Image Compression

April 19, 06

- What to code:
  - How to quantize
  - How to do bit allocation

- lossy vs. lossless.

- Requirements on Compression system
  - Compression efficiency / Ratio
  - encode / decode complexity.

- Video: 2 way → low delay for # interactive application
  < 150 msec.

- 1 way: one time encode → many time decode

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Image Compression

"What To code"?

(1) Waveform Coding

- PCM = pulse Code Modulation
- DPCM = Differential " "

(2) Transform coding

- DCT
- KLT

(3) Subband / Wavelet / Multiresolution Coding

(4) Fractal Coding, Vector quantization

/

(5) Video coding → motion estimation / Compensation

(6) Audio Coding

(6) Pick one standard. → JPEG, JPEG 2000, MP3, H.264, H.263, MPEG 1, 2, 4.

How To Evaluate / Compare various compression Technique

$f(n_1, n_2) \rightarrow$ [compression] $\rightarrow \hat{f}(n_1, n_2)$

↑ original

Normalized mean square error

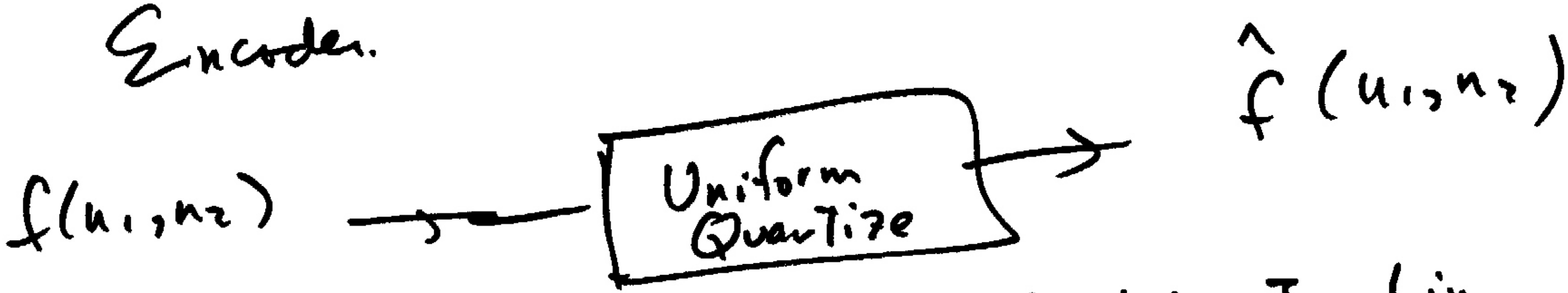
$$\text{NMSE in } \% = 100 \left(\frac{\text{Var}\left[\hat{f}(n_1,n_2) - f(n_1,n_2)\right]}{\text{Var}\left[f(n_1,n_2)\right]} \right) \%$$

$$\text{SNR in dB} = 10 \log_{10} \left(\frac{\text{NMSE in } \%}{100} \right)^{-1} \text{dB}$$

$$\text{SNR in dB} = 10 \log_{10} \left(\frac{\text{Var}(f)}{\text{Var}(\hat{f} - f)} \right)$$

Pulse Coding Modulation

Encoder.

