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

Einladung zur öffentlichen Defensio

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Thema der Dissertation

Sampling in Spaces of Variable Bandwidth

Abstract:
This doctoral thesis delves into the domain of time-frequency analysis and sampling theory, focusing on the development of novel function spaces characterized by a variable bandwidth. The notion of variable bandwidth arises from the recognition that in nature it is meaningful to allocate distinct local bandwidths to various segments of a signal. However, giving a mathematical definition of variable bandwidth is challenging, since the bandwidth is a global property of a signal and a rigorous definition conflicts with the uncertainty principle when attempting to define a space of variable bandwidth.

Three constructions of spaces of variable bandwidth that use time-frequency tools are presented. The first space of variable bandwidth is constructed with a Gabor system. The second formulation is motivated by the physics of gravitational waves, and the space of variable bandwidth is built with Wilson bases. The third variation of the space of variable bandwidth is motivated by signal processing, with a space constructed with a local Fourier basis.

All these function spaces are built by using a discrete version of a variable bandwidth space introduced by Aceska and Feichtinger. They use a time-varying frequency truncation of the short-time Fourier transform and obtain an equivalent norm for the standard Sobolev space. The resulting spaces lack the main features of a variable bandwidth space, namely sampling theorems and necessary density conditions for reconstruction.

In our definitions, the short-time Fourier transform is replaced by a frequency truncation of a Gabor system, a Wilson orthonormal basis, or a local Fourier basis.

A key contribution of the thesis is the formulation of sufficient conditions for sampling for these spaces of variable bandwidth. Sampling inequalities are established following the adaptive weights method, and they provide insights into the reconstruction of functions from discrete samples. The exploration of nonuniform sampling scenarios offers a quantitative analysis of local sampling density requirements. The results of the sufficient condition for sampling theorems are tested in numerical simulations.

Prüfungssenat

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Zeit und Ort

Montag, 30. September 2024, 10:30 Uhr

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