

CSI: Computational Science in Imaging

CSI Case Studies

with applications in biometrics and surveillance



Image deblurring



Fingerprint restoration

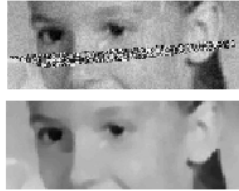
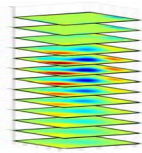


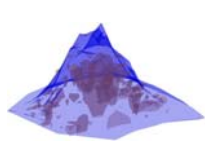
Image in-painting

We develop and implement the enabling *mathematical technology* for next-generation inversion problems arising in imaging applications, such as

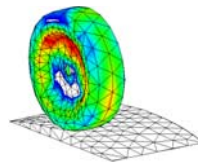
- crystallography and tomography
- acoustic holography
- geoscience



Tomography



Geoscience



Holography

CSI Lyngby

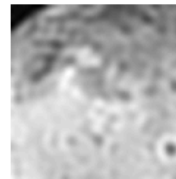
- Per Christian Hansen (principal investigator)
- Jakob Heide Jørgensen
- Klaus Mosegaard (associated)



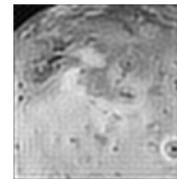
Informatics and Mathematical Modelling

Traditional algorithms, based on solving standard approximations, lack robustness and inherit inaccuracies from the approximations.

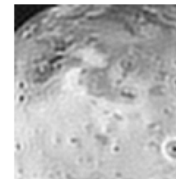
A new approach is needed – it is not enough to repair the existing methods. We develop algorithms that are faster, more accurate, and more reliable.



Blurred image



FFT deblurring (wrong method)



DCT deblurring (better method)

Project Goals

- *New algorithms.* Develop iterative methods for structured linear algebra in interior-point methods in convex optimization problems.
- *Applications.* Use case studies in imaging for testing and developing the new techniques.
- *Training.* Offer MSc and PhD courses.

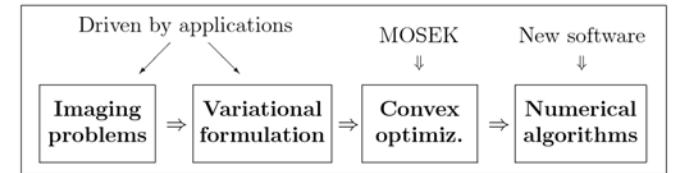
International partner universities: TU Delft, Emory (Atlanta), Rice (Houston), Tufts (Boston), and UCLA.

CSI Aalborg

- Søren Holdt Jensen
- Tobias Lindstrøm Jensen



Department of Electronic Systems



Project Ingredients

Inversion problems. We are interested in recovering hidden information from noisy measured data.

Variational formulation. We use a variational formulation to describe inversion as an optimization problem.

Convex optimization. We focus on minimizing a convex cost function subject to convex constraints.

Numerical algorithms. The important ingredients are:

- *Interior-point methods* which are currently the most efficient methods for our inversion problems.
- *Structured-matrix algorithms* that utilize the high degree of algebraic structure found in our problems.
- *Preconditioned iterative methods* which are state-of-the-art methods for solving structured problems.

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MOSEK ApS

- Erling D. Andersen
- Joachim Dahl



Mathematical optimization software