DTU Compute
Department of Applied Mathematics and Computer Science

Movable mesh for tomographic reconstruction
Prototyping and testing

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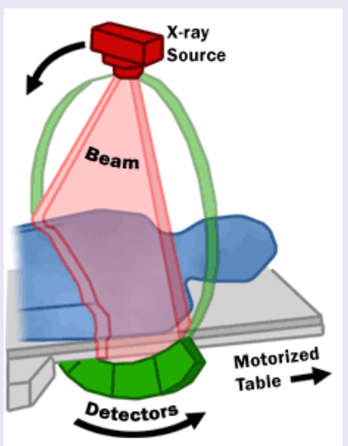
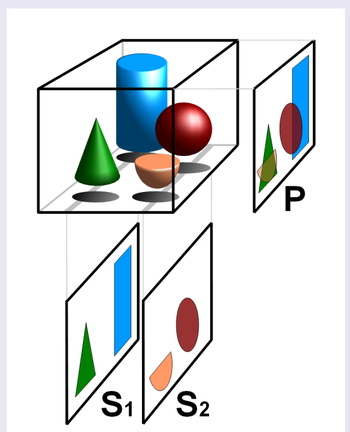
X-ray tomography has many applications today. In everything from medicine (computerised tomography) materials science from laboratory equipment to large synchrotron facilities. However, the current methods require large amounts of data and produce excessive noise. Using Deformable Simplicial Complex (DSC) can improve both these issues.





X-Ray tomography examples. The figure to the left show how a CT-scanner works. The figure to the right show different projections, based on the angle.

Current Methods

There are two main methods in use today.

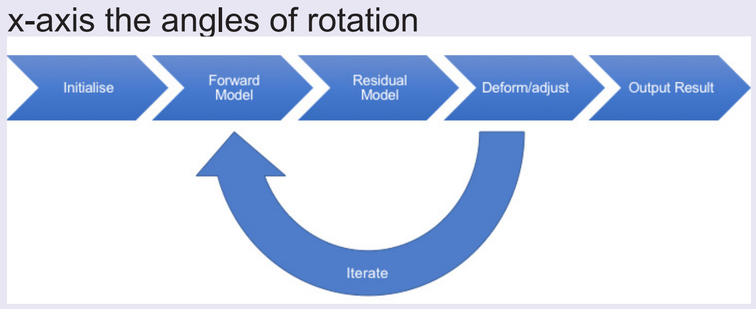
- Filtered Back Projection
  - Better resolution than simple interpolation
  - Induces noise cause by the filter
- Algebraic Reconstruction
  - Allows use of A Priori information
  - Computationally intensive

Deformable Simplicial Complex

DSC is a framework for curve representation of images. It is represented by a mesh, where each simplex is labelled. And the vertices can be moved, to deform the curve.

Algorithm

The proposed algorithm works by initialising an image, then iterating a three step, before outputting the results. The initial image is given as a curve representation, using the DSC Framework. The data is given as a sinogram, where for 2D data the y-axis represents the detector, and the x-axis the angles of rotation

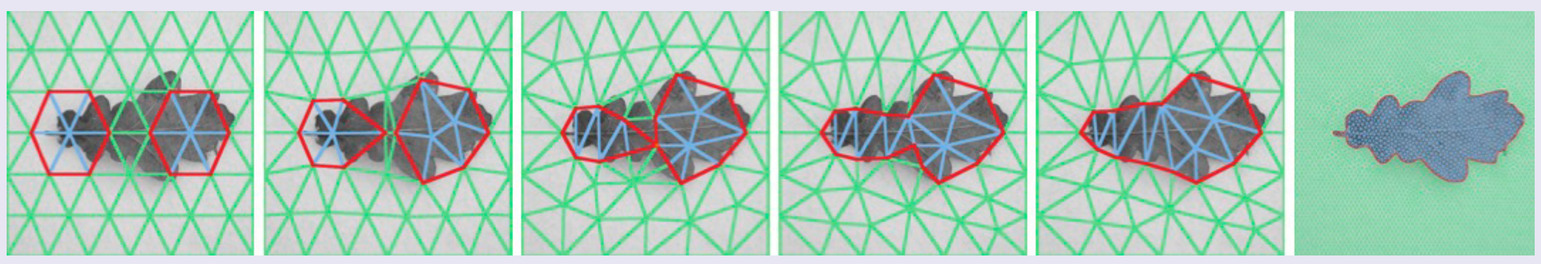


Proposed algorithm. An image is initialised, before generation of a forward model and comparison to measured data (residual model). The image is adjusted and the process is iterated until equilibrium.

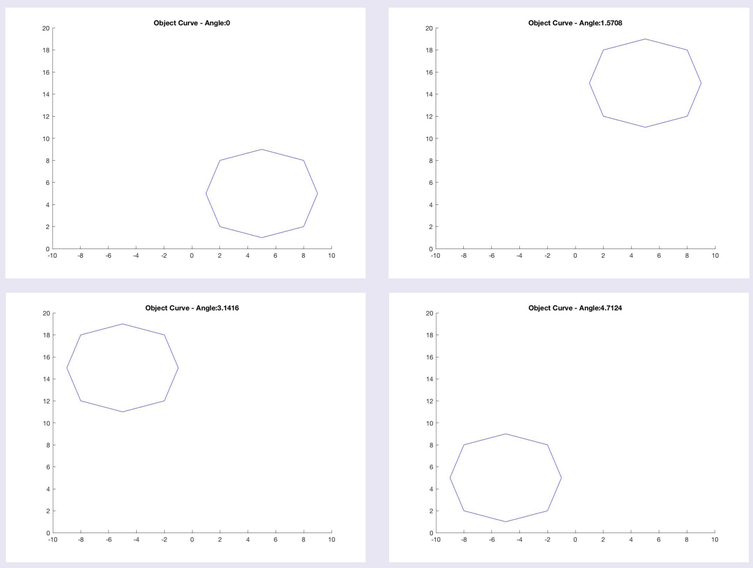
The three iterative steps are:

- Generate Forward model
  - A sinogram is generated from the curve.
- Determine residual model
  - Compared the generated sinogram with the measured sinogram.
- Deform/adjust curve
  - Adjust the initial curve based on the residual model.

These three steps are repeated until an equilibrium is reached.



Coarse Simplicial Complex. The complex is initialised in two places. The triangles inside the curve are indicate in *blue* and the triangle outside are indicated in *green*, while the interface is indicated are *red*. The last image is generated with a much finer mesh.



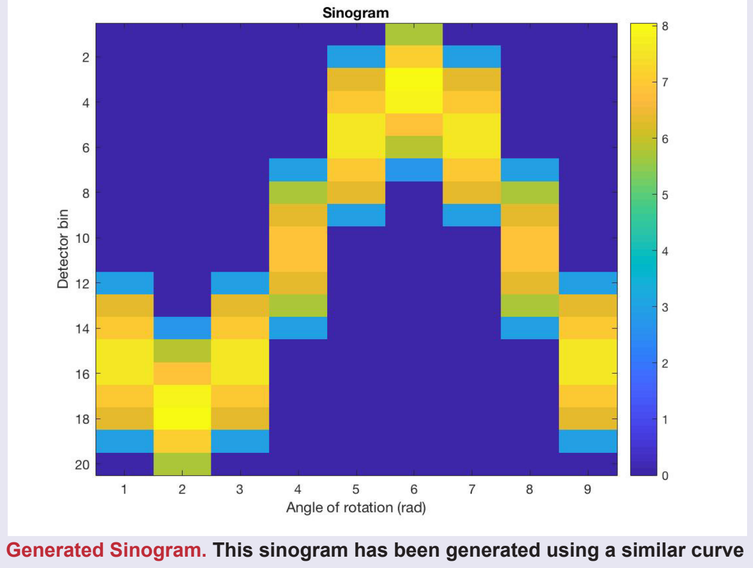
Example Input curve. An example of the input curve extracted from the DSC curve. Here it is rotated by 0, Pi/2, Pi, and 3 Pi/4 respectively.

Preliminary results

A prototype of the generation of the forward has been implemented in MATLAB. The prototype takes a curve, given as an array of line segments, in turn represented by a start point and an end point. The implementation is built in three levels.

- Calculation of each line segment.
- Calculation of each curve.
- Calculation of full sinogram, based on the given rotations.

The output is a sinogram, which can be used to generate the residual model.



Generated Sinogram. This sinogram has been generated using a similar curve to that display above, rotated to nine different angles.

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