
- Enhancing analog transmission systems using digital side information
- Lossy source-channel coding of video waveforms

Systematic Lossy Error Protection (SLEP)
- Analogous to systematic source-channel coding
- Error corrected up to a distortion introduced by coarse WZ quantizer, hence lossy protection.

Practical scheme for Lossy Error Protection

Limitations of traditional error-resilience methods
- Forward Error Correction (FEC).
- Layered video coding with UEP
- Systematic Lossy Error Protection (SLEP) [Rane, Girod, ICIP 2004]

How does SLEP compare with Layered Coding in terms of resilience to transmission errors?
Reed-Solomon codes across slices

Transmit only parity symbols

RS code across slices

Erasure Decoding

1 byte in slice
filter byte
parity byte

Simulation setup

- SLEP
  - Systematic Transmission → MPEG-2 coded bitstream
  - WZ Codec → Coarse Quantizer + RS Slepian-Wolf codec.
  - Identical slice structure for main and WZ stream
  - Main and WZ descriptions use same motion vectors and mode-decisions
  - MPEG GOP structure: I-B-P-B-B-P-...
  - Previous-frame error concealment

- Layered Coding with Unequal Error Protection
  - Video Codec → 2 layer MPEG-2 SNR scalable video codec.
  - Error protection → RS coding across slices.
  - MPEG GOP structure: I-B-P-B-B-P-...
  - Previous-frame error concealment

Average Video Quality vs. Error Probability

Bus 100 CIF frames @ symbol error rate = 10⁻⁴

With FEC
1 Mbps + 111 Kbps
(26.58 dB)

With (BL, EL) = (500 Kbps, 500 Kbps)
1 Mbps + 74 Kbps + 37 Kbps
(28.4 dB)

Instantaneous Video Quality (High Error Prob.)

Bus 100 CIF frames @ symbol error rate = 10⁻⁴

With FEC
Total: 1 Mbps + 111 Kbps
(26.58 dB)

With WZ description @ 500Kbps
1 Mbps + 111 Kbps
(28.69 dB)
Conclusions

- A Wyner-Ziv bitstream provides error-resilience in a systematic source-channel setup.
- Unlike layered coding, SLEP benefits from efficient R-D performance at low error probabilities.

Instantaneous Video Quality (Low Error Prob.)