ALaRI: Digital Signal Processing

Assignment: OFDM transmission over an acoustic channel

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Goal: to create a Matlab/Simulink implementation for realizing and evaluating an OFDM communication link over an acoustic channel.

Requirements: Matlab/Simulink in Windows, a sound card with line in/out, a loudspeaker and a microphone (possibly in a headset), m-files and Simulink model created during Exercise Sessions 1–6.

Deliverable: 1 m-file (ofdm_experiment_acoustic_channel.m) + any additional self-written functions that are called from within this m-file, 1 report (approx. 2 pages) + original and reconstructed multimedia files used for subjective performance evaluation.

Submission: send the deliverables to toon.vanwaterschoot@esat.kuleuven.be and shj@es.aau.dk by **Monday June 23, 2014 – 13h00**.

1. Communication system design:
   Create an m-file "ofdm_experiment_acoustic_channel.m" in which a communication system is designed that is capable of sending an OFDM-modulated binary signal over the acoustic channel between your PC loudspeaker and microphone, and demodulating the data at the receiver [2].

   Make sure the system is capable of dealing with:

   - frequency selectivity of the acoustic channel (due to multipath propagation),
   - time variation of the acoustic channel (due to loudspeaker and/or microphone movements),
   - measurement noise at the microphone,
   - (possibly time-varying) sampling frequency mismatch between the transmitted and received signal.

[1] For questions and remarks: toon.vanwaterschoot@esat.kuleuven.be

[2] If, for technical reasons, you are not able to use your PC loudspeaker and microphone to transmit and receive the data, then use the Matlab p-file ftp://ftp.esat.kuleuven.be/pub/sista/vanwaterschoot/alari/assignment/acoustic_channel_tv.p to simulate an acoustic loudspeaker-channel-microphone system as follows: `out = acoustic_channel_tv(in)`. In contrast to the file acoustic_channel.p that you may have used earlier in the exercise sessions, the p-file acoustic_channel_tv.p simulates a *time-varying* channel. The other properties of the system simulated in acoustic_channel_tv.p (like the channel impulse response length, saturation level, and measurement noise level) are similar to the properties of the time-invariant system simulated in acoustic_channel_tv.p.

Deliver this m-file, as well as any self-written files or functions which are called from within this m-file. In the report, write a concise overview of the different parts that your m-file consists of, and indicate how you have addressed the above four requirements (ca. 1 page).

2. Communication system parameters:
   Some of the system parameters have a profound influence on the overall performance of the communication system, more specifically:

   - the QAM constellation order (M),
   - the OFDM IFFT/FFT size (N),
   - the OFDM cyclic prefix length (L_{CP}).

   In the report, motivate the value you have assigned to each of these parameters in your communication system (ca. 1/2 page).

3. Communication system evaluation:
   Evaluate the performance of your communication system in two ways:

   - ojectively, by calculating the bit error rate and the symbol error rate,
   - subjectively, by feeding a multimedia file (e.g., a speech or audio signal or an image) as an input signal to your communication system[3], and by listening or looking at the demodulated file after transmission.

   In the report, describe the results of the performance evaluation (ca. 1/2 page). If possible, also send in the original and reconstructed multimedia file that you used for the subjective evaluation.

[3]Make sure to convert the multimedia file to a binary representation before attempting to perform the QAM and OFDM modulation. To this end, scale the signal obtained from the multimedia file such that its amplitude values are positive integer numbers, and subsequently use the Matlab function `dec2bin`. At the receiver side, you should then perform the inverse operations to obtain the reconstructed multimedia file.