3.1.4 Information Theory and Coding

Module title: Information Theory and Coding

Module summary
Module code: EITM 210I
Module coordinator: Prof. Dr. Franz Quint
Credits (ECTS): 5 CP workload: in lecture 60 h, independent study time 90 h
Semester: 1st or 2nd semester
Pre-requisites with regard to content: Knowledge in Systems Theory and Linear Algebra
Pre-requisites according to the examination regulations: none
Competencies: Upon successful completion, • the students know the most important source coding procedures • the students know the most widely used channel coding procedures • the students are able to design codes suited for given communication channels • the students are able to implement decoding algorithms • the students are able to analyse communication links from information-theoretical point of view • the students are able to assess the impact of coding on communication links • the students have expanded their mathematical abilities to finite fields
Assessment: Assessment is done by either a written exam (90 minutes) or an oral examination (20 minutes). The form of examination will be announced at the beginning of the semester
Usability: *General:* This module provides the information-theoretical foundations of systems for data transmission and storage. The two theorems of Claude Shannon serve as the starting point to a precise mathematical description of information, source and channel coding. *Connection with other modules:* Information theory requires a sound mathematical background. Shannon's theorems allow to analyse communication systems from an information-theoretic view point. Thus, this module complements the module Communication Systems of the master's program. The module Information theory however doesn't deal with physical properties of communication channels, but puts emphasis on statistical channel models and uses well-known techniques of digital signal processing, like DFT or Viterbi algorithm on finite fields.

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Module code: EITM 210I
Lecturer: Prof. Dr. Franz Quint
Contact hours: by arrangement
Semester of delivery: yearly, summer semester
Type/mode: lecture 4h/week; mandatory in the study field Information technology, optional in the other study fields of the program
Language of instruction: English or German; the course language will be announced at the beginning of the semester
Content:

- information, entropy
- source coding: arithmetic code and Huffman-code
- discrete channel models
- channel capacity, Shannon's theorems, Shannon-Hartley-channel-capacity
- bandwidth efficiency, error probability
- Galois-fields and extension fields
- design, coding and decoding of Reed-Solomon-codes
- design, coding and decoding of BCH-codes
- analysis coding and decoding of convolutional codes
- code concatenation and interleaving
- generalized code concatenation and coded modulation

Recommended reading:

M. Bossert: *Kanalcodierung,* Oldenbourg, München, 2013
B. Friedrichs: Kanalcodierung, Springer, 1996
W. Ryan, S. Lin: *Channel Codes: Classical and modern,* Cambridge University Press, 2009
R. Blahut: *Theory and Practice of Error Control Codes*, Addison Wesley, 1983
S. Lin, D. Costello: *Error Control Coding, Fundamentals and Applications*, Prentice-Hall, 1983
B. Sklar: *Digital Communications, Fundamentals and Applications*, Prentice Hall, 2001

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