Synthetic Aperture Radar Image Compression

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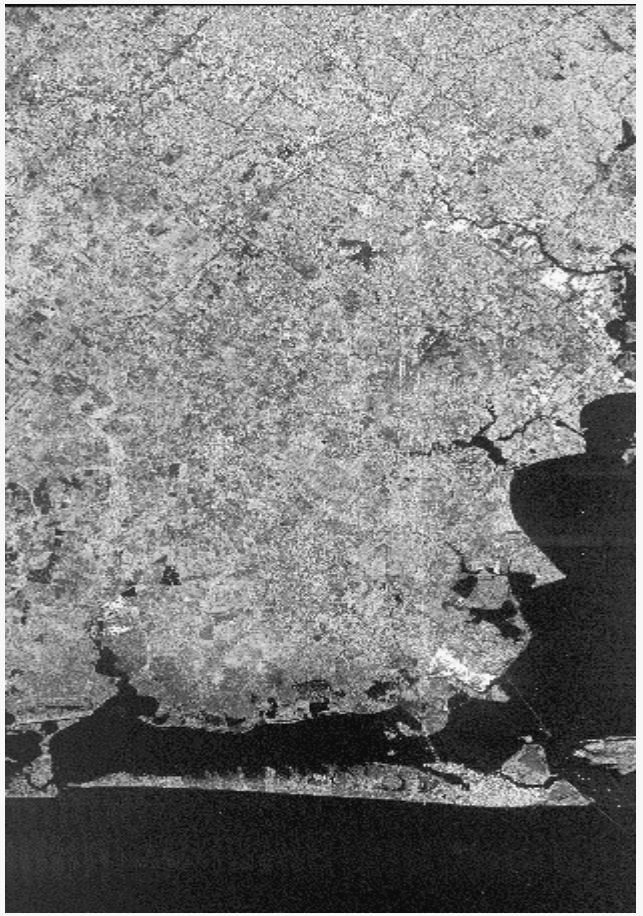
Synthetic Aperture Radar (SAR)

- SAR ?
  - Active imaging system
  - Working in the frequency range 1-10 GHz
  - All-weather system
  - High resolution compared to real aperture radar
- Applications
  - Agriculture, ecology, geology, oceanography, hydrology, military...
- Nature of SAR images
  - High volume of data
  - Speckle noise
  - More information in high frequencies than optical images

Lossy Image Compression Techniques

- Joint Photographic Experts Group (JPEG)
  - Discrete Cosine Transform
  - Fast implementation
  - Blocking artifacts
- Set Partitioning In Hierarchical Trees (SPIHT)
  - Discrete Wavelet Transform
  - Good visual quality
  - Ringing effect for high compression ratios



Quality Metrics for SAR Images

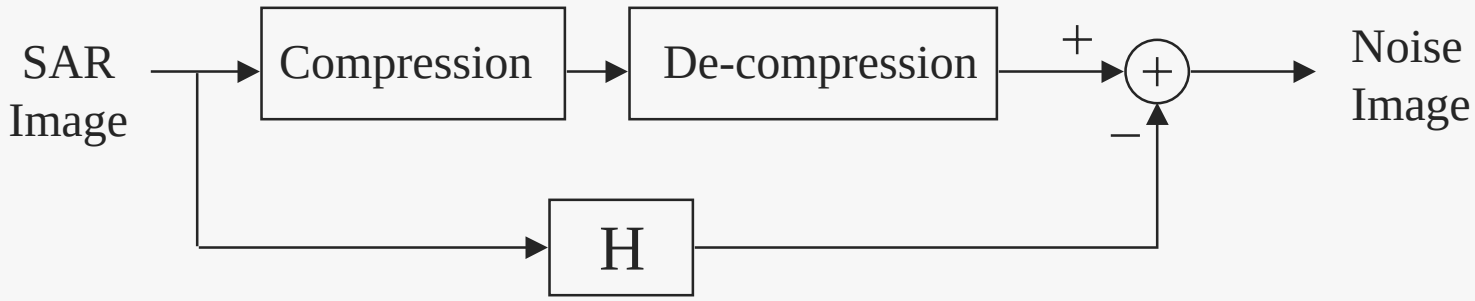
- Standard Metrics
  - Mean Squared Error (MSE)
  - Signal to Noise Ratio (SNR)
  - Peak Signal to Noise Ratio (PSNR)

