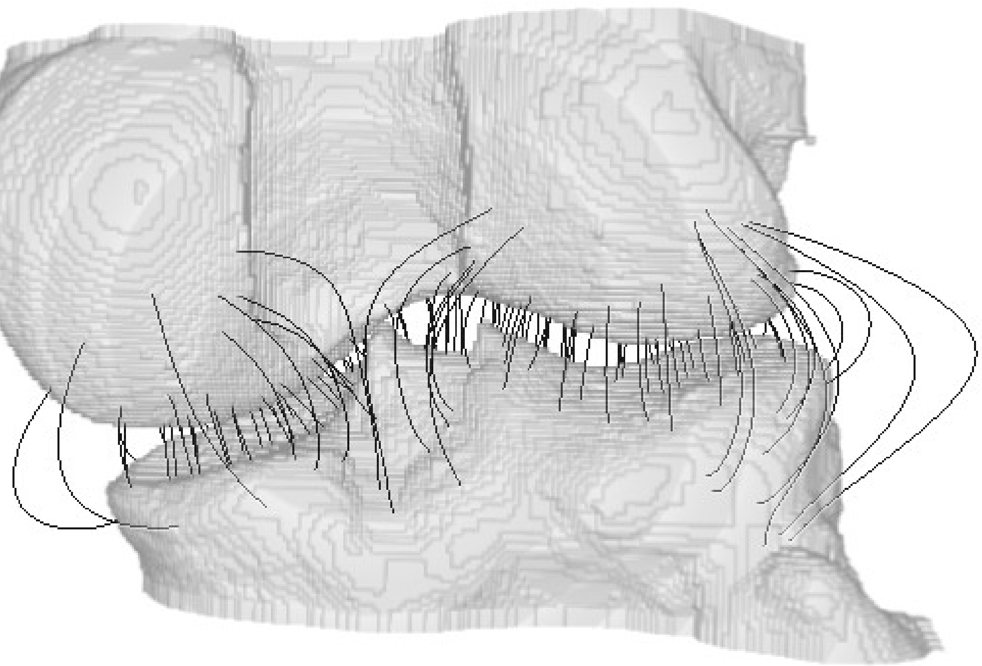
An Electrostatic Model for Assessment of Joint Space Morphology in Cone-Beam CT

Computer Integrated Surgery II – Project 11



Literature Review

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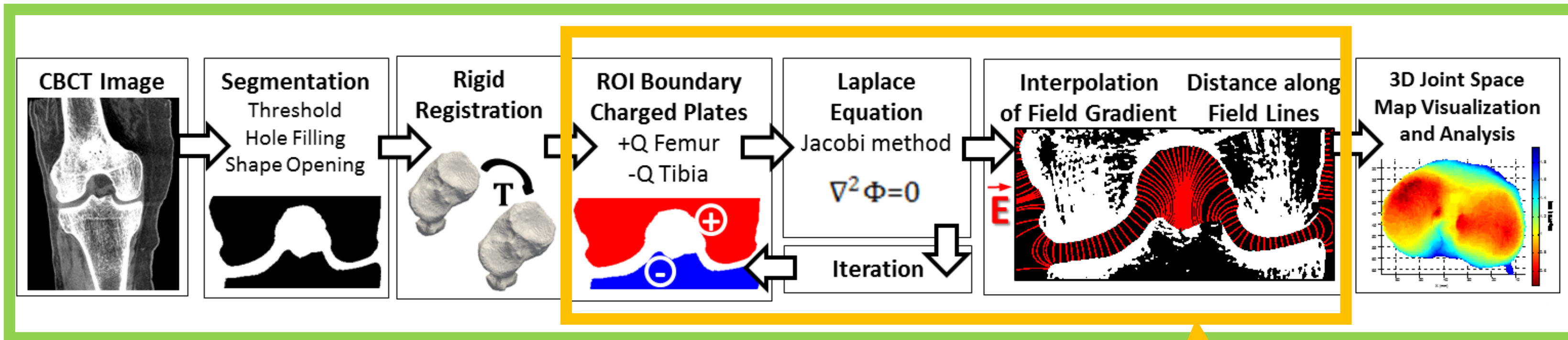
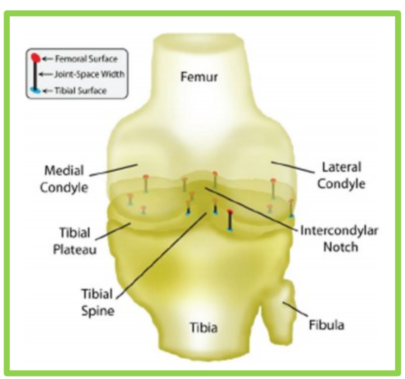
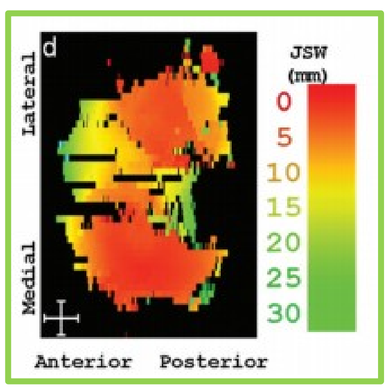
Overview

