# Predictive Reflected Residual Vector Quantization (PRRVQ)


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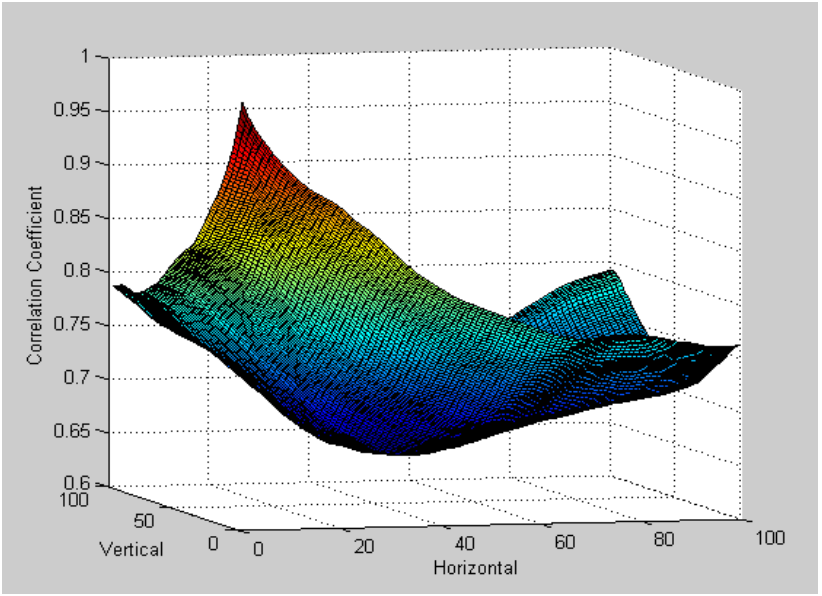
# Introduction

- Image communications is primarily constrained due to large bandwidth requirements.
- Compression Techniques allows us to increase bandwidth.
- Combination of DPCM and RRVQ provide good results for image compression.

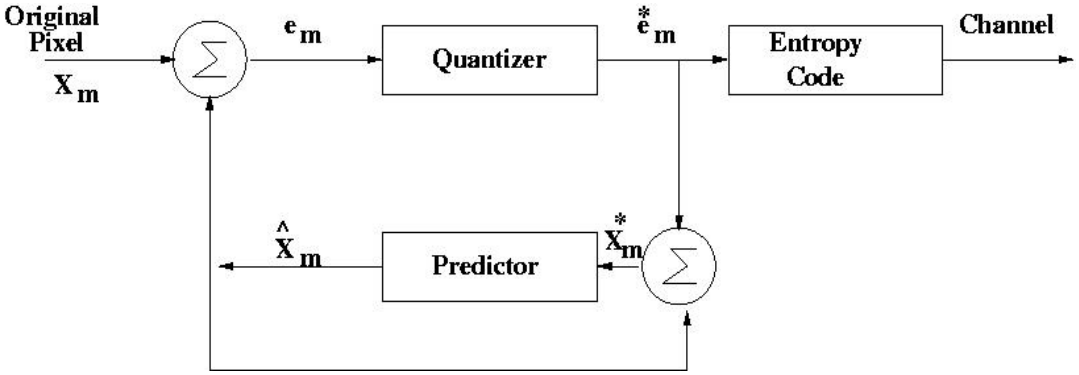
# Temporal Correlation



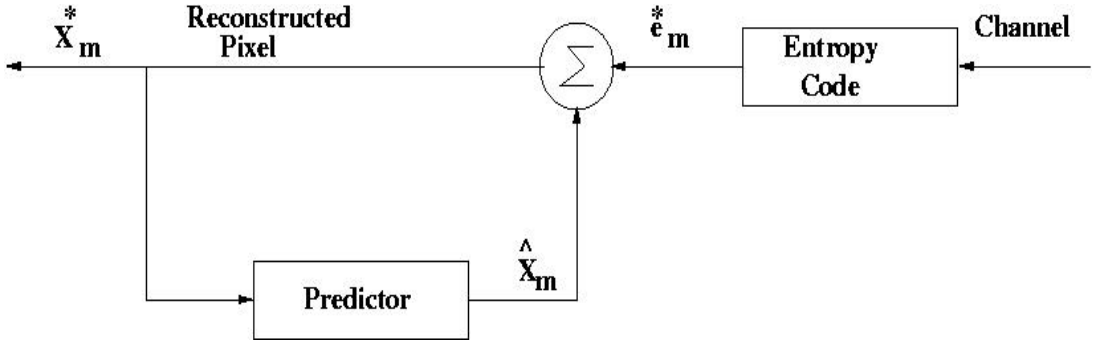

To Extract Correlation, Differential Pulse Code Modulation is needed.

