

# Research project proposal

Title: Discrete Tomography

Mentor: Tibor Lukić, PhD

## Background

Tomography deals with the reconstruction of images, or slices of 3D volumes, from a number of projections obtained by penetrating waves through the considered object. Practically, it provides information (image or 3D volume) about interior of the object. From the mathematical point of view, the problem posed is to reconstruct a function, which represents an image, from its integrals or sums over subsets of its domain. The tomography reconstruction problem may be continuous or discrete. In the discrete case, the range and domain of the function to be reconstructed are finite discrete sets and the field which deals with this problem is called discrete tomography (DT). The term DT is introduced at the meeting "Mini-Symposium on Discrete Tomography" which was held in 1994 (Rutgers University, USA). The field of DT application is diverse, it is often used in medical imaging or radiology (Computer Tomography, Positron Emission Tomography, Electron Tomography), in archaeology, biology, atmospheric science, oceanography, plasma physics, and in materials science.

## Project description

The project deals with the mathematical procedure called tomography reconstruction method. The task is to reconstruct an image from the given projection data. There exist a number of different reconstruction methods, which in general case give only approximate or "good enough" solutions. Improvement of the reconstruction methods is a challenge and a constant need. The project plan envisages the improvement of existing and developing new reconstruction methods. This plan includes:

- Prior information analysis (object convexity, area, perimeter...);
- Development of an appropriate optimization procedure;
- Analysis of the impact of the image grid selection (image grid can be classical/square, triangular, hexagonal..);
- Reconstruction model design (possible types: energy-minimization, inverse transform..);
- Experimental work in computer laboratory, often using Matlab environment.

## References

1. G.T. Herman, A. Kuba, Discrete Tomography: Foundations, Algorithms and Applications, Birkhäuser, 1999.
2. G.T. Herman, A. Kuba, Advances in Discrete Tomography and Its Applications, Birkhäuser, 2006.
3. T. Schüle, C. Schnörr, S. Weber, J. Hornegger, Discrete tomography by convex-concave regularization and D.C. Programming, Discrete Appl. Math., vol. 151, pp. 229–243, 2005.
4. T. Lukić, B. Nagy, Discrete tomography reconstruction by energy minimization method on triangular grid, Pattern Recognition Letters, vol. 49, pp. 11-16, 2014.
5. L. Varga, P. Balázs, A. Nagy, Direction-dependency of binary tomographic reconstruction algorithms, Graphical Models, vol. 73, pp. 365–375, 2011.

## Contact

Dr Tibor Lukić, docent

Room: 603  
Department of Mathematics  
Faculty of Technical Sciences  
University of Novi Sad

Email: [tibor@uns.ac.rs](mailto:tibor@uns.ac.rs)  
Homepage: <http://imft.ftn.uns.ac.rs/~tibor/>