PROTECTION OF REGIONS OF INTEREST AGAINST DATA LOSS IN A GENERALIZED MULTIPLE DESCRIPTION FRAMEWORK

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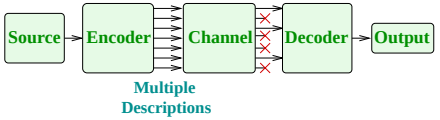
Introduction

- Goal: Protect Region of Interest (ROI), so if data loss occurs, a high quality ROI can still be reconstructed.
- Method: Extend the framework of MD-SPIHT (ICIP'99) by adding more redundancy to the ROI than to the background.
  - Compression Algorithm: Set Partitioning in Hierarchical Trees (Said and Pearlman'96).
  - Framework: Generalized Multiple Description Coding/Packet Erasure Networks.

Generalized Multiple Description Coding

Goyal, Kovačević and Vetterli'98



Goal: Satisfactory image quality when only a subset of descriptions is received.

MD-SPIHT: Algorithm

Packetization:

- Based on PZW (Rogers and Cosman'98).
- Code spatially disperse wavelet coefficient trees in each description.

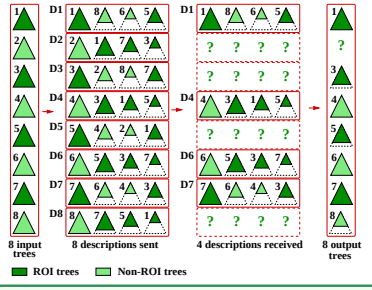
Adding Redundancy:

- Place extra copies of each tree in other descriptions.
- Code each copy at successively lower bit rates (unequal loss protection).

MD-SPIHT with ROI: Algorithm

- Wavelet coefficients in the ROI are scaled with a large factor. ROI is coded:
  - to a higher bit rate than the background.
  - in the earlier parts of the SPIHT bit stream.
- MD-SPIHT adds more redundancy to the earlier parts of the bit stream:
  - Locally important information has more redundancy than globally important data.
  - ROI is protected more at the expense of lower protection in the background.

MD-SPIHT with ROI: Coding Example



Optimization of the Redundancy Allocation

- Minimize the expected distortion of the received data subject to a description loss model (use BFOS):

$$D = \sum_{i=1}^{M} \sum_{j=1}^{N} p_{ij} D_{ij}.$$

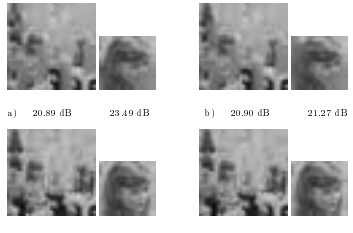
  p_{ij} - probability of using jth copy of ith tree.
  D_{ij} - scaled distortion of jth copy of ith tree.
- p_{ij} - based on description loss model and packetization.
- D_{ij} - very high for ROI trees because of scaling.
- Original and redundant ROI trees are assigned higher bit rates than background trees.

MD-SPIHT with ROI: Results

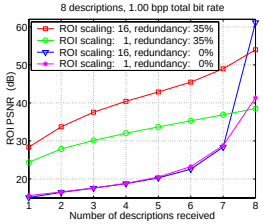
35% redundancy, 1.0 bpp, ROI scaling factor of 16.
1 – 4 descriptions received out of 8.

MD-SPIHT with ROI: Results

5/8 descriptions received. 1.0 bpp, ROI scaling factor & redundancy: a) 1, 0%, b) 16, 0%, c) 1, 35%, d) 16, 35%.



MD-SPIHT with ROI: Results



ROI quality for 1–8 descriptions received.

MD-SPIHT with ROI: Results

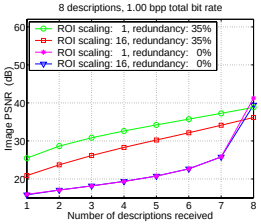
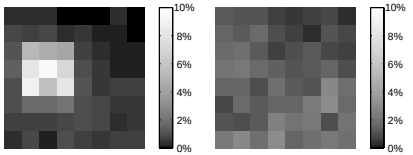


Image quality for 1–8 descriptions received.

MD-SPIHT with ROI: Results

35% redundancy allocation for the ROI scaled by 16 (left) and no scaling (right) for the girl image.



MD-SPIHT with ROI: Conclusions

- High ROI quality is achieved even when only a few descriptions are received.
- Can be extended to other compression schemes (wavelet, DCT, and VQ, JPEG 2000).
- Future Work: Joint optimization of the ROI scaling factor and redundancy allocation.

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