- Other Metrics for SAR Images
  - Weighted Signal to Noise Ratio (WSNR)
  - Linear Distortion Quality Measure
  - Correlation of Edge Information

Simulations

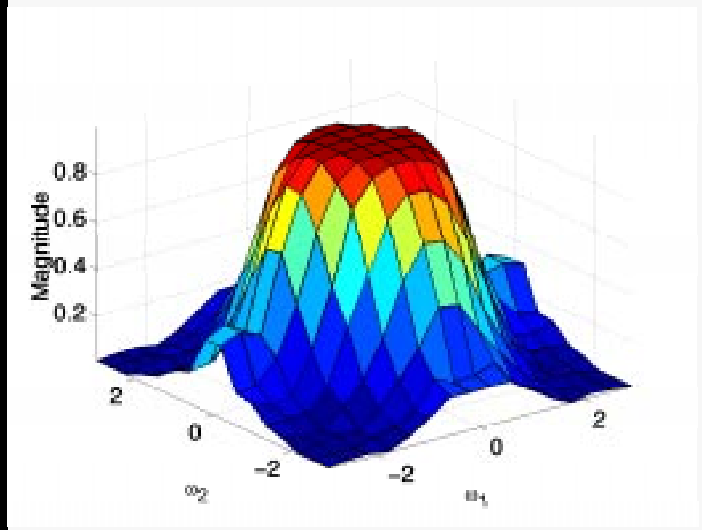
- ✔ Space borne Imaging Radar-C and X-Band Synthetic Aperture Radar
- ✔ 512 x 512 Sub-Images
- ✔ 8 bit grayscale
- ✔ Pre-filtered by a modified σ-filter
  - adapted to handle spot noise

Estimation of a Linear Model

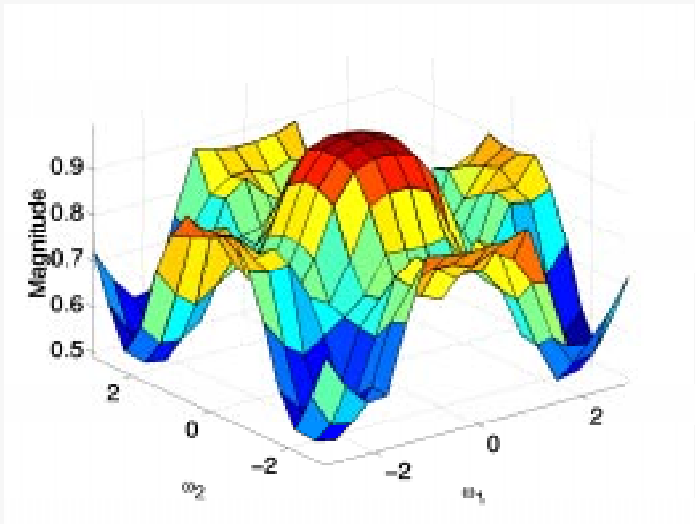


- ✔ Linear Least Square Estimate
- ✔ Linear Model is needed to
  - compute the Noise Image
  - estimate the Distortion Transfer Function (DTF)
- ✔ Drawbacks
  - Model assumes uncorrelated additive noise
  - Variance of the estimate

