Systematic Lossy Forward Error Protection for Error-Resilient Digital Video Broadcasting

- A Wyner-Ziv Coding Approach

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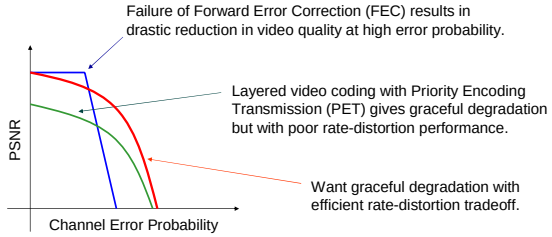
Limitations of traditional error-resilience methods

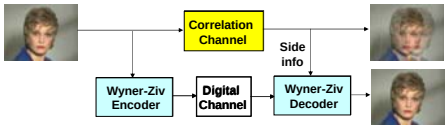


Proposed approach : Wyner-Ziv coding of the video signal

Outline

- Systematic source-channel coding
- Lossy Forward Error Protection using Wyner-Ziv coding
- Results : Comparison of FEP and FEC

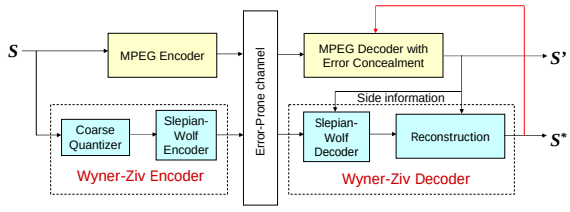
Systematic Source-Channel Coding



[Shamai, Verdu, Zamir, 1998]

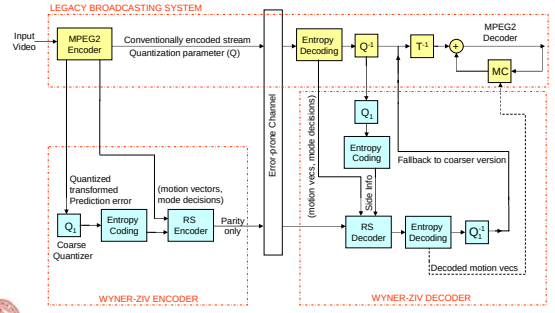
- Enhancing analog transmission systems using digital side information *[Pradhan, Ramchandran, 2001]*
- Error-resilient video compression schemes *[Sehgal, Ahuja, 2003],[Xu,Xiong, 2004]*
- Lossy source-channel coding of video waveforms *[Aaron, Rane, Girod, 2003]*

Systematic Lossy Forward Error Protection

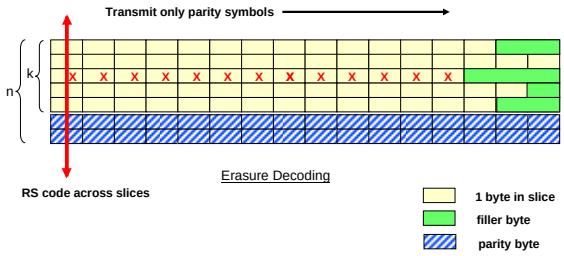


- Analogous to systematic source-channel coding
- Error corrected up to a distortion introduced by coarse WZ quantizer, hence ***lossy*** protection.

Practical scheme for Forward Error Protection



Reed-Solomon codes across slices



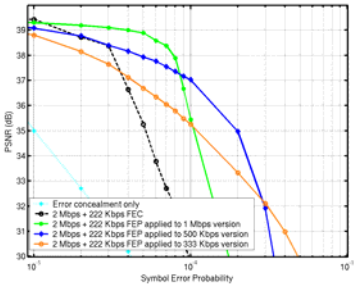
Results (1) Average video quality

foreman.cif @ 2 Mbps
222 Kbps parity

100 frames @ 30 fps

I-B-B-P-B-B-P…
Intra every 30 frames

PSNR avg. over 25 traces



Results (2) Instantaneous video quality

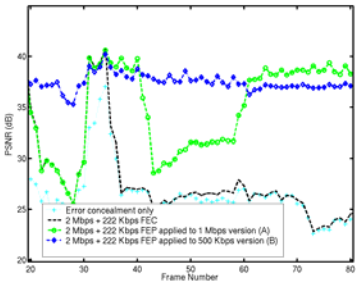
foreman.cif @ 2 Mbps
222 Kbps parity

100 frames @ 30 fps

I-B-B-P-B-B-P…
Intra every 30 frames

Sequence PSNRs

FEP (A) : 37.30 dB
FEP (B) : 35.45 dB
FEC : 29.78 dB
ERC : 26.19 dB



Results (3) Visual Comparison

Foreman 100 CIF frames @ symbol error rate = 10^{-4}

With FEC
Total : 2 Mbps + 222 Kbps
(29.78 dB)

With WZ description @ 1Mbps
2 Mbps + 222 Kbps
(35.45 dB)

Results (4) Visual Comparison

Foreman 100 CIF frames @ symbol error rate = 10^{-4}

With WZ desc. @ 1 Mbps
2 Mbps + 222 Kbps
(35.45 dB)

With WZ desc. @ 500 Kbps
2 Mbps + 222 Kbps
(37.03 dB)

Conclusions

- A Wyner-Ziv bitstream can be used to provide error-resilience in a systematic source-channel setup.
- Presented a practical systematic lossy error protection scheme for error-resilient digital video broadcasting.
- Scheme delivers superior decoded picture quality compared to conventional FEC over a wide range of error rates.
- Scheme achieves graceful quality degradation without requiring a layered signal representation in the systematic transmission.