RUHR-UNIVERSITÄT BOCHUM

Faculty of Electrical Engineering and Information Technology
Institute of Communication Acoustics

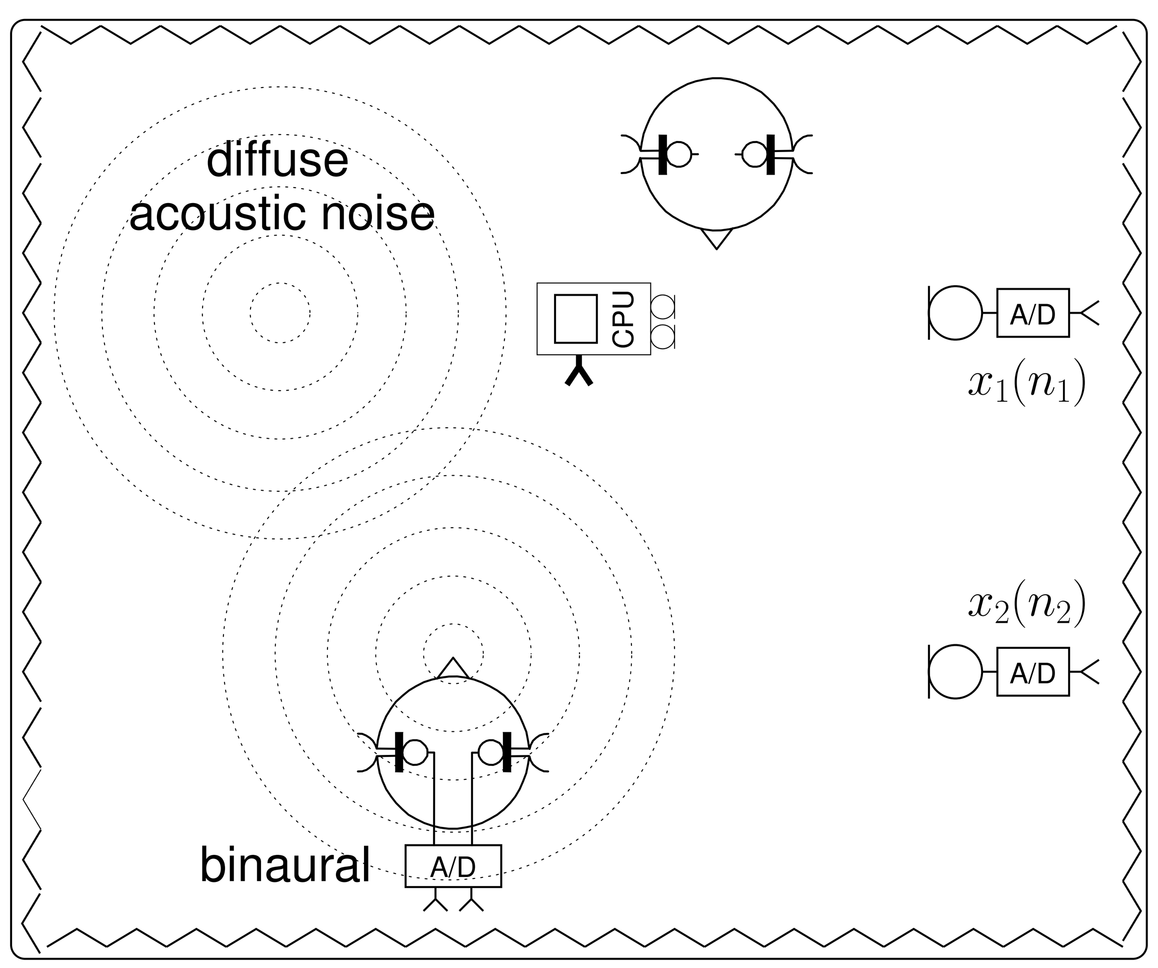
RUB

A Double-Cross-Correlation Processor (DXCP) for Blind Sampling Rate Offset Estimation in Acoustic Sensor Networks