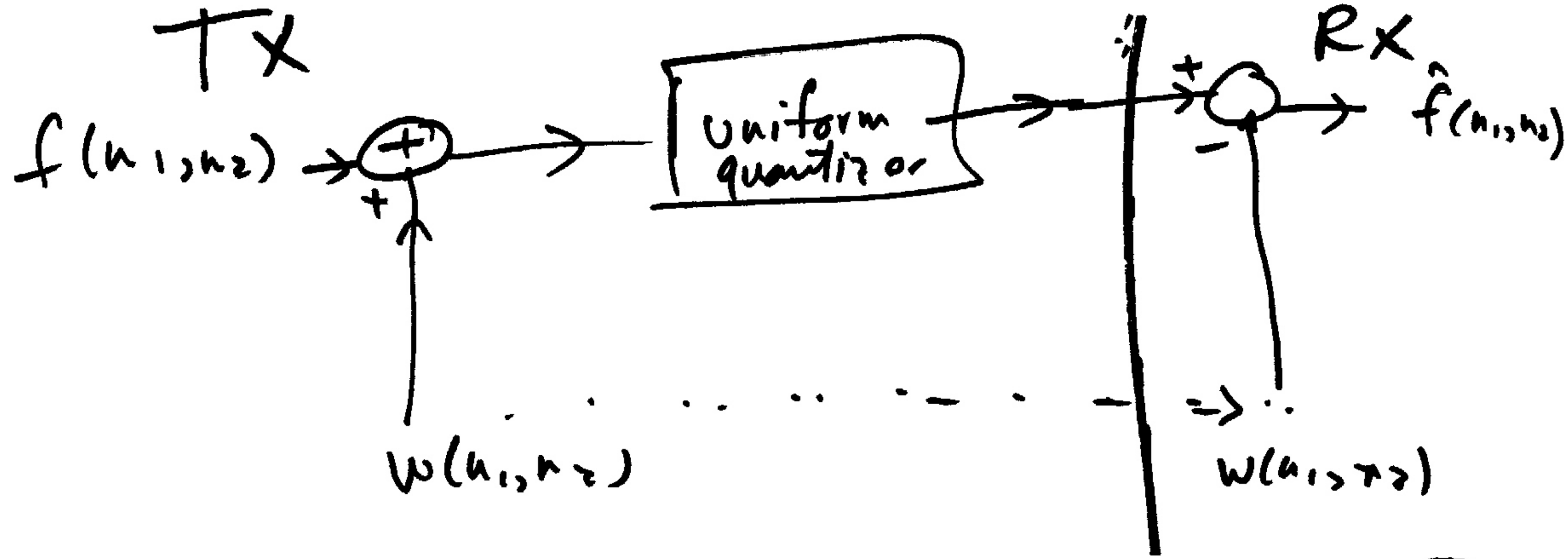


shown 10.22 (a), (b) J. Lim.

<u>How to fix</u>

Robert's Pseudonoise Technique.

transmitter/encode



$w(n_1,n_2)$ is known both at Rx and at Tx.

choose $w(n_1,n_2)$ = white noise seq with uniform pdf.

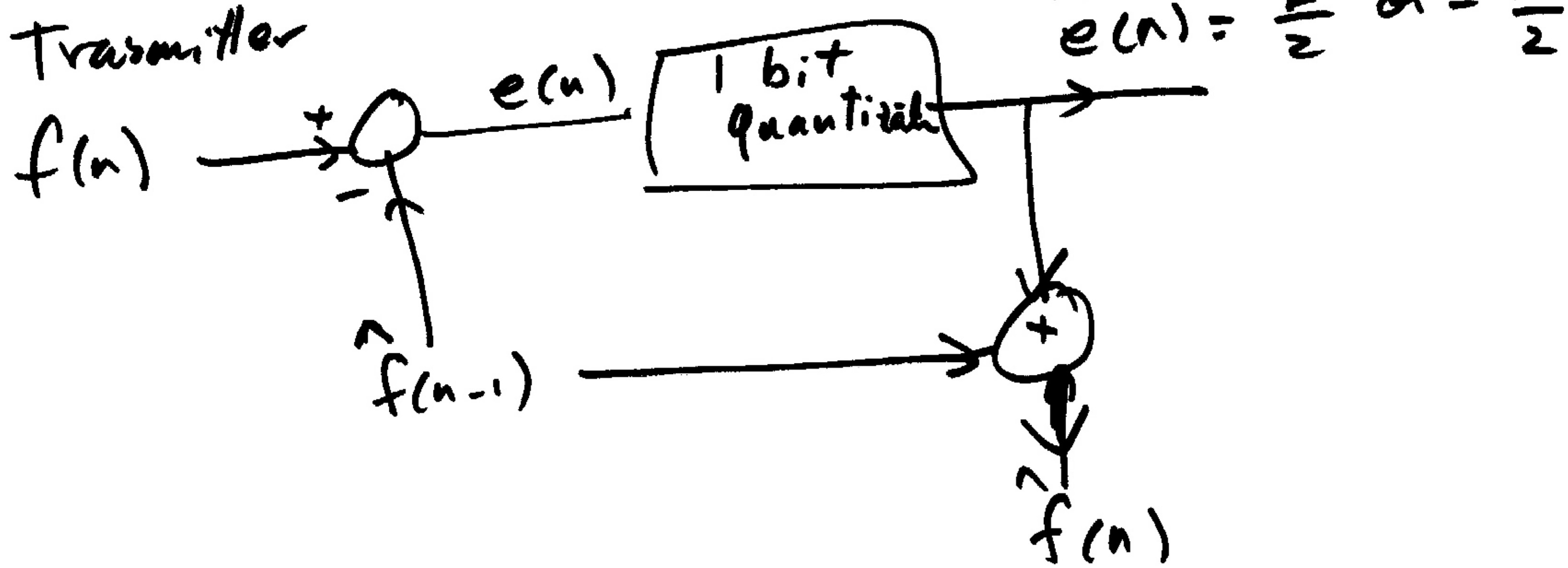
$$P_w(w_0) = \begin{cases} \frac{1}{\Delta} & -\frac{\Delta}{2} < w_0 < \Delta/2 \\ 0 & \text{otherwise.} \end{cases}$$