# What is DPCM?

Encoder




Decoder




**DPCM pixel-to-pixel correlation remover**

# DPCM Drawbacks

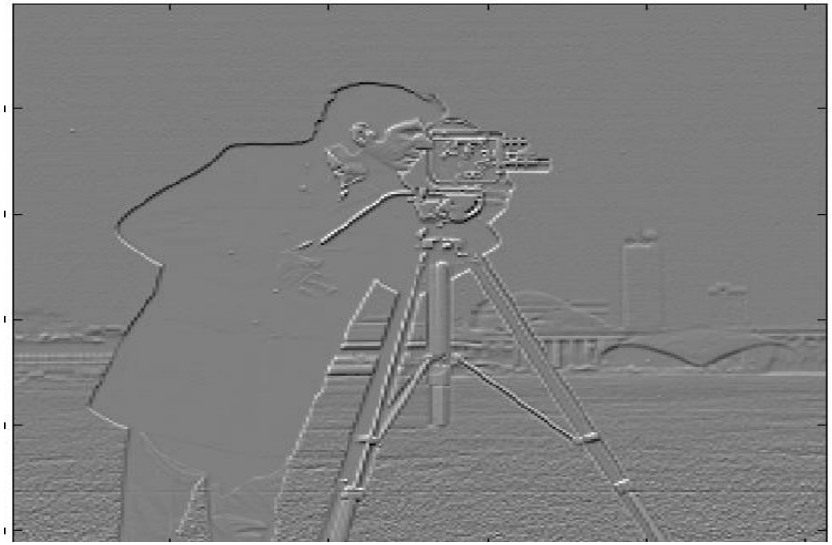
- DPCM has several drawbacks which prevents its uses in some circumstances.

