Module title: Real-Time Signal Processing

Module summary
Module code: SSTM240
Module coordinator: Prof. Dr.-Ing. Christian Langen
Credits (ECTS): 6
Semester: 2nd semester
Pre-requisites with regard to content: Computer Science, Control Theory, Analog Signal Processing
Pre-requisites according to the examination regulations: --
learning outcomes and competencies: Upon successful completion, the students • know real-time signal processing frameworks as computing platforms • understand basic concepts of digital signal processing as sampling, reconstruction and aliasing • understand fundamental filtering algorithms such as FIR, IIR, FFT and adaptive filters • can assess real-time software programming basics and principles for digital signal processing • have the ability to choose between different digital signal processing algorithms for different applications • have the ability to use different design methods to achieve better results • have the ability to evaluate experimental results (e.g. quality, speed power) and correlate them with the corresponding design and programming techniques • can implement digital signal processing and design methods on computing platforms • • can use commercial hardware and software tools to develop real-time signal processing applications
Assessment: Assessment is done by an oral examination (20 minutes) for the seminary on a course project + lab work (passed/not passed, 1 semester)

Course: Real-Time Signal Processing Seminar
Module code: SSTM241
Lecturer: Prof. Dr.-Ing. Christian Langen
Contact hours: 2 SWS
Semester of delivery: yearly, winter semester
Type/mode: seminar
Language of instruction: English
Content: • Discrete-time Signals and Systems: Convolution and Correlation • Sampling, Reconstruction and Aliasing • Review of Complex Exponentials and Fourier Analysis • Time and Frequency Domains • Z-Transform: Time and Frequency Domains

- FIR Filters: Moving Average Filters, Window Method of Design
- IIR Filters: Impulse Invariant and Bilinear Methods of Design, Simple Design Example
- Fast Fourier Transform: Review of Fourier Transforms, Derivation of Radix-2 FFT Algorithm
- Adaptive Filters: Prediction and System Identifications, Equalization and Noise Cancellation

Recommended reading:

- Chassaing, Rulph; Reay, Donald: Digital Signal Processing and Applications with the C6713 and C6416 DSK, Wiley 2008
- Kuo, Sen M.; Lee, Bob H.; Tian, Wenshun: Real-Time Digital Signal Processing. Fundamentals, Implementations and Applications. Wiley 2013
- Pirkle, Will C.: Designing Audio Effect Plugins in C++ for AAX, AU and VST3 in DSP Theory, Taylor and Francis, 2019
- Reay, Donald: Digital Signal Processing Using the ARM Cortex-M4. Wiley 2016
- Robinson, Martin: Getting started with JUCE. Levering the power of the JUCE framework to start developing applications, Pact Publishing 2013
- Yee-King, Matthew John: Build AI-Enhanced Audio Plugins with C++, Focal Press 2024

Comments:

Course: Real-Time Signal Processing Lab

Module code: SSTM242

Lecturer: Prof. Dr.-Ing. Christian Langen

Contact hours: 2 SWS

Semester of delivery: yearly, winter semester

Type/mode: Laboratory

Language of instruction: English

Content:

- Introduction to the Real-Time Signal Processing Framework and Development Tool Chain
- Signal Quantization and Aliasing
- Sine, Rectangular and Pulse Signal Generation
- Non-Recursive Systems. Example: Delay
- Recursive Systems. Example: Echo
- Non-Recursive Filters with Finite Impulse Response (FIR)
- Recursive Filters with Infinite Impulse Response (IIR)
- Fast Fourier Transform (FFT)
- Adaptive Filters. Least Mean Square (LMS) Algorithm

Recommended reading:

- Chassaing, Rulph; Reay, Donald: Digital Signal Processing and Applications with the C6713 and C6416 DSK, Wiley 2008
- Kuo, Sen M.; Lee, Bob H.; Tian, Wenshun: Real-Time Digital Signal Processing. Fundamentals, Implementations and Applications. Wiley 2013
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• Yee-King, Matthew John: Build AI-Enhanced Audio Plugins with C++, Focal Press 2024
Comments: