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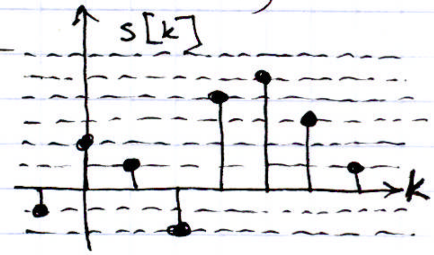
6.02
9/9/10

Rec. 1

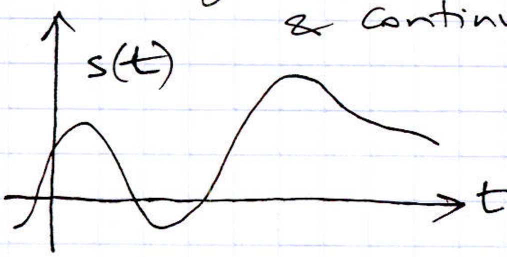
$\underbrace{\text{Digital}}$ communication systems

digitized signals, i.e., quantized (discrete levels)
& discrete time



versus

Analog, i.e., continuous levels
& continuous time



$\Longrightarrow$ Can certainly approximate an analog signal by a digital one

The dominant communication paradigm used to be analog:

Analog sources → Analog channels → Analog outputs

- Analog sources ⇓ e.g. microphone voltage, mechanical pressure, light field, ...
- Analog channels ⇓ copper wire, air, vinyl record, film, ...
- Analog outputs ⇓ loudspeaker motions, projected images

Thanks to people like Nyquist, Shannon, the paradigm started to move to digital, 1920's, 1948 onwards

Digital paradigm:

Represent/<u>approximate</u> the source by a <u>finite</u> set of values at each discrete time → easier to transmit, preserve, reconstruct (nearly error free) — coding

transform

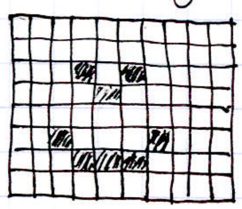
— analog world doesn't go away! (but in background)

For now, assume digital abstraction is already made,
e.g. analog waveform is sampled
$\underbrace{\text{sufficiently fast}}$ to represent it well,
'Nyquist rate' = 2 x highest freq. (much more on this in 6.003)

e.g. quantized to 8 bits (256 levels)

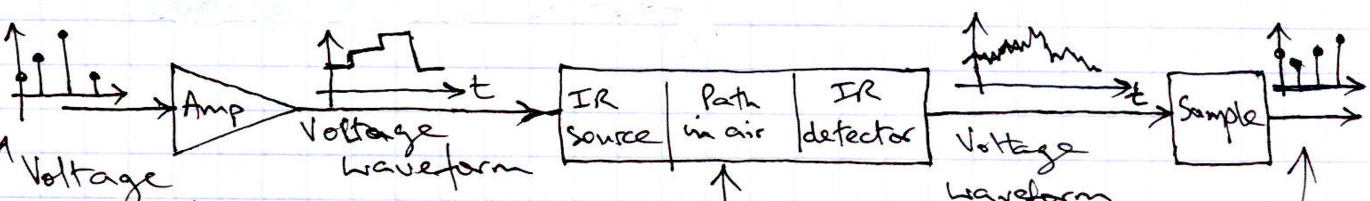
now just a binary stream of 1's and 0's

e.g. image



64 x 64 pixels, 4K values
32K bits

Our setup (Lab 1):



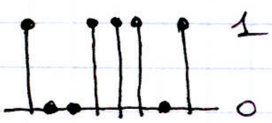
Voltage commands from processor, 4 M samples/sec

Noise!!

Transmitted samples (mapped from binary input source — your task!!)

Received Samples

To transmit 1 0 1 1 1 0 0 1, it would be a mistake to command input samples to be

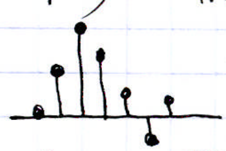


least significant bit first, in this case

because channel (end-to-end, i.e., samples to samples) cannot respond that fast:

Response to  at input (unit sample)

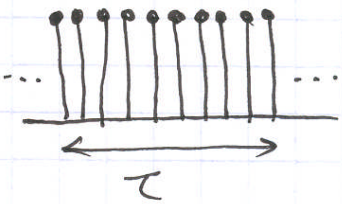
is likely to be something like



$\underbrace{\qquad\qquad}$ unit sample response

rather than just 

So use τ samples/bit, e.g. $\tau = 10$ or 40 or 400 or ...

... 1 ... is mapped to ...  ... 10 samples, to be sent,

with resulting output maybe 

To synchronize clock at receiver, need $0 \to 1$ and $1 \to 0$ transitions to happen fairly frequently. Other issues too. So more subtle coding may be needed, e.g. 8b/10b described in lab.