Ditigal Transmitters and Recievers

February 20, 2018

Contents

1 Lecture 1 - History of Communication

This is mt, I have not a copy of these notes. Mainly discussed how in the last 120 years we/society has gone from using semophores to using modern fast as light coms.

2 Lecture 2 - A cont. of lecture 1

More info I don't have a copy of. . . .

3 Lecture 3

4 Lecture ?

:DATE: *<2018-02-05 Mon>*

Use correlators to match input to possible transmitted waveforms

5 Lecture ?

5.1 Transmitter

5.2 Reciever

two bits per symbol - four possible wave forms

symbol	bits	four possible waveforms
0	00	0^0
1	01	90^0
2	10	180^0
3	11	270^0

6 Lecture ?

6.1 Fourier Transfrom

- **F** {g(t)} = G(f) = $\int_{-\inf}^{\inf} g(t)e^{-j2\pi ft}$
- **F** $^{-1}$ {G(f)} = g(t) = $\int_{-\inf}^{\inf} G(f)e^{j2\pi ft}$

6.1.1 TODO Properties: verify that 6.1.1 is correct

- Linearity
  - **F** $a_1x_1(t) + a_2x_2(t)$ = a_1 **F** $x_1(t)$ + a_2 **F** $x_2(t)$
- Time Shift
  - **F** $x(t-T_0)$ = $\int_{-\inf}^{\inf} x(t-t_0)e^{-j2\pi ft}$
    λ = t-t_0
    = $e^{-j2\pi f} \int_{-\inf}^{\inf} x(\lambda + t_0)$
    = $e^{-j2_0} \int_{-\inf}^{inf} x(\lambda)e^{-2\pi f\lambda}d\lambda$ (EQ1)
    = e^{-2j_0} X(f)
- Frequency Property
  - **F** $^{-1}X(f-f_0) = e^{j2\pi f_0 t} \int_{-\inf}^{\inf} x(t)$

6.2 TODO Graham-Schmidt: check matrix algebra book on this topic.

:DEADLINE: *<2018-02-05 Mon>*

- Signals $S_1(t),\ldots,S_m(t)$
- basis functions $\phi_n(t),\ldots,\phi_n(t)$, $N \neq M$
- $S_i(t) = \sum n = 1 N S_{in} \phi_n(t)$
- $\mathbf{S_i} = [S_{i1}\ S_{i2}\ \ldots\ S_{in}]$

6.2.1 1st signal

$E_{s1} = ||S_1||^2$
$\phi_1 = \frac{S_1(t)}{\sqrt{E_{s1}}}$
$S_{11} = \sqrt{E_{s1}}$

6.2.2 2nd – Nth signal

Creating a new basis function
$S_{21} = \langle S_2(t), \phi_1(t) \rangle$
$r_2(t) = S_2(t) - S_{21}\ \phi_1(t)$ <– orthogonal to $\phi_1(t)$
`If remainted r_i(t) = 0 skip the steps below`

- The part of signal 2 that can't be represented by $\phi_1(t)$.

  $E_{r2} = ||r_2(t)||^2$

  $\phi_2(t) = \frac{r_2(t)}{\sqrt{E_{r2}}}$

  $S_{22} = \sqrt{E_{r2}}$

- others

  $S_{ni} = \langle S_n(t)\ ,\ \phi_i(t) \rangle$ for $\phi_i(t)$ which are defined.

  $r_i(t) = S_i(t) - \sum\{S_{in}\}\ \phi_n(t)$

:DATE: *<2018-02-09 Fri>*

6.3 Distortionless System

x(t) $- > - >$ y(t)

6.3.1 Acceptable

- Amplification//

$y(t) = K x(t)$//

- Delay

$y(t) = x(t - t_0)$, t_0: positive integer, positive required for causality$//

- Overall//

$y(t) = Kx(t - t_0)$

6.4 Freq representation

$Y(f) = Ke^{-j2\pi f t_0} X(f) = H(f)X(f)$ Linear time invariant. where $H(f) = Ke^{-j2\pi f t_0}$