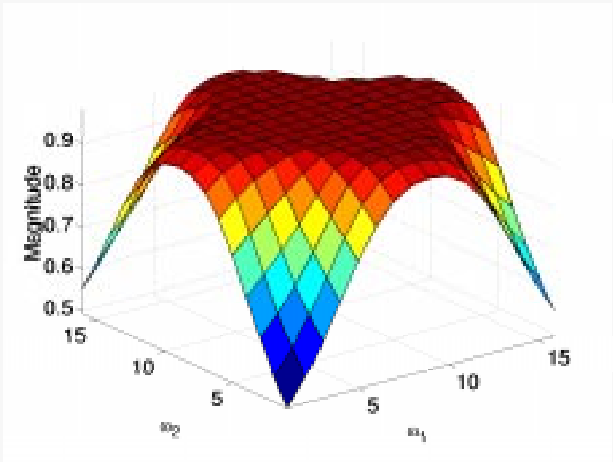
Linear Models



JPEG

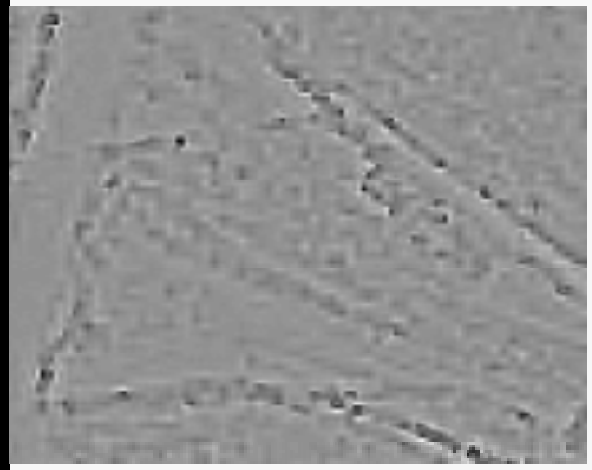


SPIHT



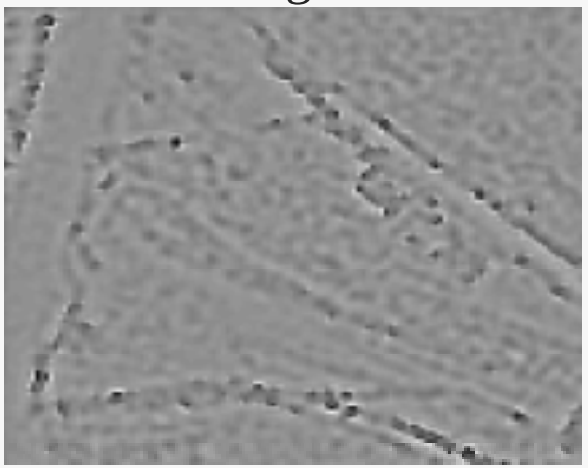
CSF

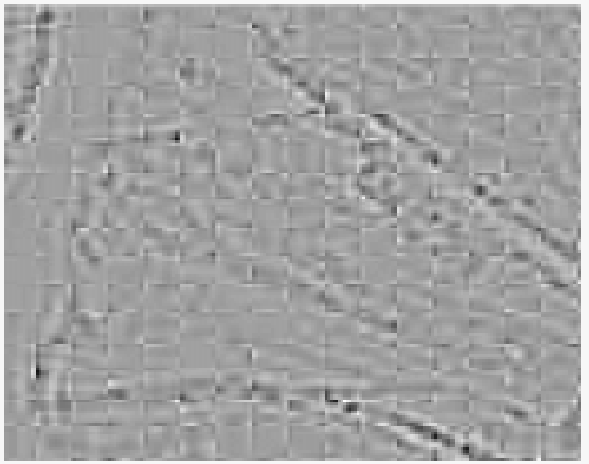
