MRE Reconstruction: Inverting the wave equation

Stephan Wäldchen

(Technische Universität Berlin)

BIOQIC Day 2017

Berlin (Germany)

September 19, 2017

Outline of This Talk

1. Why we need MRE
2. Data Reconstruction and current Problems
3. Denoising Techniques
4. First Experiments
5. What comes next

Why do we want to do MRE?

- Stiffness is used diagnostically
- MRE: non-invasive technique

How does the measuring process work

- A vibrating pillow
- Reaction of the tissue, 3 component vector field in time and space
- motion encoding gradient
- MRI measurement in 3 spatial directions and 8 time steps

Data reconstruction

$$\mathbf{u} = \mathbf{u}(\mathbf{x}t)$$

$$\mu =$$

$$\sum_j \partial_j \left(\mu \left(\partial_j u_i + \partial_i u_j\right)\right) + \partial_i \left(\lambda \partial_j u_j\right) = \rho \ddot{u}_i$$

- differential equation –¿ inverse problem
- Problem underdetermined, we need boundary values
- Problem: some regions are close to nodes –¿ no movement
- Solution: Multi frequency inversion
- Problem: Need to reconstruct the derivatives
- motion encoding gradient
- MRI measurement in 3 spatial directions and 8 time steps
- MRI measurement in 3 spatial directions and 8 time steps and 3 frequencies –¿ 72 times MRI overhead
- –¿ reduced resolution

Our plan of work

- Do simuations in 1d: wavelets
- Do simulations in 2d: wavelets, shearlets
-

- Problem: Need to reconstruct the derivatives
- slight noise can lead to totally wrong derivatives –¿ inversion is useless
- MRI measurement in 3 spatial directions and 8 time steps –¿

What would be nice results

- Have better resolution of the stiffness map
- Have clinically useful values, at the moment to varying
- Have shorter acquisition times per pixel

- Problem: Need to reconstruct the derivatives
- slight noise can lead to totally wrong derivatives –¿ inversion is useless
- MRI measurement in 3 spatial directions and 8 time steps –¿