Wireless Communications Systems Design with MATLAB and USRP Software-Defined Radios

OEM: MathWorks • Duration: 2 Days (16 hrs) • Code: MW-WIRELESS-COMMUNICATIONS-SYSTEMS-DESIG

COURSE MODULES & TOPICS

Day 1 of 2

Communication over a Noiseless Channel

- Sampling theorem and aliasing
- Using complex baseband versus real passband simulation
- Creating a random bit stream
- Discovering System objects and their benefits
- Modulating a bit stream using QPSK
- Applying pulse-shaping to the transmitted signal
- Using eye diagrams and spectral analysis
- Modeling a QPSK receiver for a noiseless channel
- Computing bit error rate

Noisy Channels, Channel Coding, and Error Rates

- Modeling an AWGN channel
- Using channel coding and decoding: convolutional, LDPC, and turbo codes
- Decoding using Trellis diagram and Viterbi algorithm
- Using Parallel Computing Toolbox to accelerate Monte Carlo simulations
- Discussion of alternative acceleration methods: GPUs, MATLAB Distributed Computing Server™, Cloud Center

Timing and Frequency Errors and Multipath Channels

- Modeling phase and timing offsets
- Mitigating frequency offset using a PLL
- Mitigating timing jitter using Gardner timing synchronization
- Modeling flat fading channels
- Using training sequences for channel estimation
- Modeling frequency selective fading channels
- Using Viterbi equalizers for time-invariant channels and LMS linear equalizers for time-varying channels
- Demonstration of a real-time demodulation of single-carrier broadcast using RTL-SDR

Day 2 of 2

Multicarrier Communications Systems for Multipath Channels

- Motivation for multicarrier communications
- Introduction to Orthogonal Frequency Division Multiplexing (OFDM)
- OFDM symbol generation using the IFFT
- Inter-block interference prevention using a cyclic prefix
- Reduction of out-of-band emissions using windowing
- Advantages and disadvantages of OFDM
- Timing and frequency recovery methods for OFDM
- Channel estimation using pilot symbols
- Frequency domain equalization

Using Multiple Antennas for Robustness and Capacity Gains

- Advantages and types of multi-antenna systems
- Transmit and receive beamforming
- Receive diversity techniques
- Transmit diversity using orthogonal space-time block codes
- Narrowband multiple input-multiple output (MIMO) channel model
- MIMO channel estimation
- Spatial multiplexing using ZF and MMSE equalization
- Wideband communications using an MIMO-OFDM system

Building a Radio-in-the-Loop System

- Overview of the radio-in-the-loop workflow
- MathWorks communications hardware support (RTL-SDR, ADALM-PLUTO, USRP, Zynq®-Based Radio)
- Hardware alternative comparison (pros/cons table)
- Different RIL transmit and receive modes (single burst, looped, streamed)
- Creation of an end-to-end single-antenna multicarrier communications system using a USRP
- Demonstration of a 2x2 OFDM-MIMO over-the-air system using USRPs