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Application of the MATLAB ITA-Toolbox: Laboratory Course on Cross-talk Cancellation

Anwendung der MATLAB ITA-Toolbox: Praktikumsversuch zur Übersprechkompensation (CTC)

About the Laboratory Courses

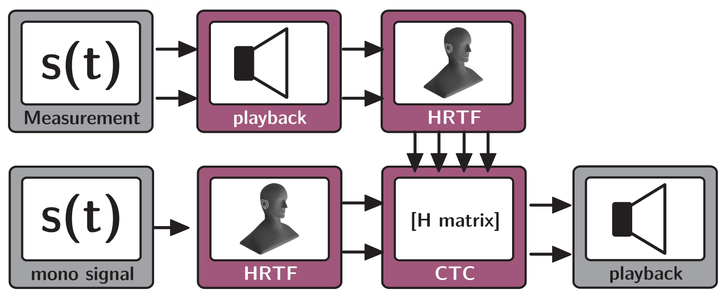
We offer a laboratory course for students in the Master's program where students step into 11 different acoustical fields in teams of two. Data acquisition and post-processing is realized using the *ITA-Toolbox*. It offers functionality for a wide range of acoustic measurement and signal processing tasks. Students have access to the source code enabling them to follow, comprehend and even modify parts of the signal processing chain.

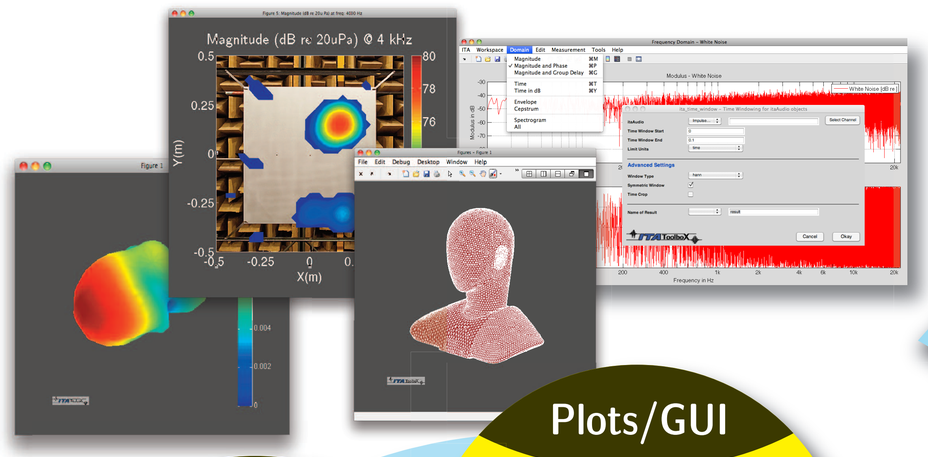
CTC Laboratory

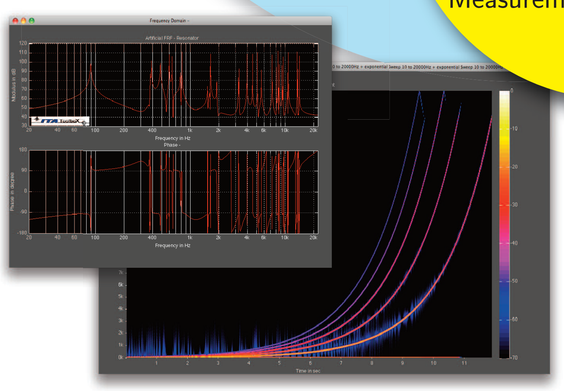
In this 3 hour practical course students must design their own loudspeaker based binaural reproduction system. The task starts with understanding the concepts of binaural hearing, by measuring a set of HRTFs and finally design own crosstalk cancellation filters. At the end, their results are tested by listening to filtered binaural signals. The ITA-Toolbox is used to provide a framework where the students can solely concentrate on the algorithm.

Theoretical Background

First the transfer function from the two loudspeakers is measured with a dummy head. These results are post-processed and used for the inversion in the CTC filter generation.







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Laboratory

Students and academic stuff during instruction and testing of the CTC-filters in the new course.

Script Example

```
%% ***** CTC filter generation *****
beta = 1e-6;

% [a b; c d] = H'.H + beta*I
a = HLL*conj(HLL) + HLR*conj(HLR) + beta;
b = HRL*conj(HLL) + HRR*conj(HLR);
c = HLL*conj(HRL) + HLR*conj(HRR);
d = HRL*conj(HRL) + HRR*conj(HRR) + beta;
determinant = a*d - b*c;

% [LL RL; LR RR] = inv(H'.H +beta) H'
CTC_LL = (d*conj(HLL) - b*conj(HRL))/determinant;
CTC_LR = (a*conj(HRL) - c*conj(HLL))/determinant;
CTC_RL = (d*conj(HLR) - b*conj(HRR))/determinant;
CTC_RR = (a*conj(HRR) - c*conj(HLR))/determinant;

%% ***** CTC filtering *****
outL = inL*CTC_LL + inR*CTC_RL;
outR = inL*CTC_LR + inR*CTC_RR;

%% ***** Test Channel Separation *****
LL = HLL*CTC_LL + HRL*CTC_LR;
LR = HLR*CTC_LL + HRR*CTC_LR;
RL = HLL*CTC_RL + HRL*CTC_RR;
RR = HLR*CTC_RL + HRR*CTC_RR;
```

Acknowledgment

The authors would like to thank the electrical and mechanical workshop at ITA for their support. *PortMusic* and *playRec* were used to realize stable audio data acquisition with MATLAB. Thanks to all users and students and users for their feedback and bug reports.

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