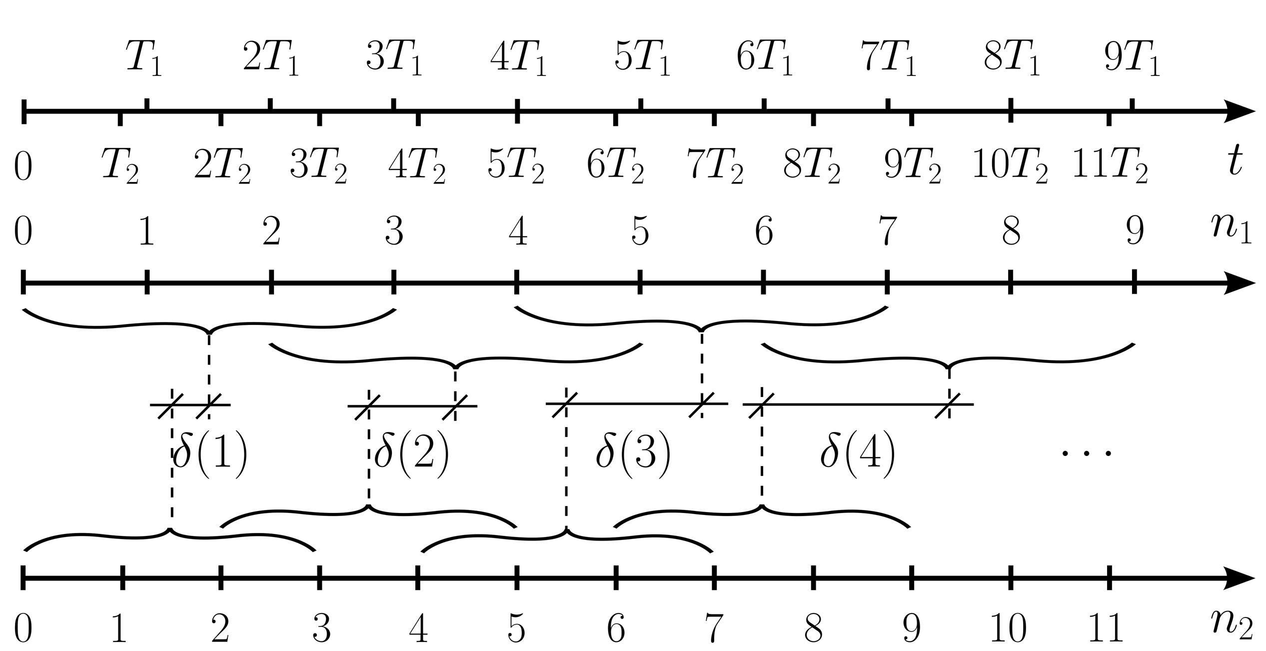
Aleksej Chinaev, Philipp Thüne, and Gerald Enzner

1. Acoustic Sensor Network

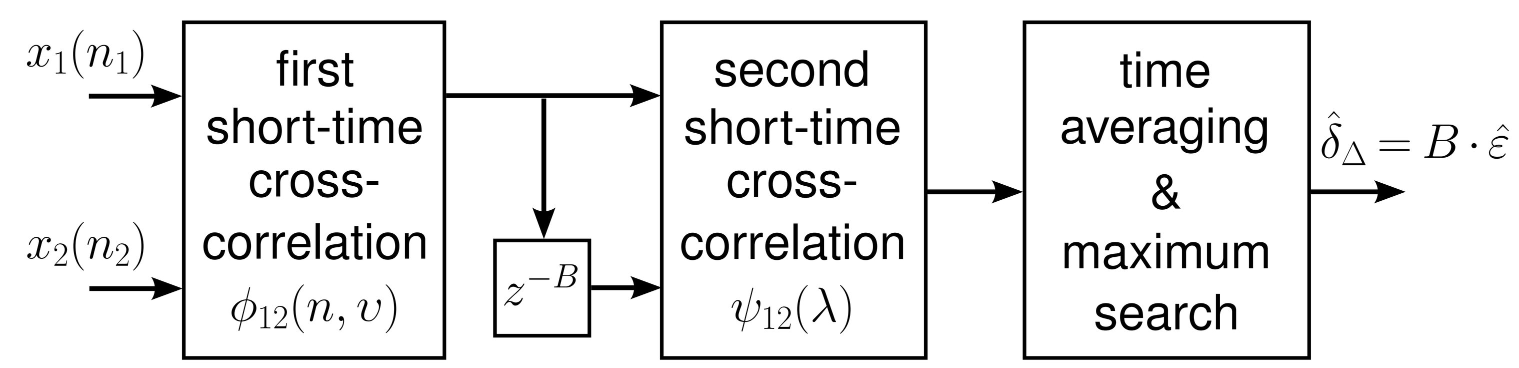
- Autonomous and thus individual sampling rates on individual sensors in a smart home/office enclosure



- Time synchronization of acquired signals requires an estimation of sampling rate offset (SRO) $\varepsilon = f_{s,2}/f_{s,1} - 1$ between sensor clocks, which is assumed to be time-invariant
- Timing diagram of two autonomous sensor signals $x_1(n_1)$ and $x_2(n_2)$ with corresponding accumulating time delays (ATDs) $\delta(\ell)$ for frame-oriented signal processing

