COMPRESSIVE SENSING FOR LOW-COMPLEXITY VIDEO CODING

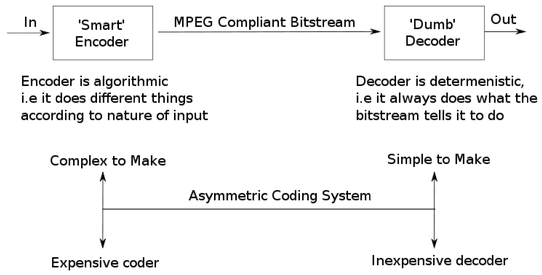
M. Salman Asif[1], Felix Fernandes[2], and Justin Romberg[1]

[1]Georgia Institute of Technology [2]Samsung Telecom America

Background and Motivation:

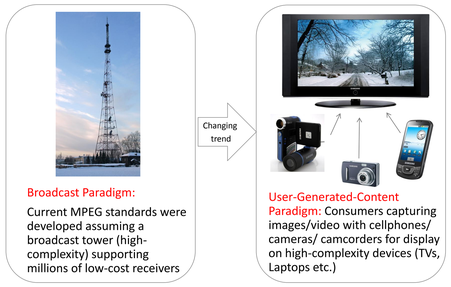
"Compression achieved by removing the spatio-temporal redundancies in the videos"

Current video coding paradigm:



Major blocks in the encoder:
Motion estimation, Transform coding, Entropy coding

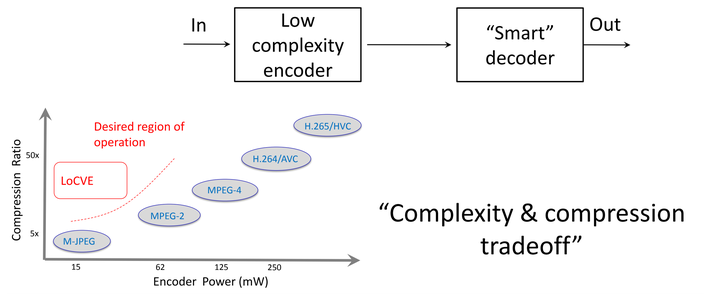
Why low complexity encoding?



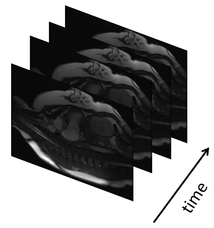
Need for low complexity and low power image/video capture in portable devices

Low Complexity Video Encoding (LoCVE)

shifts processing burden from the encoder to the decoder



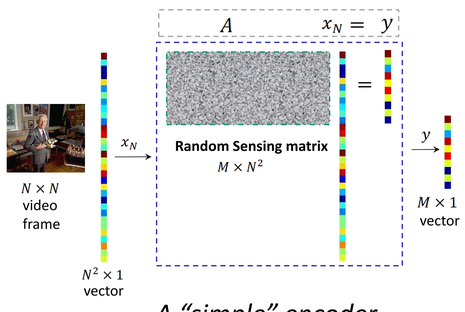
"Complexity & compression tradeoff"



Applicable to other imaging modalities

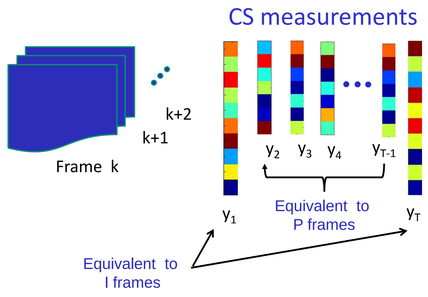
Medical imaging (e.g., dynamic MRI)
Hyperspectral Imaging

Structure and Randomness:



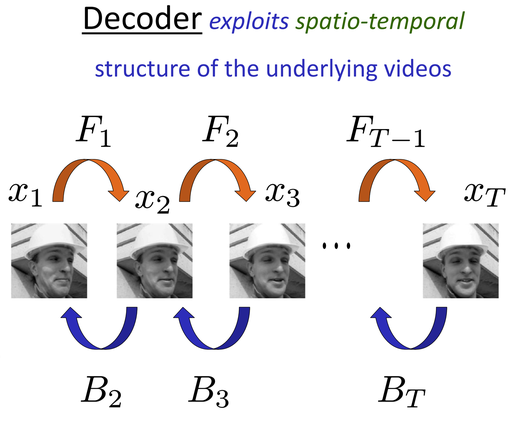
A "simple" encoder

Encoder complexity is minimal, and all the computational load is shifted to the decoder