Correlation of Edge Information



SPIHT

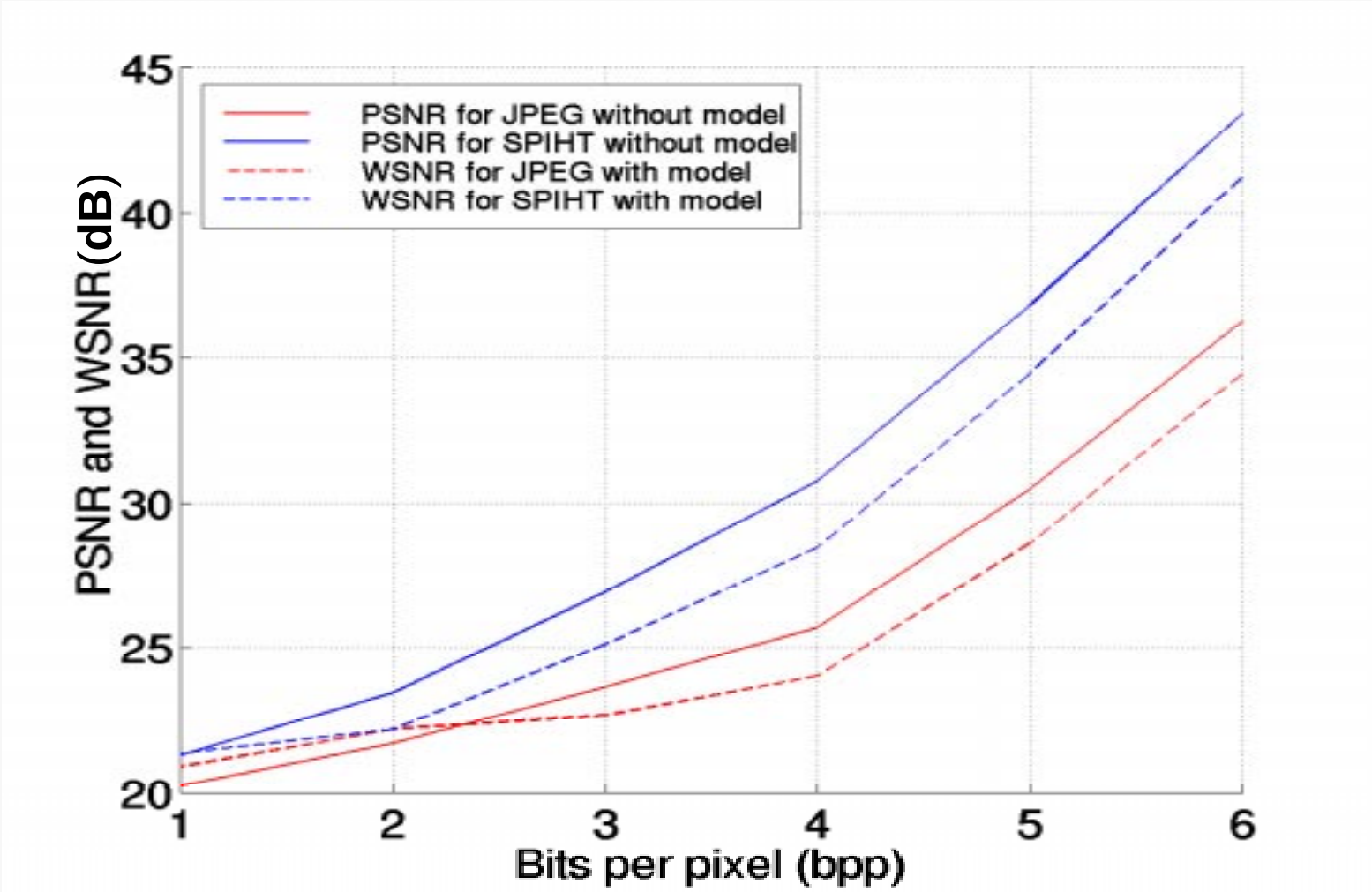
Original



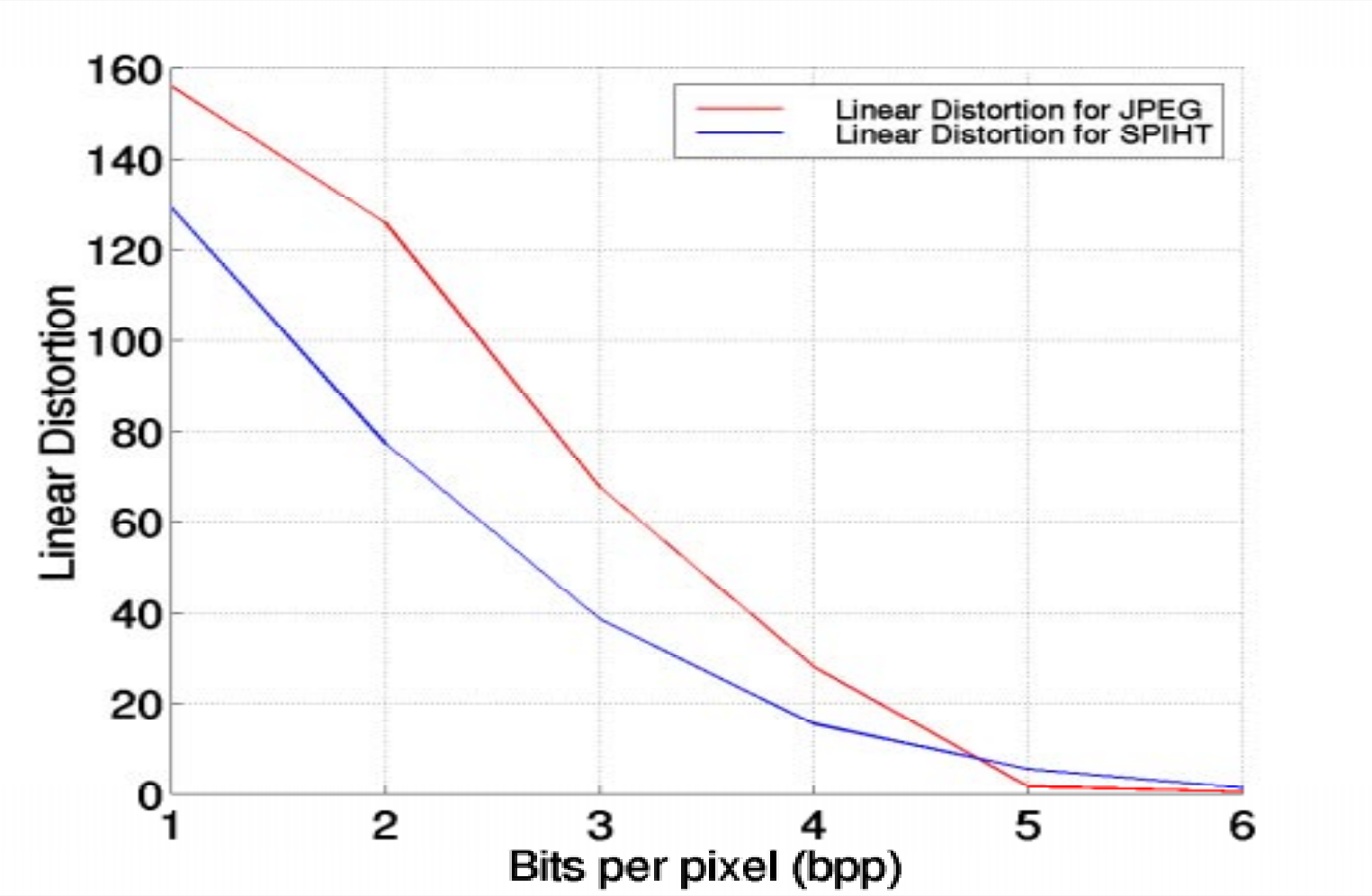


JPEG

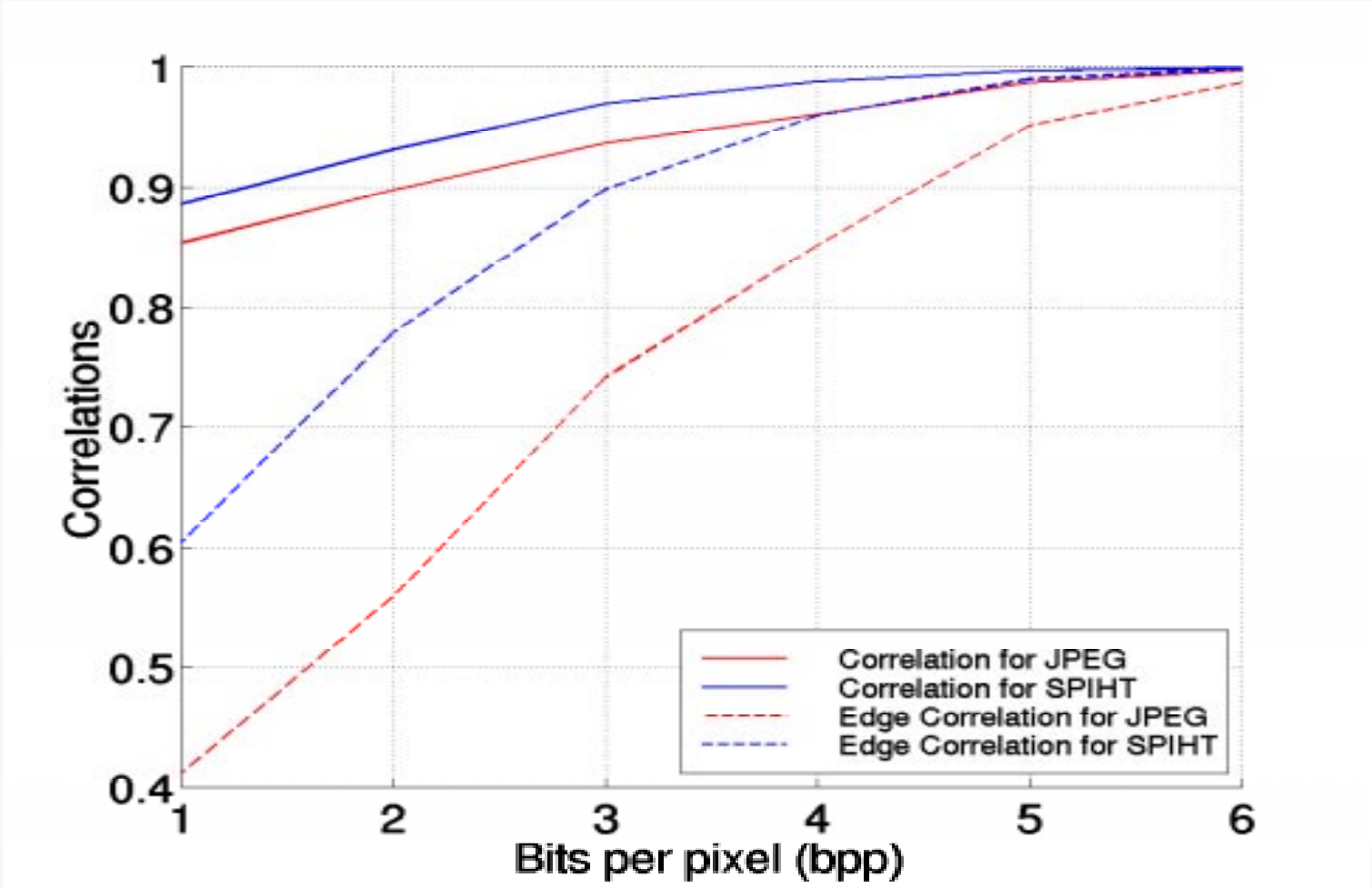
Results - WSNR and PSNR



Results - Linear Distortion Measure



Results - Correlation



Conclusions

- ✔ Standard metrics does not give results consistent with visual quality
- ✔ A framework for evaluation of SAR Images
  - Weighted Signal to Noise Ratio
  - Linear Distortion Measure
  - Distortion of edge information
- ✔ SPIHT outperforms JPEG