Tomographic back projection from Schlieren images

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Introduction

Schlieren images provide 2-dimensional projections of the acoustic beam; the brightness of a pixel (x0, z0) in the x-z plane is related to the accumulated power along the line (x0, y, z0) where y is a variable.

Back projection is the process of generating a 3D object from a set of 2D projections acquired at known angles. For visualization we take a 1D slice from each of the 2D projections and create a 2D cross-section of the 3D object.

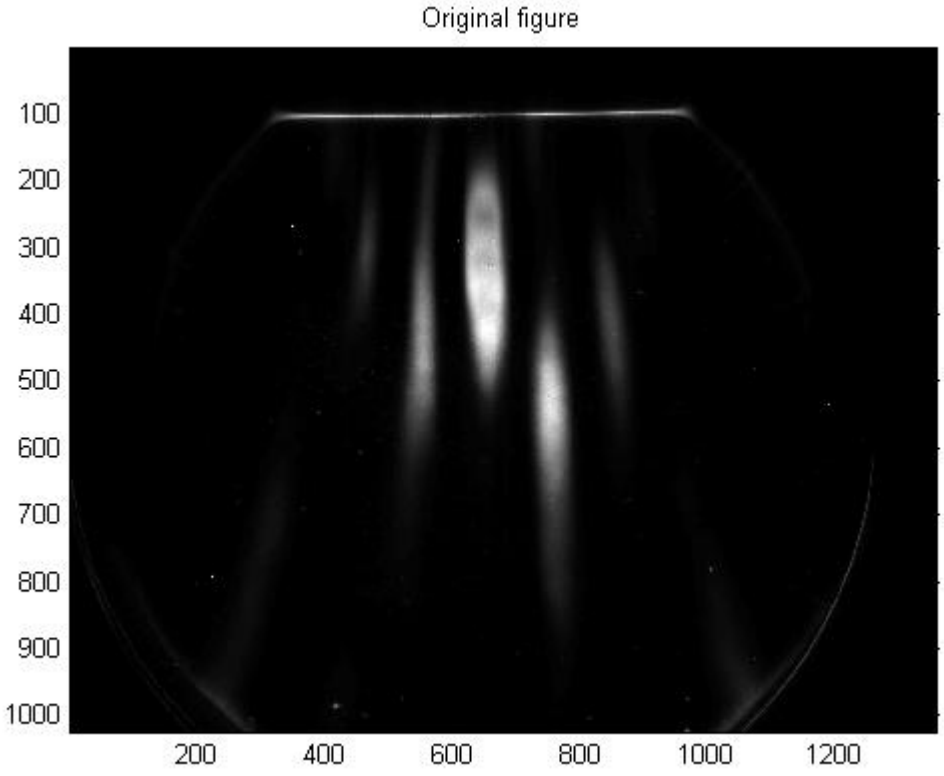

Figure 1: original Schlieren image

Algorithm

1. I took a standard Schlieren image (Figure 1)
2. Down sample it by averaging from 1024x1360 to 101x201 pixels.
3. Create a left-right symmetric image (this is necessary only because I am using a single Schlieren image to simulate multiple image acquisitions. In future I will use the automatic rotating system to acquire images at known angles).
4. Select the level of cross section and extract the 1D slice from the image.
5. Duplicate the slice 180 times (simulate 180 Schlieren images, evenly spaced between 0 – 179 degrees).
6. Use tomography (the inverse Radon transform) to generate the 2D cross section.

Results

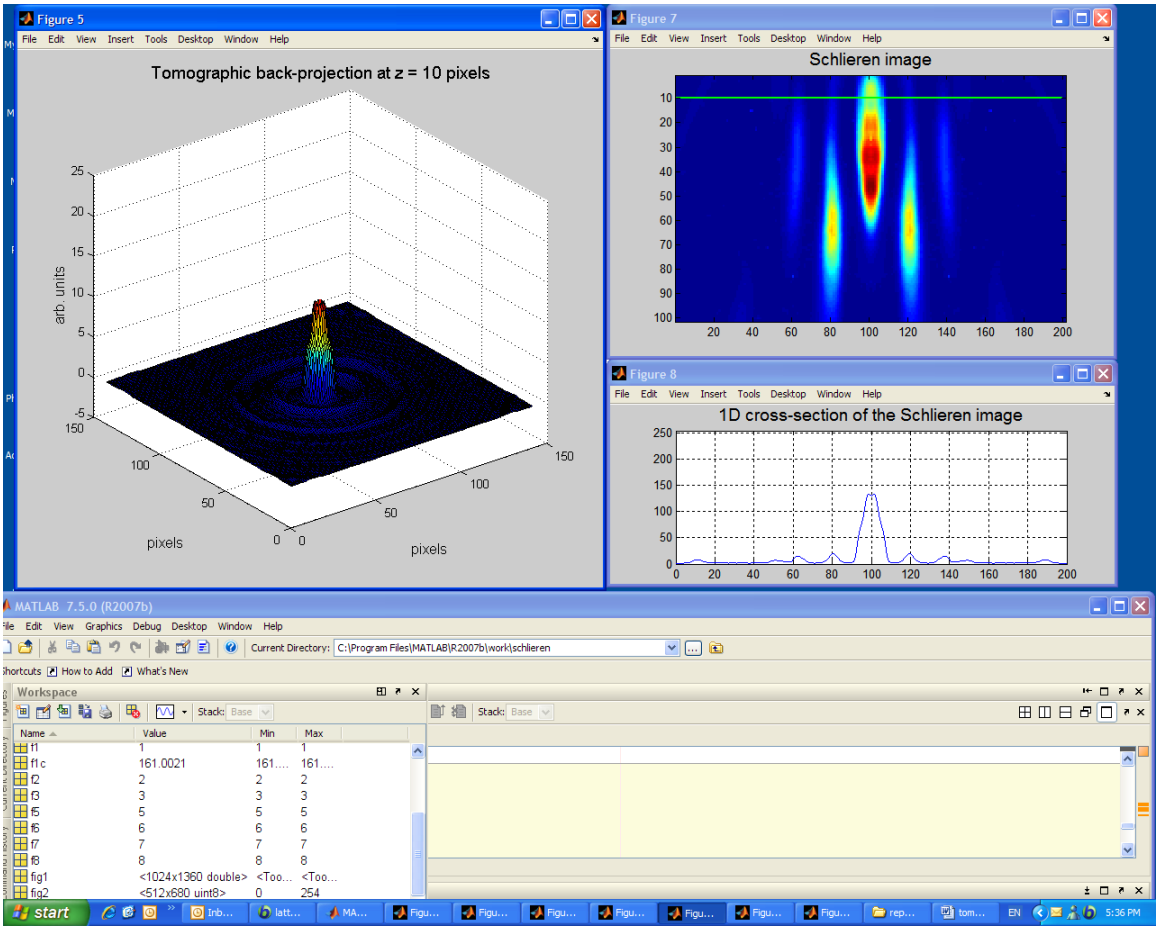

Figure 2: Cross section at z=10 pixels of the symmetric image.

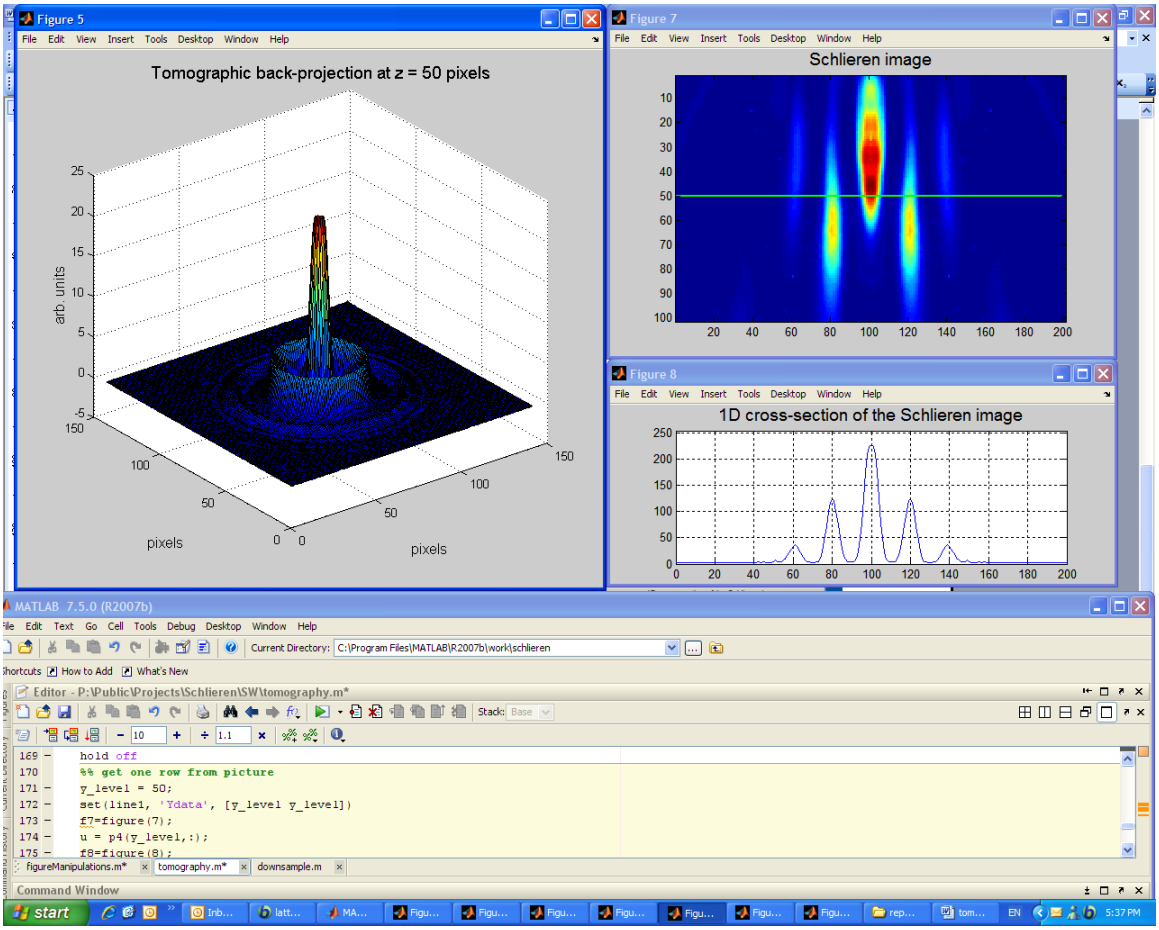

Figure 3: Cross section at z=50 pixels of the symmetric image.

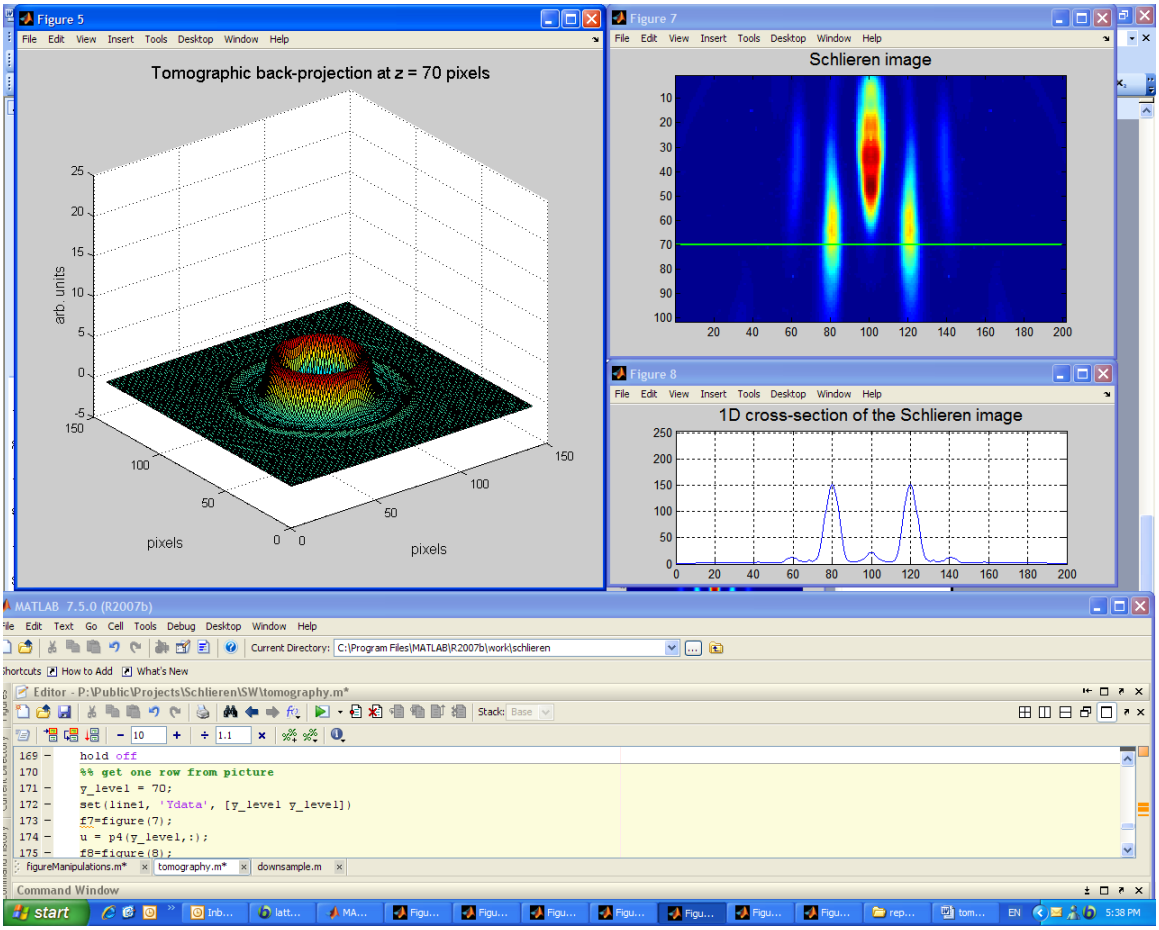

Figure 4: Cross section at z=70 pixels of the symmetric image.

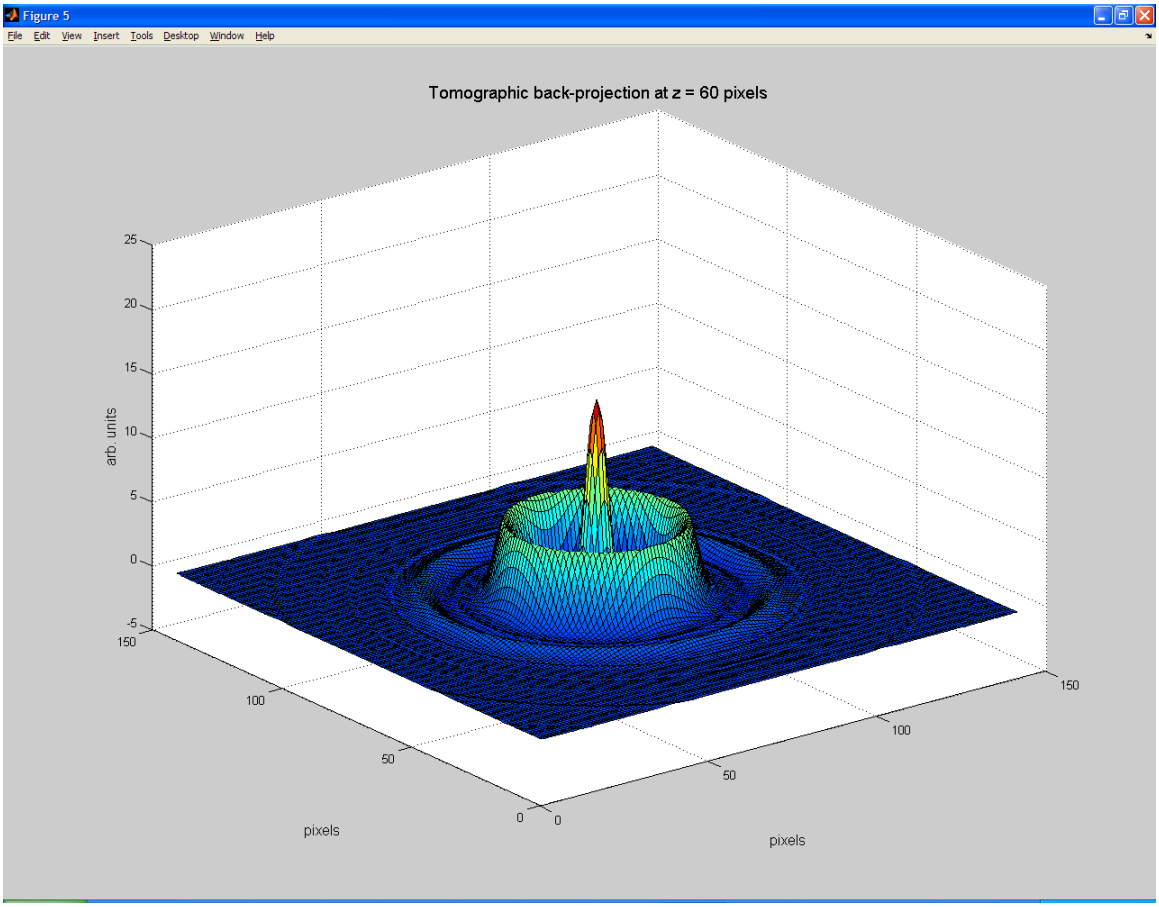

Figure 5: Back projection at z=60 pixels.

What next

- To get true scaling of the image: pixels -> millimeters
- Utilize the rotating motor for multiple image acquisitions.
- ???