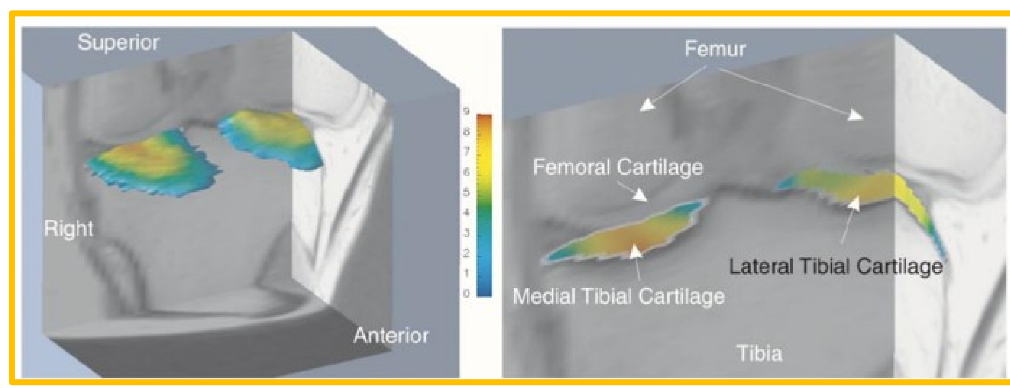


1. Kalinosky, B., Sabol, J. M., Piacsek, K., Heckel, B., & Gilat Schmidt, T. (2011). Quantifying the tibiofemoral joint space using x-ray tomosynthesis. *Medical Physics*, *38*(12), 6672–82. doi:10.1118/1.3662891

2. Yezzi, A. J., & Prince, J. L. (2003). An Eulerian PDE approach for computing tissue thickness. *IEEE Transactions on Medical Imaging*, *22*(10), 1332–9. doi:10.1109/TMI.2003.817775





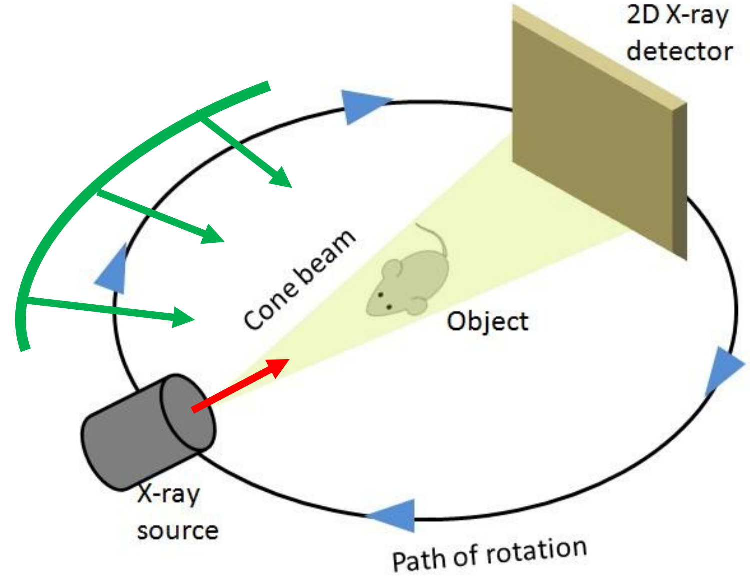


Kalinosky et al: Modality

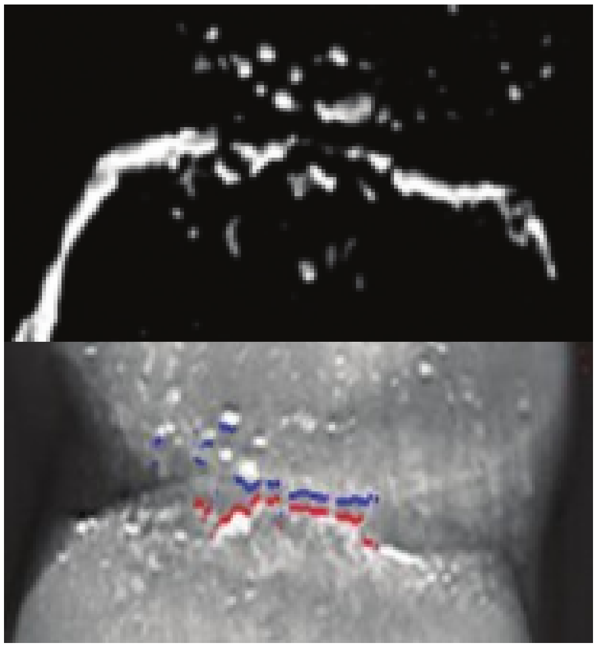
Radiograph

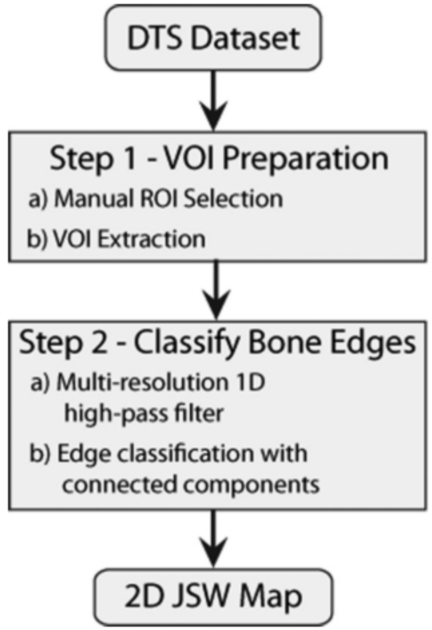