$h(t) = K\delta(t - t_0)$

6.5 Bode rep

$H(f) = Ke^{-j2\pi f t_0}$

$H(f) = K < -constantMag(gain)$

$\angle H(f) = -2\pi f t_0 < -linear, slope = -2\pi f$

Group Delay: $t_g(f) = \frac{-1}{2\pi}\frac{d}{df}(\angle H(f))$

6.6 Filters

- ideal

- realistic
  - Lowpass
  - Highpass
  - Bandpass
  - Bandstop

filter type	ideal	realistic
lowpass	sharp rect around center	hill flat top
highpass		
bandpass		
bandstop		

7 LEcture ? -

:DATE: *<2018-02-12 Mon>*

7.1 TODO Project

7.2 Fourier Series - Fourier Transform Relationship

7.2.1 Fourier Series

F.S. $g(t) = \sum_{-\inf}^{\inf} G_n e^{jn2ßf_0t}$

F.T. $G(g) = *F * g(t)$ &= $\sum_{\text{- inf}}^{\text{inf}}$ $\mathrm{G_n}$ **F** {$\mathrm{e^{jn2\pi\ f_{ot}}}$}\$ $= \sum G_n \delta(f - f_0)$ -inf -> inf.

7.3 Energy spectral density???????????

$E_g = \int_{-\inf}^{\inf} |G(f)|^2 df$

$x(t) -> h(t) -> y(t)$

$X(f) -> H(f) -> Y(f)$

$E_y = \int_{-\inf}^{\inf} |X(f)H(f)|^2 df = \int_{f_0 - \delta f}^{f_0 + |deltaf}$ **Energy Spectral Density** $\Psi_x(f_0) = \lim_{\Delta f -> 0} \frac{1}{\Delta f} \int_{f_0 - \frac{\Delta f}{2}}^{f_0 + \frac{\Delta f}{2}} |X(f)|^2 df = |X(f_0)|^2$

Energy $E_x = \int \Psi_x(f) df$

Energy int bandwith *B centered at $\mathrm{F_1}$ $\int_{-f_1 - \frac{*B*}{2}}^{-f_1 + \frac{*B*}{2}} \Psi_x(f) df = \int_{f_1 - \frac{*B*}{2}}^{f_1 + \frac{*B*}{2}} \Psi_x(f) df$

8 TODO get units for

let: \$g(t) = Π(t$\frac{}{Whatbanwidthcapacitydoweneedtopassexactly}$90

$E_g = \int |g(t)|^2 dt =$ \$g(t) -> "Ideal LPF bandwidth B" -> y(t) 90%$\mathrm{E_g}$ = 0.9T energy

9 TODO insert lecture from previous week in here.

10 TODO Lecture ? - HW2 review: Hw4; due 2/21; 3.4-2; 3.6-1; 3.7-3 – see next page; 3.7-4

DATE: *<2018-02-14 Wed>*

10.1 Freq shift

$g(t)cos(2\pi f_0 t) <==> \frac{1}{2}[G(f-f_0)+G(f+f_0)]$

10.2 Project specs

10.2.1 Important params

- $\mathbf{F_s}$ = sample Rate; 8000
- bit rate R_b 214
- $\frac{F_s}{R_b} = Samplesperbit$; 37.3

\$g(t) = Π(t$_{\overline{|tau\$\$E}}$g = τ\$
\$y(t) = g(t)*h(t)\$
\$Y(f) = G(f)H(f)\$

H(f) ideal LPF bandwidth B
What is B to obtain: \$$E_y$ = 0.9 E_g\$
\$$E_y$ &= $\int_{\text{-inf}}^{\text{inf}}$|Y(f)|^2 df &= $\int_{\text{-inf}}^{\text{inf}}$|G(f)H(f)|^2 df &= inf$_{\text{-B}}^{\text{B}}$|G(f)|^2 &= 2inf$_0^{\text{B}}\tau$ sinc^2(π f τ) df = -.0τ\$

