Digital Signal Processing Project

(1) Scope

This document describes the general conditions for the projects which are necessary for the course “Sensor Systems” in the Mechatronics Master study program.

(2) Learning outcomes

1. Literature Research (LR)

- I know where to look for and how to find appropriate publications for a specific topic (find a starting point, work with databases and indices…)
- I can estimate the usefulness of a publication (paper, article, book…) for solving a specific problem based on the abstract or summary.

2. Working with scientific publications (SP)

- I can read and understand scientific publications in the area of signal processing.

3. Implementation (IM)

- I can realize a functioning (prototyping) system out of a description of an algorithm

(3) Constraints

1. Groups

- Working in groups up to 3 persons is possible, but also individual work is welcome.
- When working in groups, everyone has to reach all learning outcomes -> workload must be distributed mainly “horizontally”, not “vertically” (do not assign paper study work to one person and implementation to another -> distribute all the selected papers to all people and discuss the results!)
- For “mixed groups” (incoming students and local students), the projects can be slightly smaller, such that the total workload due is the same (more focus on internationalization issues)

2. Time schedule

- 06.10. project scope presentation
  - find topics and organize in groups
- 13.10. groups are fixed, also preliminary topics
  - searching for literature for the selected topic
  - first evaluation based on abstracts (LR)
- 27.10. topics, project titles are fixed, literature is selected
  - literature evaluation phase (SP)
- 17.11. Presentation of final literature evaluation
  - working on the implementation of the project (IM)
  - blog with project progress in ILIAS
  - documentation
- 22.12. project presentation and hand-in of documentation (end of project)
- 12.01. feedback to the project and final oral exam

(4) Documentation

The project documentation should contain the following (besides standard information):

- Short problem description
- Literature analysis: documentation why articles have been selected or rejected. All used sources must be mentioned here
- Argumentation for the selection of the topic for implementation
- Test scenario: how to prove that the final implementation works
- Implementation issues (document only what is not documented in the selected literature, but necessary for implementation, e.g. software structure…)
- Results
- (only electronically): implementation itself must be documented in the source code.

(5) Topics

Topics can be chosen arbitrarily, as long as they are suited to show that all learning targets have been reached. Roughly, the following facts should be clear in advance:

- scientific literature (publications, scientific papers, conference papers, journals) should be available showing ideas, implementation and results (do not choose a topic that has not been treated and analysed yet -> good for master thesis)
- the topic should not be trivial and should not be a main topic of the lecture, more than one solution possibility should be available to choose from
- digital signal processing must be a key element to solve the problem
- it must be possible to realize a prototype implementation (MATLAB…) within time
- implementation issues (real-time, embedded platform…) are not in focus

The following topics or areas of topics are examples (which of course can also be selected if the group has not found an own topic).

- Encoder Signal Filter: Find a filter/algorithm that results in a realistic velocity output based on discrete position signals (=comparison of different techniques to compute derivations of noisy discrete time signals)
- Reliable recognition of a tennis ball impact based on a sound signal (topic from Head)
- Information extraction form an IR sensor signal using wavelets (topic from Zumtobel)
- Computing a 2D sound image out of a microphone array (“beamforming”)
- Using extended Kalman filter in order to estimate the states of a (nonlinear) pendulum
- Comparison of wavelets vs. classical filters for different noise filters
- Acoustic filter: timescale modification, pitch modification…
- Acoustics: Accurate pitch detector, beat detection, …
- Steganography: theoretical and practical approach
- Image recognition algorithms (face recognition, OCR, pulse detection)
- Digital signal modulation techniques

More hardware – oriented topics could be:

- Safe transmission of single bit information over 1-2m distance
- Optimized implementation of a fast Fourier transform in an embedded system (microcontroller)