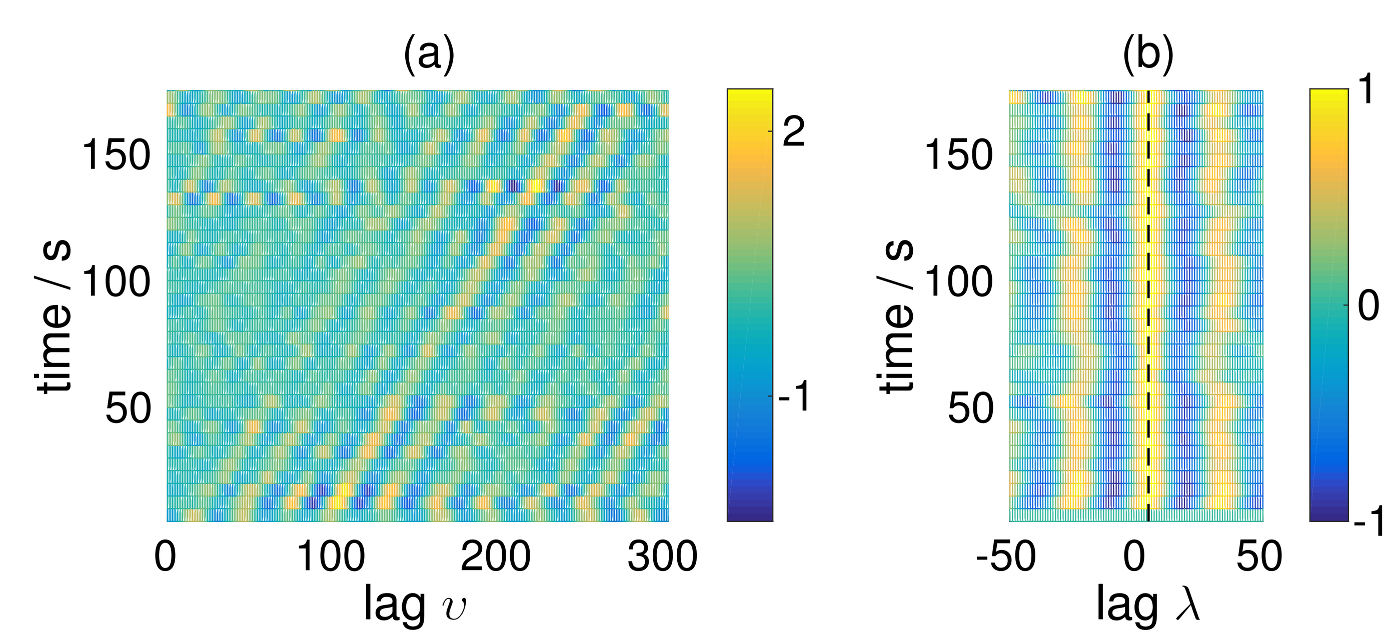


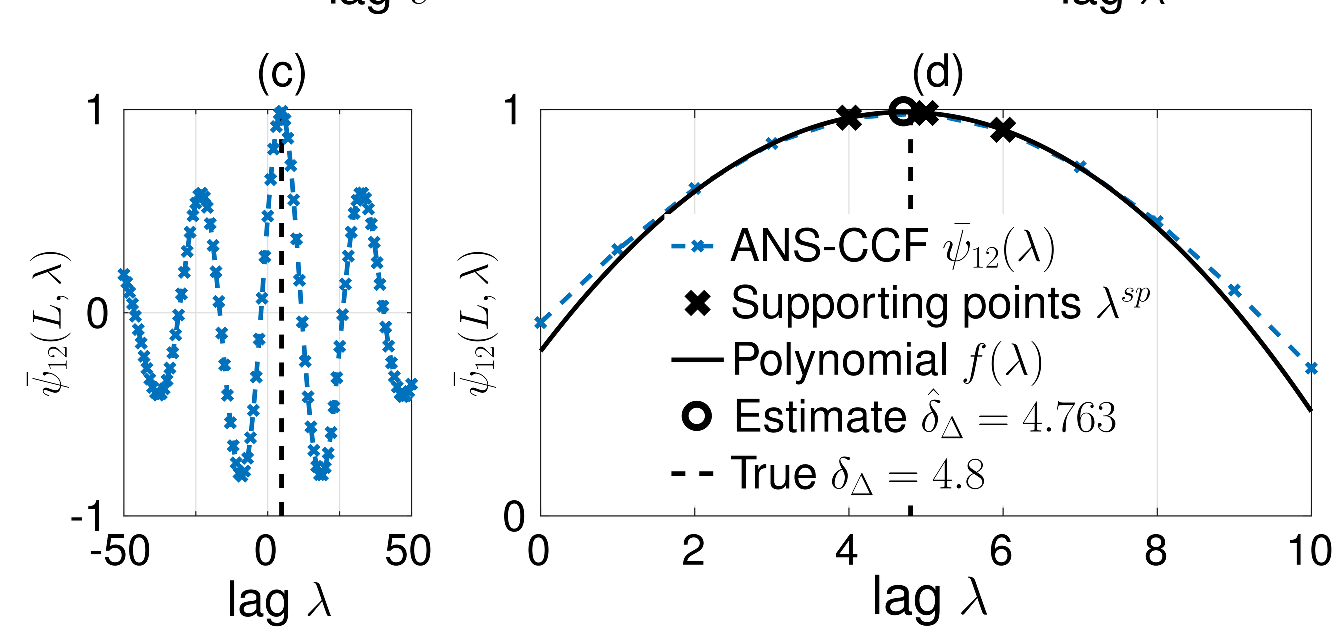
2. Double-Cross-Correlation Processor



- time-varying $\phi_{12}(n,\upsilon) = \hat{\mathrm{E}}\{x_1(n) \cdot x_2(n+\upsilon)\}$
- stationary, ergodic $\psi_{12}(\lambda) = \hat{\mathrm{E}}\{\phi_{12}(n,\upsilon) \cdot \phi_{12}(n-B,\upsilon+\lambda)\}$