11 Lecture ? - Bell 103 modems specs?

:DATE: *<2018-02-19 Mon>*

11.1 A history of Modem Sounds:

200 Baud to 56K

- Early modems sounds tonal, and later, higherspeed modems sounds noisy.
- Connection sequence occurs
- YT: ckc6XSSh52w
- oona.windytan.com/posters/dialup-final.png
  - Short time fourier transform

11.2 DONE Choices: Get clarification of stopbits; Use two '1' bits as stop signal.

- Answering and originating tones, we will use higher tones.
  - HIgh tones are answer tones
  - Data rate 100 bps
  - USE 2 stop bits. Not the same as the 0start and 1 stop bit.
  - Use continuous phase, no discontinuity. [[img]

11.3 TODO HW 5 due 2/26; 3.8-4, 4.2-1, 4,2-7

11.4 Power Spectral Density PSD

Almost a perfect parallel to ESD Watts/Hz

- Computed differently
  - **Autocorrelation** $R_g(\tau) = \lim t\inf \frac{1}{T} \int -TT/2g * (t)G(t+\tau)$
  - **Power Spectral Density** $\mathrm{\$S_g(f) = \mathbf{F}\ \{R_g(\tau)\}}$
- ESD
  - autocorrelation
  - $\psi_g(\tau) = \int_{-\inf}^{\inf} g * (t)g(t+\tau)dt$
  - ESD $\mathrm{\$\Psi_g(f) = \mathbf{F}\ \{\psi_g(\tau)\}}$
- Where would we use PSD?
- A set of data [[img]
- Can't take the FT of binary data.

11.5 LTI Systems

$x(t) - >> y(t)$
ESD $\Psi_y(f) = \Psi_x(f)|H(f)|^2$
ESP $S_y(f) = S_x(f)|H(f)|^2$

11.6 Noise - AWGN Additive White Gaussian Noise

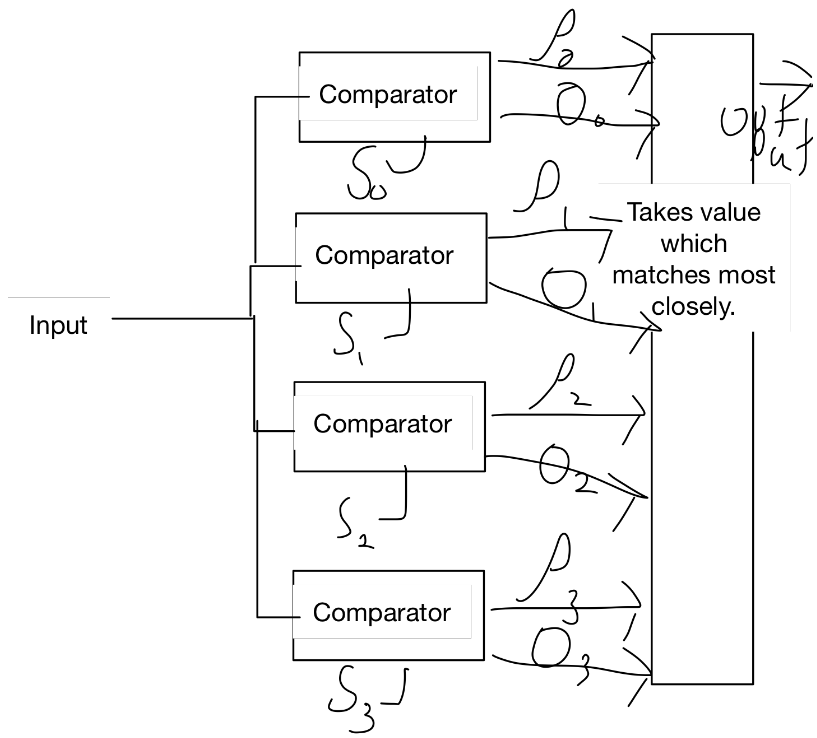

Figure 1: internals of Ditigal reciever with two-bit decode