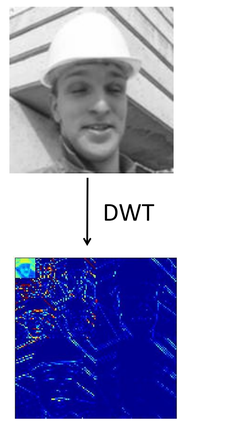


In a block of T frames, encode the 1st frame and the last frame in a set with *more* measurements

This helps with "motion information propagation"



Temporal decorrelation
(Motion estimation and compensation)



Spatial decorrelation
(Wavelets or Total variation)

Recovery scheme:

Pseudocode:

0. Find Initial frame estimates
Repeat
   1. Calculate motion from frame estimates
   2. Use the motion information to refine estimates

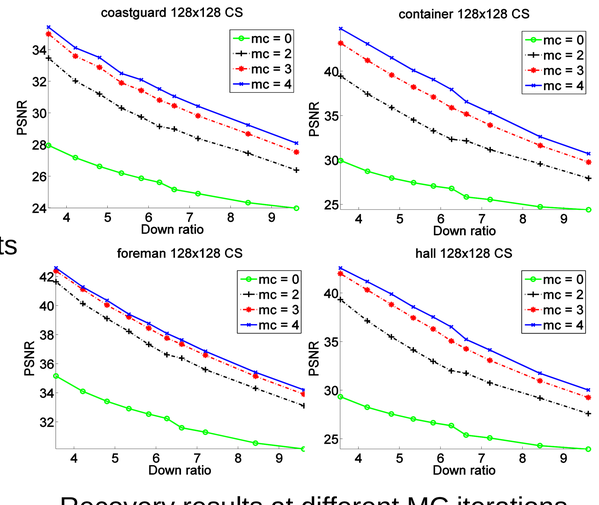
Example convex problem:

$$\underset{x_1,\ldots,x_T}{\text{minimize}} \sum_k \underbrace{\|A_k x_k - y_k\|_2}_{\text{Data fidelity}} + \underbrace{\tau_k \|x_k\|_{\Psi_1}}_{\text{Spatial regularity}} + \underbrace{\alpha_k \|F_k x_k - x_{k+1}\|_{\Psi_2}}_{\text{Forward motion res.}} + \underbrace{\beta_k \|B_k x_k - x_{k-1}\|_{\Psi_3}}_{\text{Backward motion res.}}$$

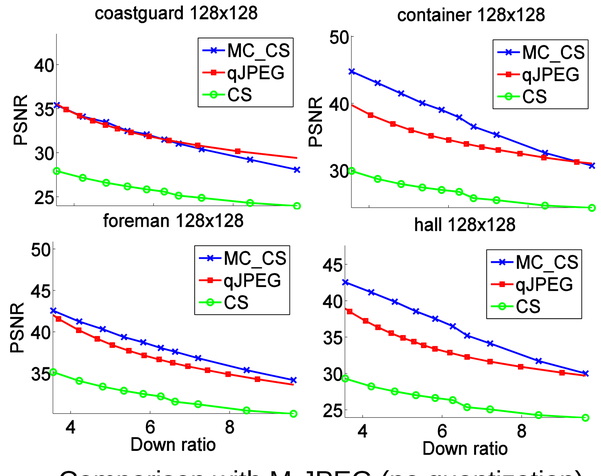
Experiments:

Setup:

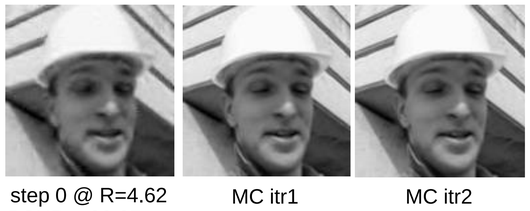
Measurements:
   Scaling coefficients+Noiselets
   Boundary frames have more samples
Spatial regularization:
   ℓ_1 analysis with biorthogonal complex wavelets
Motion estimation and compensation:
   ME via complex wavelets local phase
   MC via bilinear interpolation
   ℓ_1 analysis on motion residuals



Recovery results at different MC iterations



Comparison with M-JPEG (no quantization)



step 0 @ R=4.62
PSNR = 32.07

MC itr1
PSNR = 39.7

MC itr2
PSNR = 40.2

email: sasif@gatech.edu