AV312 - Lecture 13

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Figures from "Communication Systems" by Haykin and "An Intro. to Analog and Digital Commn." by Haykin and Moher

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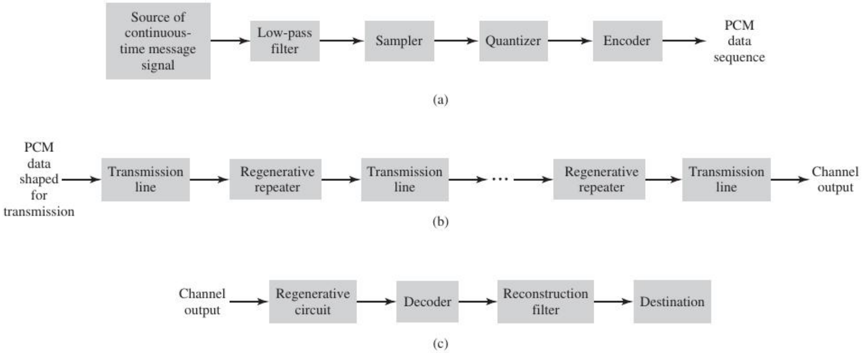
Review of last classes

- Sampling
- Pulse amplitude modulation (PAM)
- Quantization
- Pulse code modulation (PCM)

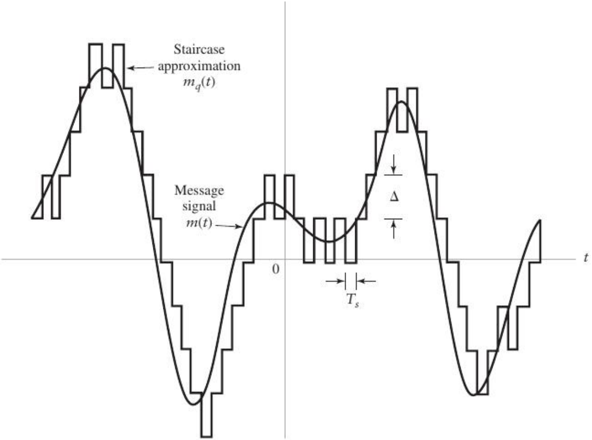
Today's class

- Review of Pulse code modulation
- Delta modulation
- Delta-Sigma modulation
- Differential PCM
- Today's scribes are Mrinalini and Muhammed Althaf

Pulse code modulation

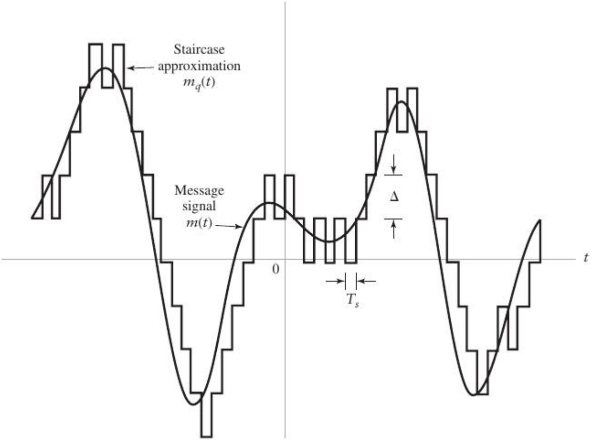


Delta modulation



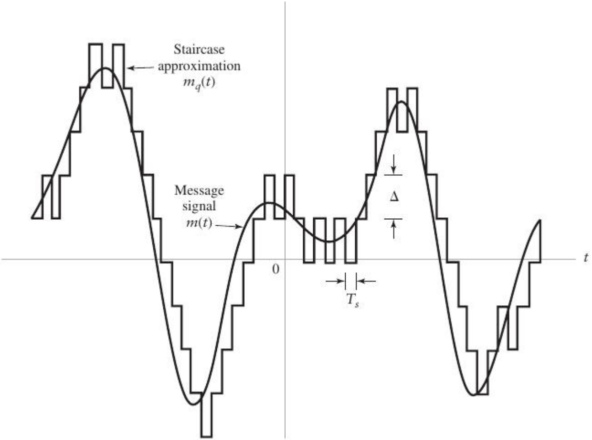
- $e(nT_s) = m(nT_s) - m_q(nT_s - T_s)$

Delta modulation



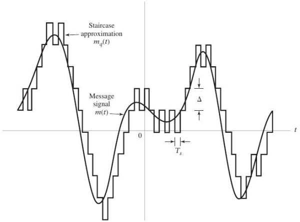
- $e(nT_s) = m(nT_s) - m_q(nT_s - T_s)$
- $e_q(nT_s) = \Delta sgn(e(nT_s))$