Δ = quantization step size.

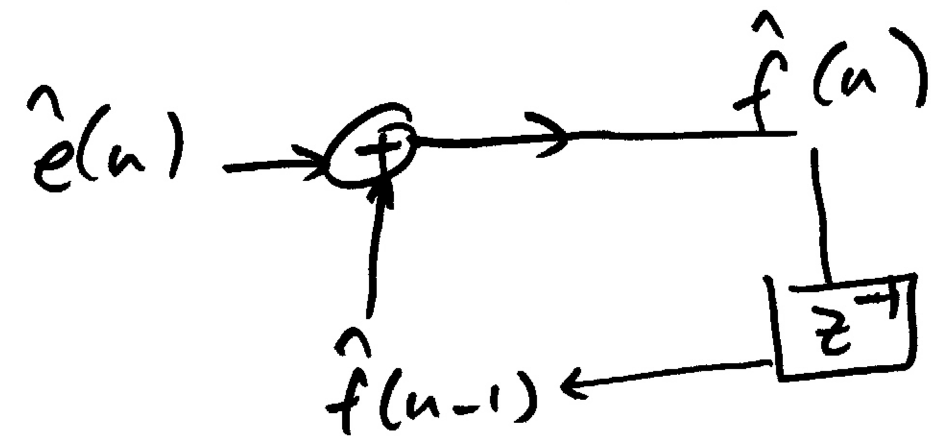
Fig 10.21 J. Lim
10.22 " "

Improve visual quality by doing postprocess to reduce noise.

Delta Modulation



Receiver



$e(n) = f(n) - \hat{f}(n-1)$

$\hat{e}(n) = \begin{cases} \frac{\Delta}{2} & e(n) > 0 \\ -\frac{\Delta}{2} & e(n) < 0 \end{cases}$

