Fundamentals of Digital Communications
Class 7: Demodulation, Detection, and Error Probability

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3rd Homework – How? Where? When?

When:

► due to Feb. 5, 2018 - 15:00

Where:

► SPSC homeworks mailbox (Inffeldgasse 16c/EG)
► you find map at course webpage
► MATLAB code (*.m) and simulation protocol (*.pdf) via email (hw1.spsc@tugraz.at)
Schedule – to master Digital Communications

Demodulation and Detection Theory

Class 8

Class 7

Class 2

Class 4

Class 6

Class 1

Class 3

Class 5

Signal Spaces

Signals and Systems

Stochastic
Class 7 – Demodulation, Detection, and Error Prob.

Goals:

- Understand the correlation receiver.
- Understand the matched filter receiver.
- Understand maximum likelihood detection.
Problem 7.1 - Matched Filter Demodulator

Given:

- $M = 4$-ary bi-orthogonal signals
- AWGN channel with double-sided PSD $N_0/2$
- two orthogonal rectangular pulses of length $T/2$
- $T$ is the symbol period

Questions:

- sketch the waveforms and find their vectorial representation
- find MF impulse responses
- construct the MF output for one signal waveform and give received signal vector after sampling at time $T$
Problem 7.2 - Correlation type demodulator

Given:

- symmetric 4-ary PAM
- rectangular pulse shape

Questions:

- find the vectorial representation and express pulse amplitudes as a function of symbol energy $E_s$.
- derive the correlation-type demodulator
- characterize the statistics of the demodulator output (for an AWGN channel)
- sketch the likelihood functions for $E_s/N_0 = 8 = 9$ dB
Questions

- How many matched filter do you need for a 3D signal space?
- How is the matched filter defined for a 1D signal with the orthonormal basis $\psi(t)$ and symbol duration $T$?
- Draw a correlation receiver for an N-dimensional signal with symbol duration $T$?
- Transmission over an AWGN channel & MF demodulator: How is the received vector distributed (PSD of $N_0/2$ and transmitted symbol $s_m$)?
**Questions**

- How many matched filter do you need for a 3D signal space? For $N$ dim. signal space $N$ MF needed.

- How is the matched filter defined for a 1D signal with the orthonormal basis $\psi(t)$ and symbol duration $T$? $h(t) = \psi(T - t)$

- Draw a correlation receiver for an N-dimensional signal with symbol duration $T$? blackboard

- Transmission over an AWGN channel & MF demodulator: How is the received vector distributed (PSD of $N_0/2$ and transmitted symbol $s_m$)? Gaussian with mean $s_m$ and variance $N_0/2$:

$$f(r|s_m) = \frac{1}{\sqrt{\pi N_0}} \exp\left\{-\frac{r - s_m}{N_0}\right\}$$