- Insight into functionality of the proposed DXCP





(a) Time drift of the first cross-correlation function (CCF) $\hat{\phi}_{12}(n,\upsilon)$

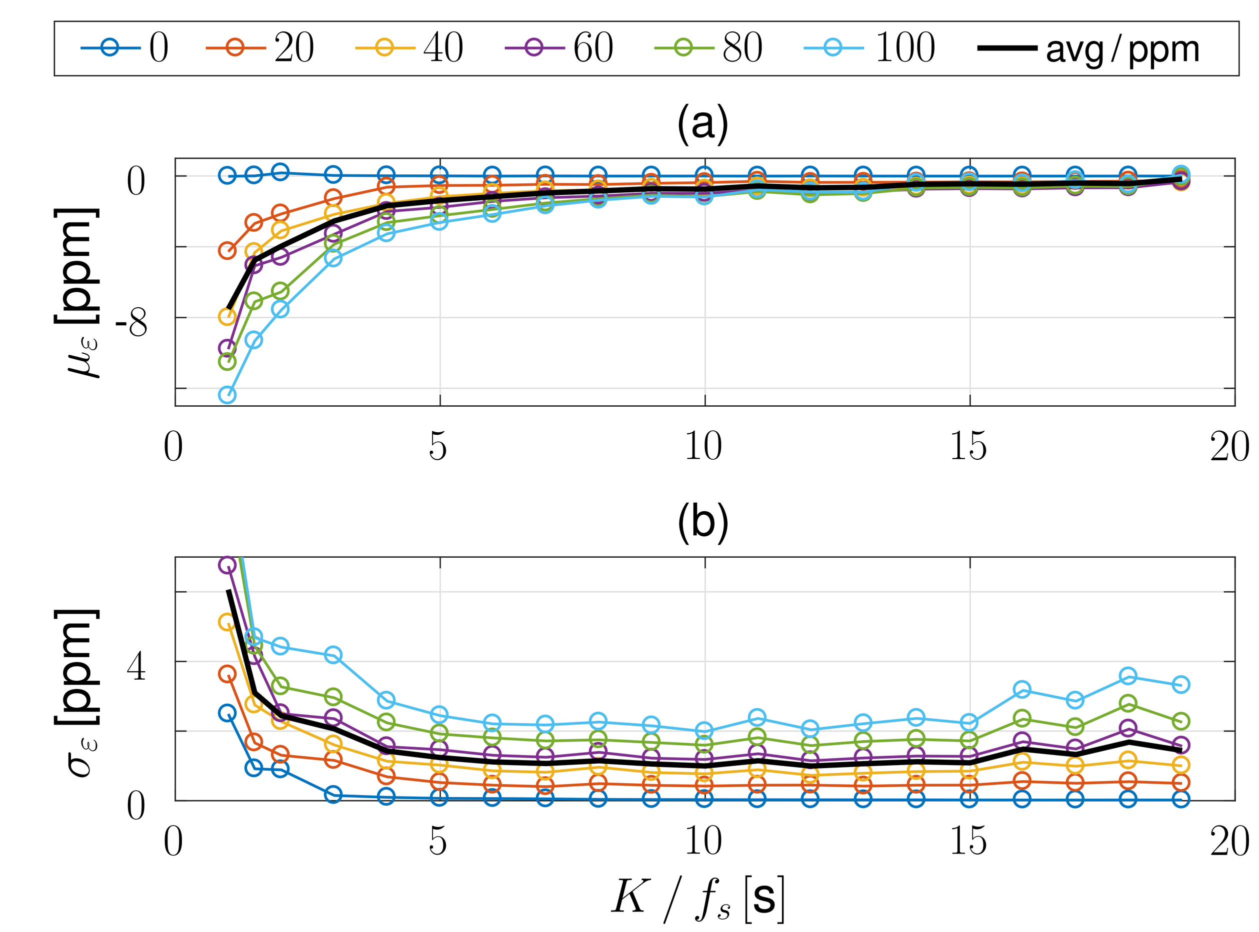
(b) Time course of a normalized second CCF $\tilde{\psi}_{12}(\lambda)$