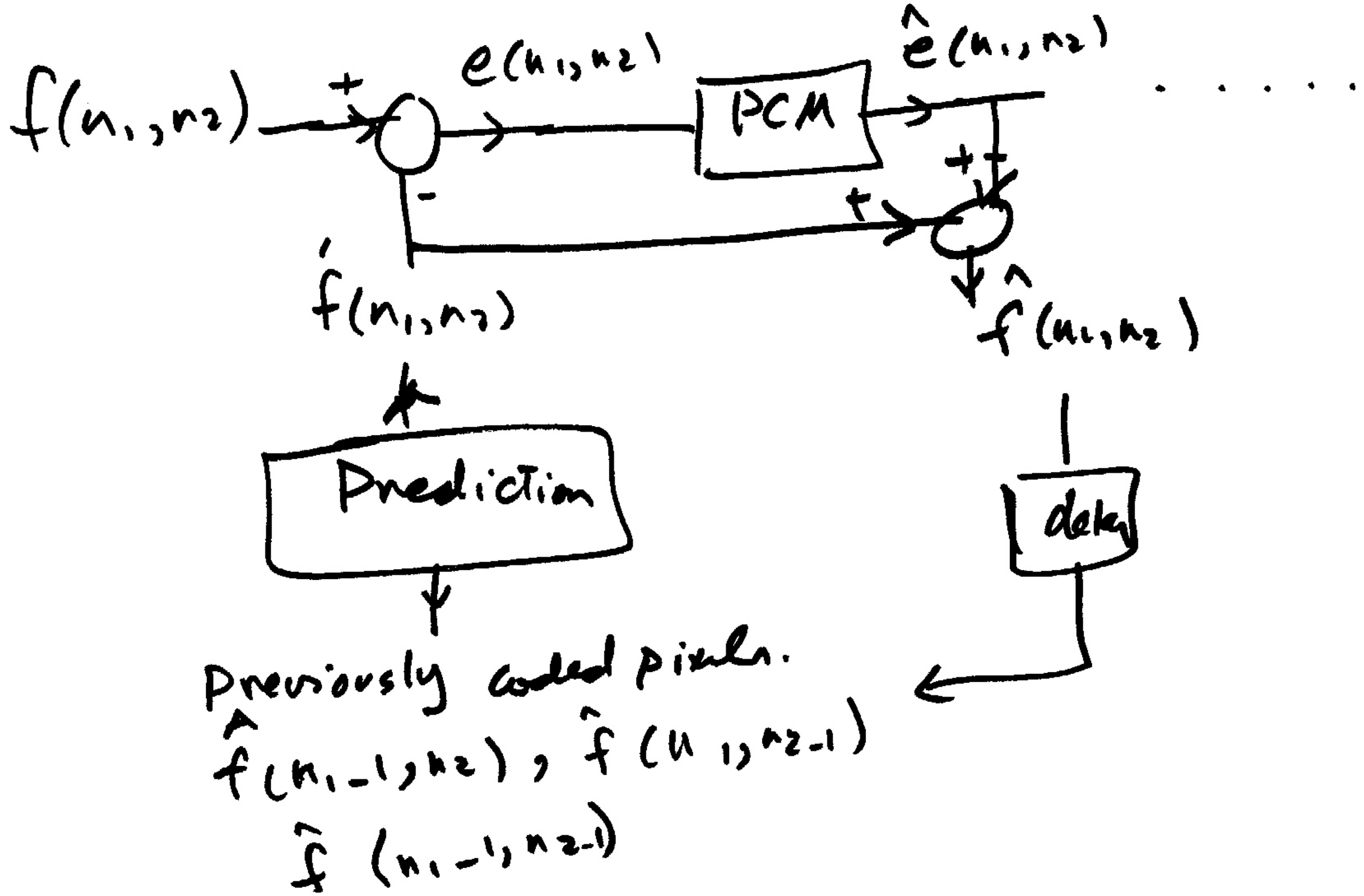
quantization noise $= \hat{f}(n) - f(n) = \hat{e}(n) - e(n)$

How To pick Δ optimally?

