Note Title 4/14/2014

Section 7 Sampling (discrete-time signal processing)

Q Given a CT impulse response $h(t)$, how to implement it.

Method 1: A conti-time approach by capacitors, resistance, etc.

Hard. Most of the time we can only approximat it.

Method 2: ①

②

③

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Before we continue, let's focus on the basic reconstruction system. (No processing between sampling & reconstruction.)

$$x(t) \longrightarrow \boxed{\text{Sampling}} \xrightarrow{x[n]} \boxed{\text{Reconstruction}} \longrightarrow \hat{x}(t)$$

Q: How to perform sampling & reconstruction in the 'best' way?

Q: What is sampling?

* A continuous curve $x(t)$ is now converted to a __________ & a single __________

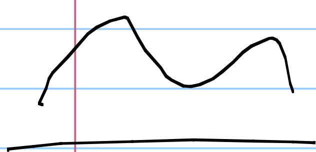
__________ :

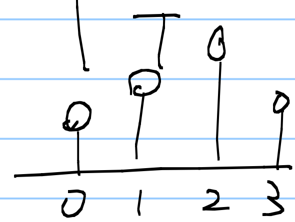
$x[n]$

T

$2\pi/T$

$x(t) \xrightarrow{\text{sampling}} \{x[n]\} \xrightarrow{\text{reconstruction}} \hat{x}(t)$





$T = 0.2$ sec

The goal of reconstruction is to determine $\hat{x}(t)$ when $t \neq nT$ ex: $\hat{x}(\pi)$

* How to connect the dots?

Method 1: Linear Interpolation: Connecting the dots by line segments.

Advantage: ① Easy to implement

② When T is small or $\omega_s = \frac{2\pi}{T}$ is large.

it approximates $x(t)$ very well.

Disadvantage: When the sampling freq is small $\frac{2\pi}{T}$ is small, we lose too much detail.

Method 2: zero-order hold.
Hold the sample value until the next sample point.

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Advantage: ① The easiest
② When $\frac{2\pi}{T}$ is large, it's good.

Disadvantage: The same as linear interpolation

Question: Is there always loss of information during sampling?

If not, under what condition can $x(t)$ be perfectly reconstructed from $\left\{\frac{x[n]}{T}\right.$ & how?

Observation: What is causing the problem?

$x(t)$ oscillates too fast s.t. the fast movement cannot be captured by the equally spaced samples.

Intuitively.
A slowly moving $x(t)$ can be reconstructed

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More explicitly, a $\boxed{}$ can be perfectly reconstructed.

To formalize this idea, we consider a new type of sampling:

Remark 1: $x[n]$ and $x_p(t)$ present the same amount of info. ⇒ They are equivalent.

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Remark 2: