Fast 3D image reconstruction for OPT microscopy

B.Sc. project in Applied Mathematics - Mathematical Biology (Applied Analysis)

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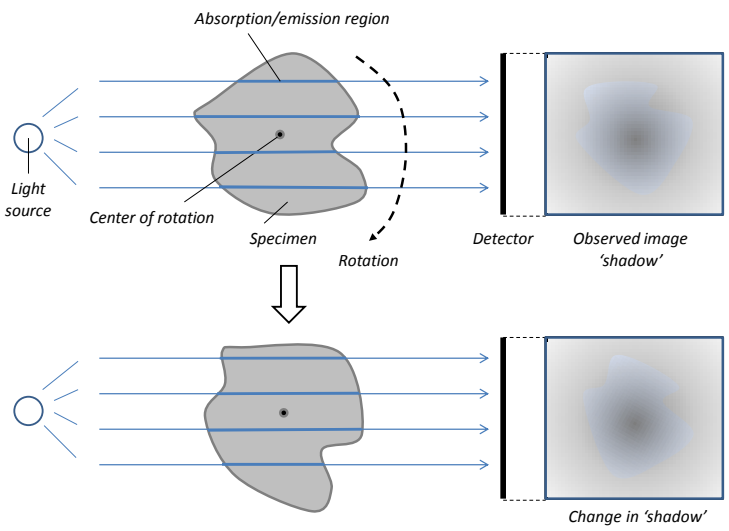
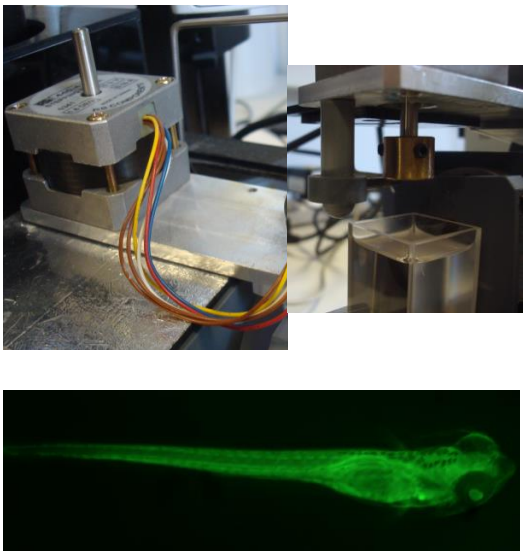
Optical Projection Tomography (OPT) microscopy is a new technique for 3D optical microscopy, originally developed in Edingburgh (UK). In Leiden an experimental OPT microscope is set-up by Fons Verbeek. It allows to reconstruct a 3D image of a biological specimen of about 1 cm diameter. Currently, it takes about 30-45 minutes to compute an image reconstruction. The ultimate objective of this project is to help to improve the speed of the reconstruction algorithm used. This may be achieved either by using a computationally more effective algorithm, if mathematically possible, or to allow for parallel computing. With an improved reconstruction speed the microscope operators can then validate the results of their imaging more quickly and adjust microscope settings accordingly.

In Projection Tomography one measures the amount of light absorbed or emitted when an (almost) parallel bundle of light is cast through the specimen (see Figure below) under different angles, ranging along a full circle. Thus one measures a quantitative shadow: where the object is thicker it absorbs more light and the shadow is darker. The shape of the specimen can be reconstructed from all these 'shadows' by means of the so-called back-projection algorithm.





Mathematically, this procedure relates to the field of Geometric Tomography. The reconstruction is algorithm is based on the so-called *Radon transform* and its inverse. The project consists mathematically first of getting acquainted with the Radon transform and its properties, the inverse in particular. Then a literature study will be made on existing ideas of implementation of the inverse transform (starting from discrete data), as is applied already in tomography, including parallelization. Next, novel ideas for implementation may be formulated. In Computer Science a BSc student will be involved in the implementation of improved microscope control, processing and presentation software. The student in this project will work collaboratively with the latter, guiding the implementation of an improved back-projection algorithm.

A detailed presentation of this project cannot be given in the last week of January, unfortunately. ***Please contact the lecturer by email if you are interested and want further information.***