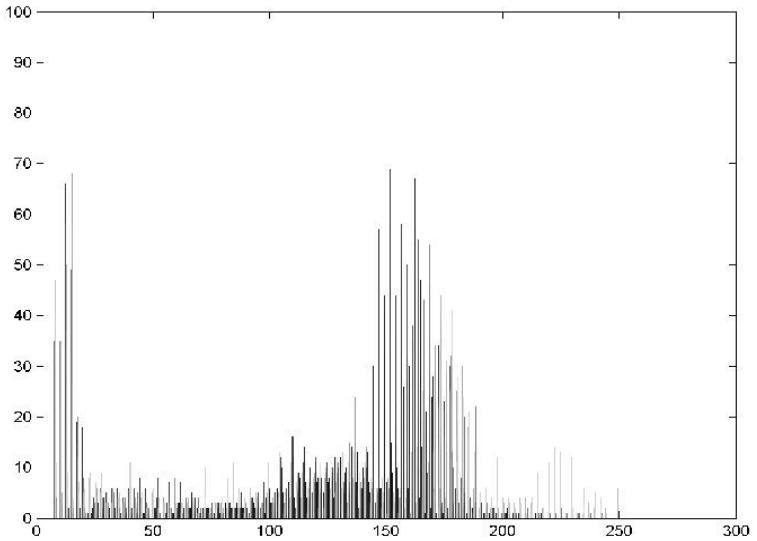
- Two main drawbacks are

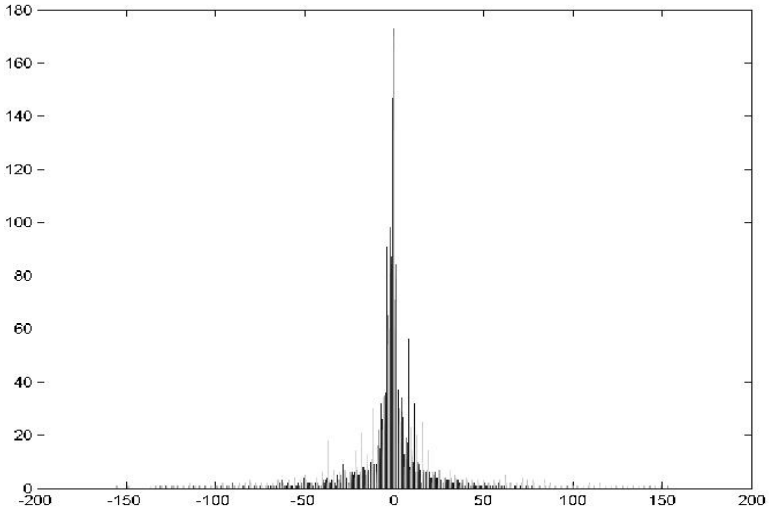
1. Channel error sensitivity

2. Poor rate distortion performance

# DPCM Results





# Alternative Solution

- DPCM Predictive Residual images are coded using Vector Quantization (VQ) such a structure is referred to as Predictive Vector Quantization (PVQ).

- Although the PVQ structure is simple and well understood, its design is problematic due to feedback loop involved .

# Predictive vector Quantization (PVQ)

- Two simple approaches for PVQ design exist.

1. First approach referred to as open loop, solves the vector Quantization design problem by assuming no feed back.

2. The second approach referred to as closed loop is an iterative design employed for updating the training set and the quantizer given a fixed predictor.

# PVQ (cont.)

- Closed loop was improved further by jointly optimizing vector predictor and quantizer.

- The stated design showed improvement but exhibit significant stability problem.

- The stability of closed loop design is analyzed and a modified design with a name of Asymptotic closed loop is proposed.

# Asymptotic PVQ

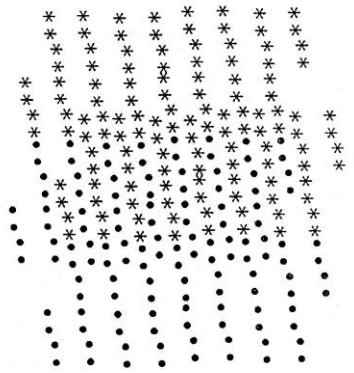
- Solved stability problem but vector size is constrained.
- RVQ introduced to solve vector size constraint.
- For very large vector sizes, RVQ is also not the best choice.
- For very large vector sizes, like 16x16 or 32x32, we employ Reflected RVQ.

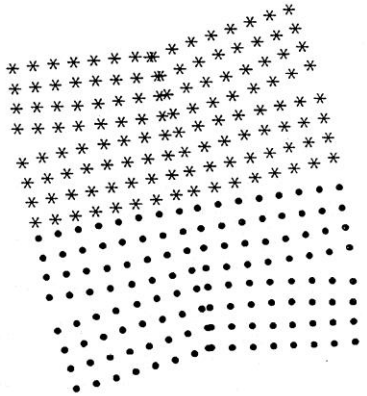
# Reflected Residual Vector Quantization (RRVQ)

