New Directions in Discrete Tomography and Its Applications in Neutron Radiography

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Founded by: Hungarian Scientific Research Fund (OTKA) [7]

Partners:
- KFKI Atomic Research Institute [8] (Márton Balaskó [9])

Related projects:
- DIRECT [10]

Lifetime from: 2005
Lifetime to: 2008

Short description: New approaches in Discrete Tomography are investigated. Studies are concentrating on absorbed projections, fan-beam geometry, new geometrical properties of discrete sets. Besides, new application fields (such as neutron radiography) are studied.

Description:
This project follows a former one that investigated the basic aspects of Discrete Tomography (DT). In this research several new problems of DT are studied, we are mainly focusing on the following fields:

1. New Projection Geometries: We study the reconstruction in the so-called fan-beam projection model. Experiments are conducted to determine the optimal parameter values for this kind of problem.

2. New Geometrical Properties: We introduce classes of discrete sets defined by new geometrical properties (line-convexity, decomposability) in which the reconstruction can be performed in polynomial time. Uniqueness of the solution is also studied.

3. Emission Discrete Tomography: Existence, Uniqueness and Reconstruction problems are studied in case of absorbed projections.

4. Neutron and X-ray Tomography in Non-Destructive Testing (NDT): A new complex neutron-, gamma-, and X-ray three-dimensional computer tomography system suitable for experimental and industrial applications has been built at 10-MW Budapest research reactor site. A number of objects were investigated and tomographic projections were made. We study the optimal preprocessing steps and the optimal parameterization of pixel-based and geometry-based reconstruction methods to obtain DT reconstruction techniques that are suitable for practical applications in NDT. Pipe corrosions, damages of turbine blades, and other industrial objects are...
5. Analysis of DT reconstruction algorithms: We performed a benchmark evaluation of large-scale optimization approaches to Binary Tomography. We also designed algorithms to generate discrete sets having some convexity and connectedness properties using uniform random distributions to compare the performance of several reconstruction algorithms. Implementing those generators we supply benchmark collections for the reconstruction of hv-convex discrete sets [12].

6. Exploiting structural features of images from their projections: We apply learning methods (especially, decisions trees) to obtain geometrical properties of binary images solely from their projections, in order to be able to choose the proper algorithm and its parameters that fit best to the given reconstruction task. Algorithms which wisely can use learnt priors are also developed.

As a part of the project we implemented some of our reconstruction algorithms in the DIRECT [13] framework.

Reconstruction of pixel-based and geometric objects by discrete tomography. Simulation and physical experiments [50], Kiss, Zoltán [27], Rodek, Lajos [29], Nagy, Antal [21], Kuba, Attila [20], and Balaskó, Márton [46], ELECTRONIC NOTES IN DISCRETE MATHEMATICS, 2005, Volume 20, p.475 - 491, (2005)


On the number of hv-convex discrete sets [59], Balázs, Péter [41], Combinatorial Image Analysis, Apr 2008, Number 4958, Buffalo, NY, USA, p.112 - 123, (2008)


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