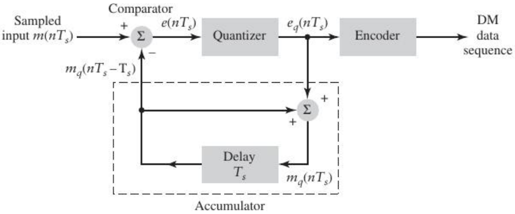
Delta modulation



- $e(nT_s) = m(nT_s) - m_q(nT_s - T_s)$
- $e_q(nT_s) = \Delta sgn(e(nT_s))$
- $m_q(nT_s) = m_q(nT_s - T_s) + e_q(nT_s)$

Delta modulation system

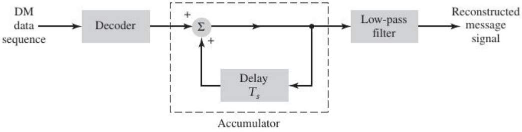


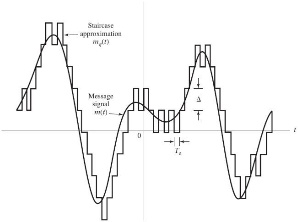


- $e(nT_s) = m(nT_s) - m_q(nT_s - T_s)$; $e_q(nT_s) = \Delta sgn(e(nT_s))$
- $m_q(nT_s) = m_q(nT_s - T_s) + e_q(nT_s)$

- Fast sampling increases "correlation" between samples
- Possible to have same performance as a quantizer with more steps!

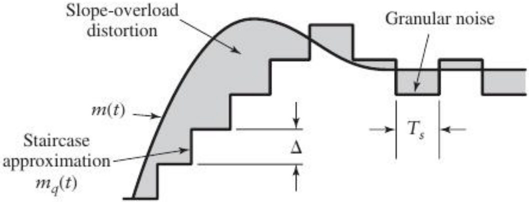
Delta demodulation system





- $m_q(nT_s) = m_q(nT_s - T_s) + e_q(nT_s)$
- $m_q(nT_s) =$
  $m_q(nT_s - 2T_s) + e_q(nT_s) + e_q(nT_s - T_s)$
- $m_q(nT_s) = \sum_{i=1}^{n} e_q(iT_s)$

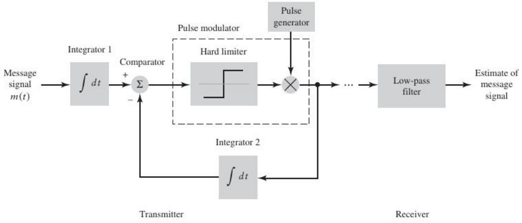
Errors/Distortions in delta modulation



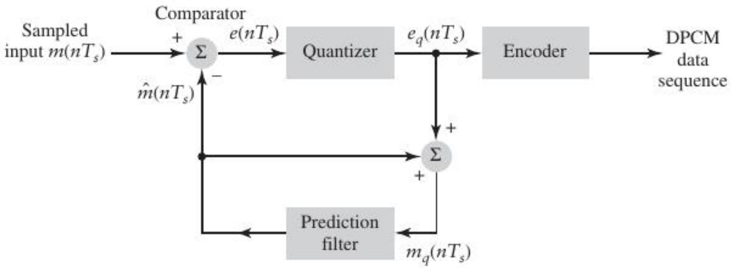
- Slope overload distortion and Granular noise
- Suppose $q(nT_s)$ is the quantization error, i.e. $q(nT_s) = m(nT_s) - m_q(nT_s)$. Then $e(nT_s) = m(nT_s) - m(nT_s - T_s) - q(nT_s - T_s)$
- Need the step Δ such that $\frac{\Delta}{T_s} \geq max\left|\frac{dm(t)}{dt}\right|$
- But a large Δ means that granular noise would be large

Delta-Sigma modulation

- Think of the delta modulation scheme using the continuous time signal $m(t)$ (alternate implementation)
- In delta-sigma modulation (more precisely, sigma-delta modulation) the $m(t)$ signal is integrated first; we can think of sharp transitions in $m(t)$ getting smoothed out (noise-shaping in the second pass)
- The receiver architecture is simple



Differential pulse code modulation



- A Taylor series interpretation!
- Why not reduce the error further?
- The prediction filter is usually a tapped delay line filter
- Read DPCM from the textbook "Communication Systems"