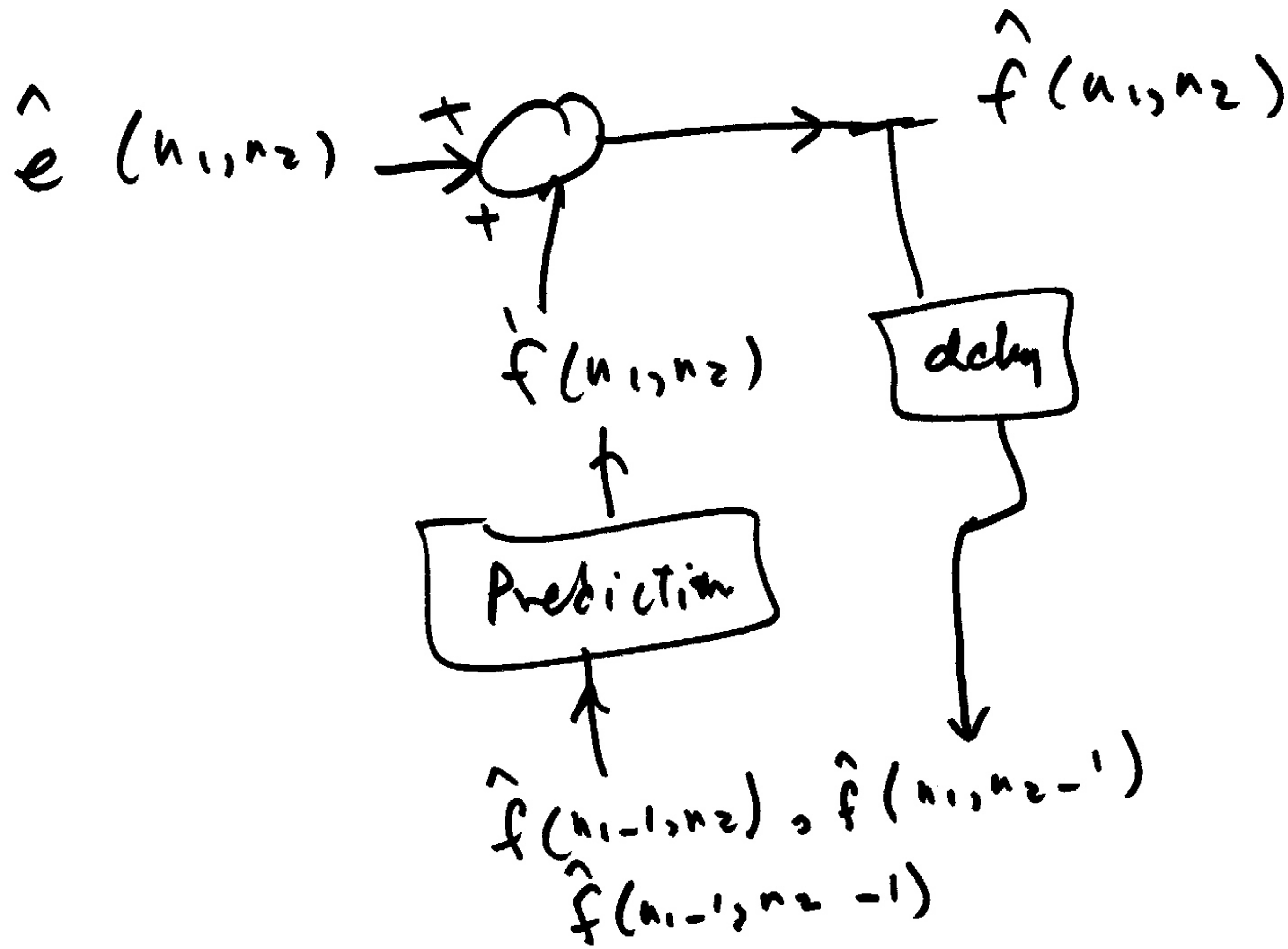
Fig 10.26 J. Lim
10.27

DPCM = Differential Pulse Code Modulation

Transmitter



Receiver.



$\hat{e}(n_1, n_2)$
+
+
$\hat{f}(n_1, n_2)$
delay
$f'(n_1, n_2)$
Prediction
$\hat{f}(n_1-1, n_2)$, $\hat{f}(n_1, n_2-1)$
$\hat{f}(n_1-1, n_2-1)$

How to do Prediction

$$\grave{f}(n_1, n_2) = \sum_{(k_1, k_2) \in R_a} \sum a(k_1, k_2)\, \hat{f}(n_1 - k_1, n_2 - k_2)$$

how to choose a

minimize

$$E\left[e^2(n_1, n_2)\right] =$$

$$E\left[\left(f(n_1, n_2) - \sum\sum a(k_1, k_2)\, \hat{f}(\ldots)\right)^2\right]$$