- A Reflected RVQ is a multi-stage structure with binary stage code-books

1-Reflection Constraint

2-Sequential Search becomes optimal





# Predictive Reflected Residual Vector Quantization (PRRVQ)

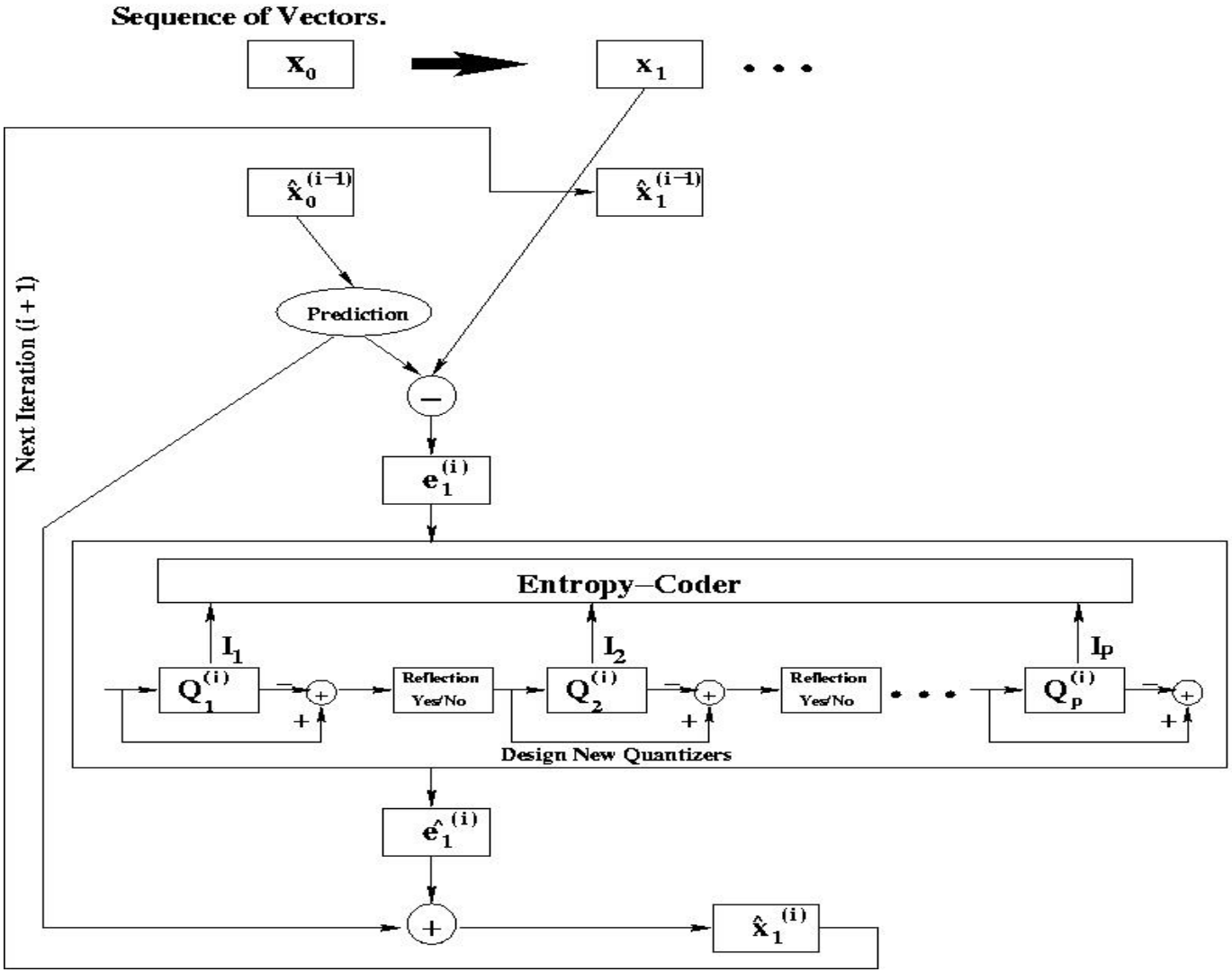
- To extract linear and most of the non-linear correlation among image source, we suggest the use of large block RRVQ with current PVQ structure.

- Large block RRVQ take advantage of linear or non-linear correlations present among the block of pixels and the predictive structure with feed back loop to exploit the intra block dependencies

# Asymptotic Closed Loop

- ACL design was adopted for incorporating reflected RVQ in a PVQ structure
- The operation of ACL can be described in the following steps
  - The training set of prediction errors are generated by subtracting prediction vectors of previous iteration from current input
  - The errors are then quantized and used to produced reconstruction vectors
  - The above process is repeated from iteration to iteration

