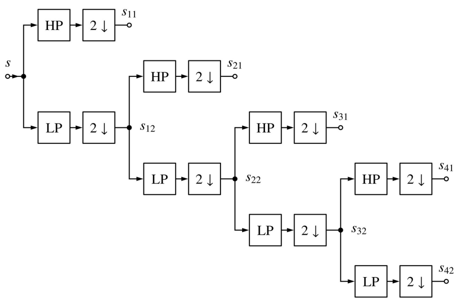

Fabian Klein


Andreas Linggi

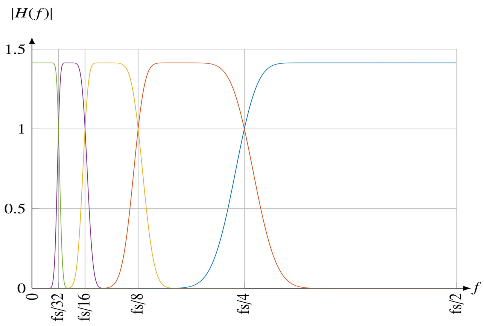
Graduate Candidates	Fabian Klein, Andreas Linggi
Examiner	Prof. Dr. Guido Schuster
Co-Examiner	- -
Subject Area	Sensor, Actuator and Communication Systems
Project Partner	Sonova Holding AG, Stäfa, ZH

Dynamic range estimation

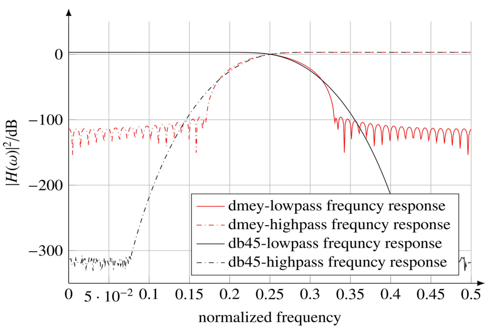
Loudness range estimation



Dyadic analysis filter bank with four stages



Frequency response of the sub-band filters according to the analysis filter bank above



Two different high- and lowpass Wavelet filter. First is known as Discrete Meyer and second as Daubechies 45

Problem: The company Sonova AG, which develops hearing aids, is looking for an alternative solution to estimate the dynamic range of an audio signal. The hearing aid has to adjust the volume and the compression rate for a user and a given environment. A use case can be for example if the user watches a movie. In the movie are several sound environments like explosions, gun-shots, normal speech or whispering. The volume can change rapidly which can cause problems for a hearing aid. A hearing impaired person can not hear quiet sounds but the pain level for loud sounds remains the same as for a person with intact hearing. In the best case the full dynamic range from the environment, that means the loudest to the most quiet sound, has to be transferred in the full hearing range of the hearing impaired person. In this thesis several approaches for measuring the dynamic range and detect fast changes in the dynamic are discussed.

Objective: In order to estimate the spectral power density of a non-stationary signal more precisely, the sub-band division uses a dyadic analysis filter bank. In order to estimate the power in the sub-bands correctly, the filter requirement of such a filter bank has been researched. It turned out that the wavelet theory provides filters which have these properties.

Result: To estimate the dynamic range several approaches in the time and frequency domain were compared. A problem was that de dynamic range for a audio signal is not properly defined, particularly what the most quiet sound is. Due to this some properties for the dynamic range had to be defined. Beside obvious solutions in the time and frequency domain with short time Fourier transform and filtering, the approach of using the discrete Wavelet transform for spectral power estimation has been researched.To the fact that the dynamic of a sound signal is not appropriate defined, the search for a more suitable solution, led to to the loudness range. The loudness and the appropriate loudness range is accurate defined by the European Broadcasting Union and has similar properties to the dynamic range.