(c) Final averaged normalized second (ANS) CCF $\bar{\psi}_{12}(\lambda)$

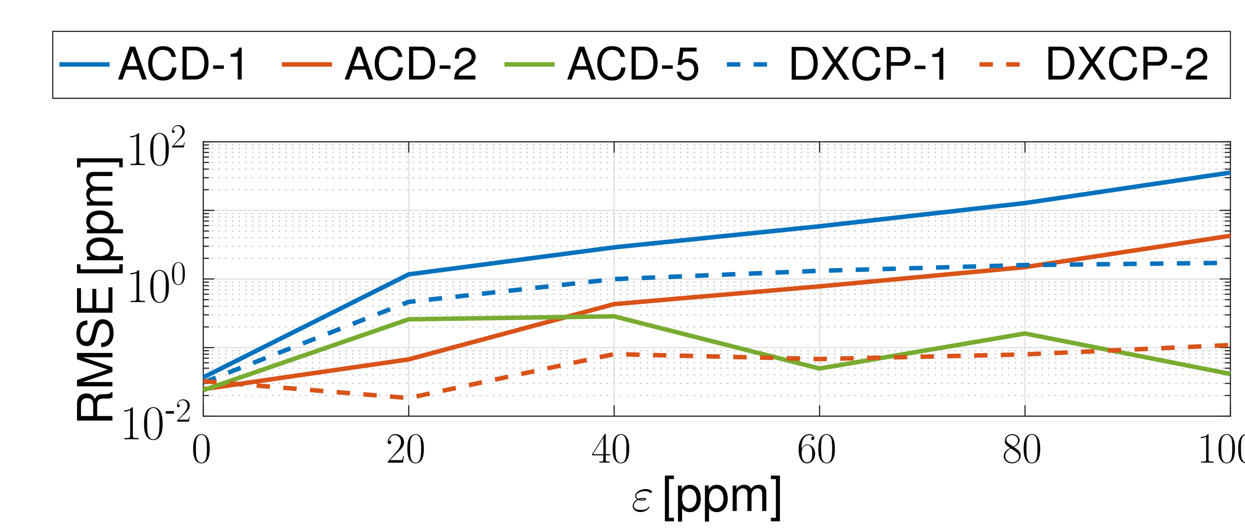
(d) Parabolic interpolation with resulting estimate $\hat{\delta}_\Delta = B \cdot \hat{\varepsilon}$

3. Experimental Results

- Optimization of mean estimation error μ_ε and standard deviation σ_ε of SRO estimate via frame size parameter $K = 2 \cdot B$



- Comparison with Multi-Stage (MS) Averaged Coherence Drift (ACD) method [Markovich-Golan et al., IWAENC, 2012], as in Weighted ACD [Schmalenstroeer et al., MMSP, 2017]



Speech distorted by babble noise at SNR $= \{10, 20, 30\}$ dB for microphone distance of 3 m with $T_{60} = \{0.1, 0.5, 1\}$ s

Estimator	ACD-I_{MS}				DXCP-I_{MS}	
MS-Iterations I_{MS}	1	2	5	10	1	2
RMSE [ppm]	15.67	1.88	**0.17**	0.18	1.19	**0.07**
Realtime factor	0.005	0.128	**0.498**	1.115	0.006	**0.131**

This work has been supported by DFG under grant EN 869/3-1 within the Research Unit FOR2457 "Acoustic Sensor Networks".

44th Int. Conf. on Acoustics, Speech, and Signal Processing (ICASSP), 2019, May 12 – 17, Brighton, UK