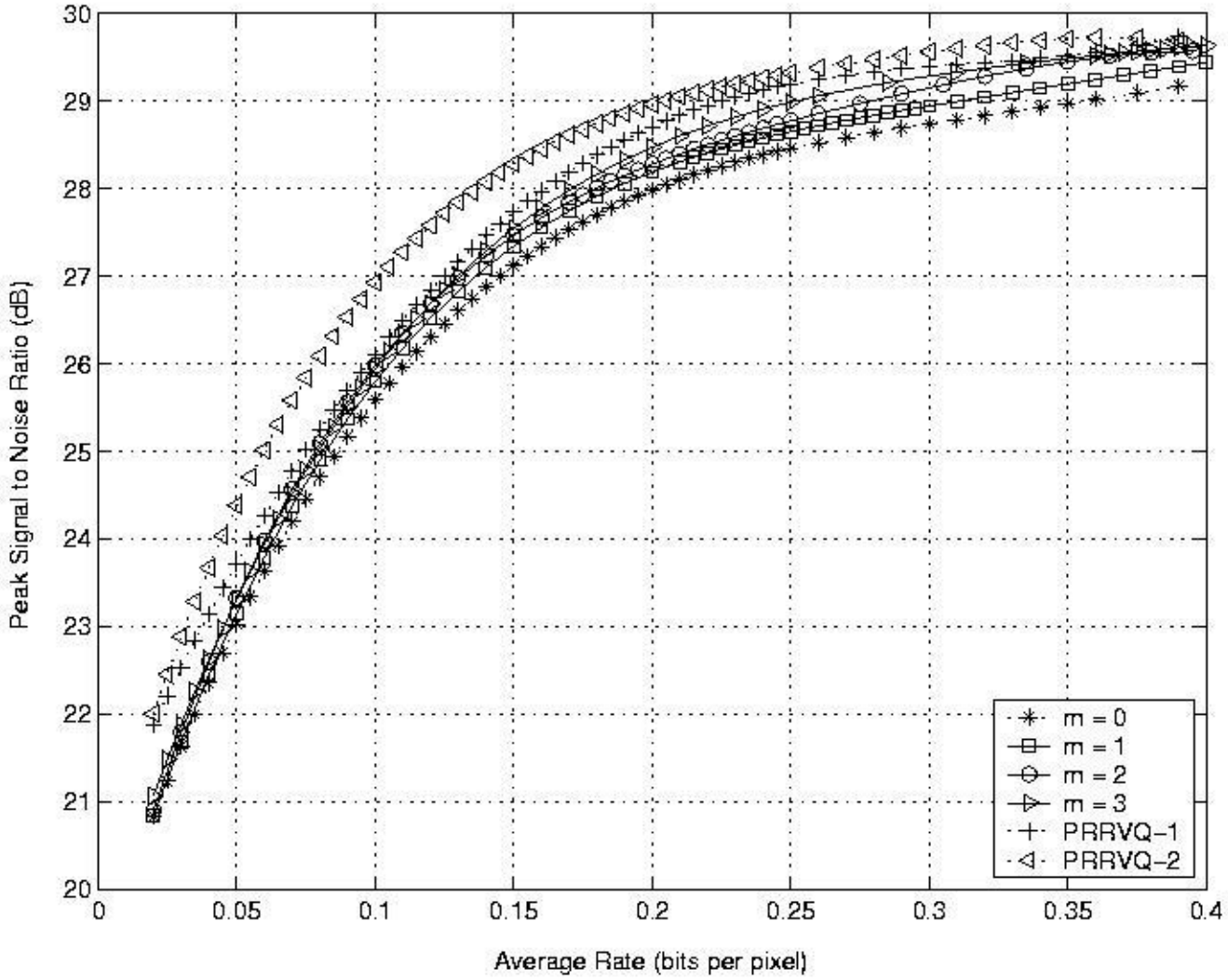
# Asymptotic closed loop + RRVQ



# Simulation Results

- PRRVQ is compared with unpredictive RRVQ
- The training set comprised of more than 500000 vectors and 32 fixed rate RRVQ stages were designed giving 0.05 bpp
- The results were compared at different order of markov model
- The second order PEC-RRVQ emerges as the most successful predictive quantizer design

# Comparison


Peak Signal to Noise Ratio (dB)
Average Rate (bits per pixel)
30
29
28
27
26
25
24
23
22
21
20
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
m = 0
m = 1
m = 2
m = 3
PRRVQ–1
PRRVQ–2

# Subjective Evaluation

**Image Barbara coded using**
**(a) CEC-RVQ at a bit rate of 0.28 bpp with PSNR of 24.54 dB (b) PEC-RRVQ**
**(b) at a bit rate of 0.282 bpp with PSNR of 24.61 dB. Both of dimensions 8x8**


# Q & A
# Thank You