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FAKULTÄT FÜR MATHEMATIK
Dekan Univ.-Prof. Dr. Radu Ioan Boţ

Einladung zur öffentlichen Defensio

Irina SHAFKULOVSKA

Thema der Dissertation

Topics in time-frequency analysis

Abstract:
This thesis consists of six papers in the field of time-frequency analysis and sampling theory. The common thread is the so-called short-time Fourier transform (STFT), an integral transform that arises as the representation coefficient of the Schrödinger representation of the Heisenberg group.
We study four types of problems, namely, (i) sampling and the existence of new Gabor frames, (ii) optimization of point configurations, (iii) phase retrieval of the short-time Fourier transform, and (iv) uncertainty principles for joint time-frequency representations.
We construct new Gabor frames for two types of windows: Hermite functions and periodic exponential B-splines. For the Hermite functions, we rely on the Janssen representation of the Gabor frame operator, specifically, the Janssen test, to establish new Gabor frames for Hermite functions. For the periodic exponential B-splines, we derive a near-optimal result on sampling with derivatives in shift-invariant spaces generated by such windows. As a direct consequence, we also obtain new Gabor frames for periodic exponential B-splines and separated sets with density arbitrarily close to the critical density.
We also investigate the frame bound behaviour of Gabor frames on rectangular lattices. In particular, we show that if the window is the hyperbolic secant, an eigenfunction of the Fourier transform, then among all rectangular lattices of integer density, the square lattice is the unique optimizer of both bounds, and thus has the best condition number.
We employ similar techniques to provide new insight into the open problem of universal optimality in two dimensions. In particular, we exclude that the honeycomb structure, the natural non-lattice contender of the conjectured optimal hexagonal lattice, is universally optimal.
We continue with the phase retrieval problem for the short-time Fourier transform: a nonlinear non-stable problem that deals with the uniqueness of phaseless samples of the

short-time Fourier transform. We focus solely on the recovery of compactly supported functions from phaseless samples of their short-time Fourier transform with respect to particularly chosen holomorphic windows, not necessarily the Gaussian window.
We conclude with uncertainty principles for metaplectic time-frequency representations of square-integrable functions in the spirit of Benedicks's theorem. While such an uncertainty principle already exists for a subclass of metaplectic time-frequency representations, includingthe classical time-frequency representations, there was a lack of an understanding of the underlying group structure which would include all existing results as special cases in a unified framework for metaplectic time-frequency representations. We characterize the structure of metaplectic operators whose associated time-frequency representation allows for a Benedicks-type of an uncertainty principle, both in the sesquilinear and the quadratic version.

Prüfungssenat

Univ.-Prof. Mag. Dr. Andreas Cap
(Vorsitz, Universität Wien)

Univ.-Prof. Mag. Dr. Karlheinz Gröchenig
(Universität Wien)

Prof. Dr. Christopher Heil
(Georgia Institute of Technology)

Prof. Dr. Jorge Abel Antezana
(Universidad Autónoma de Madrid)

Zeit und Ort

Dienstag, 18. Juni 2024, 11:30 Uhr

Seminarraum 16, Kolingasse 14-16, 1090 Wien