Tomosynthesis

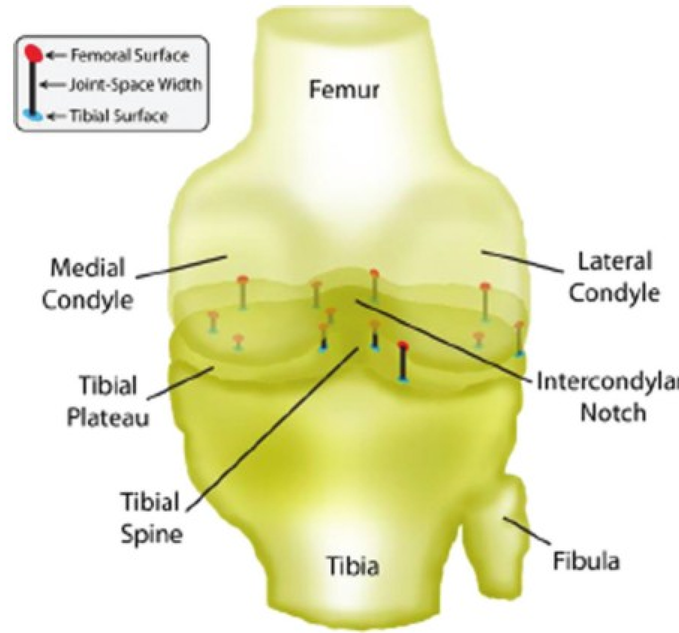
Computed Tomography



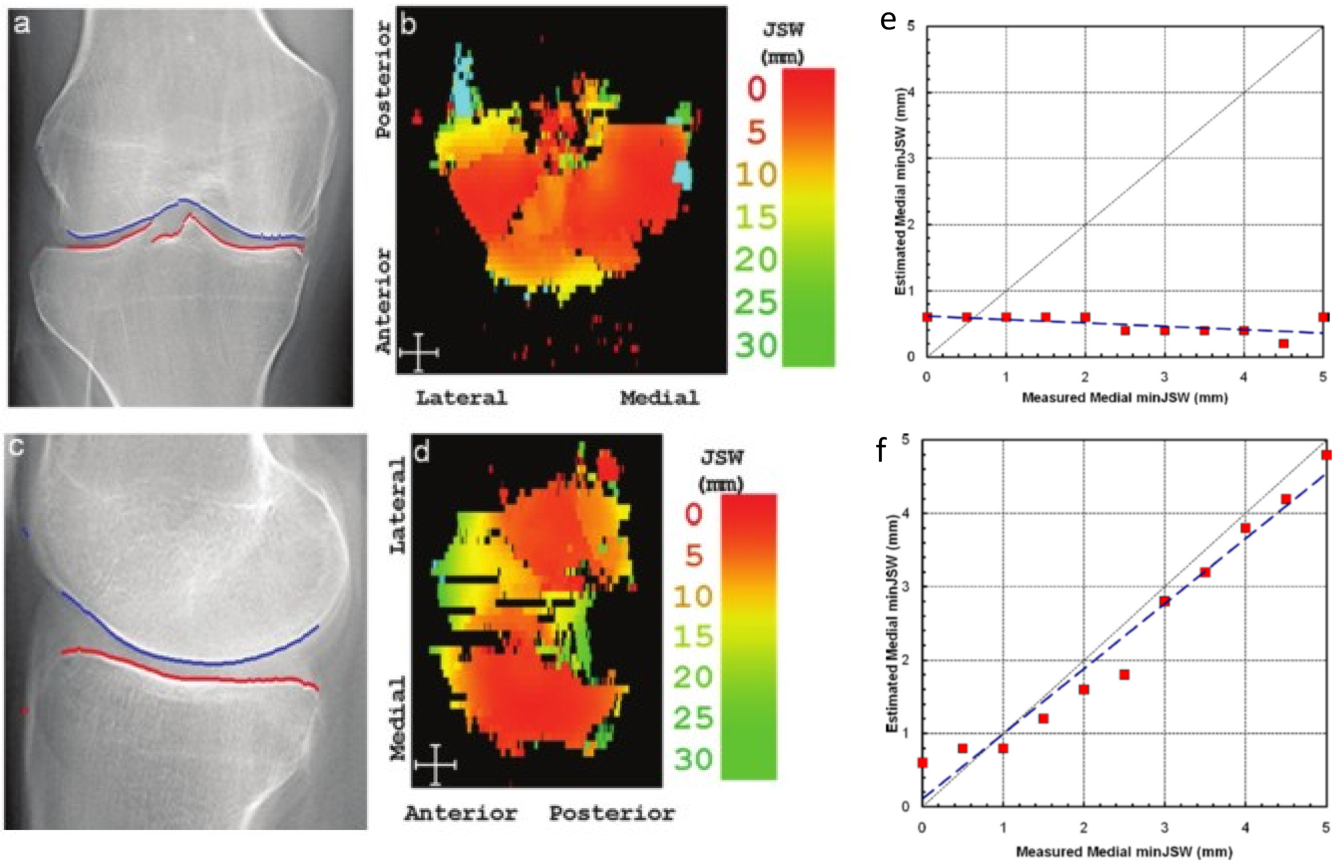
Kalinosky et al: Methods



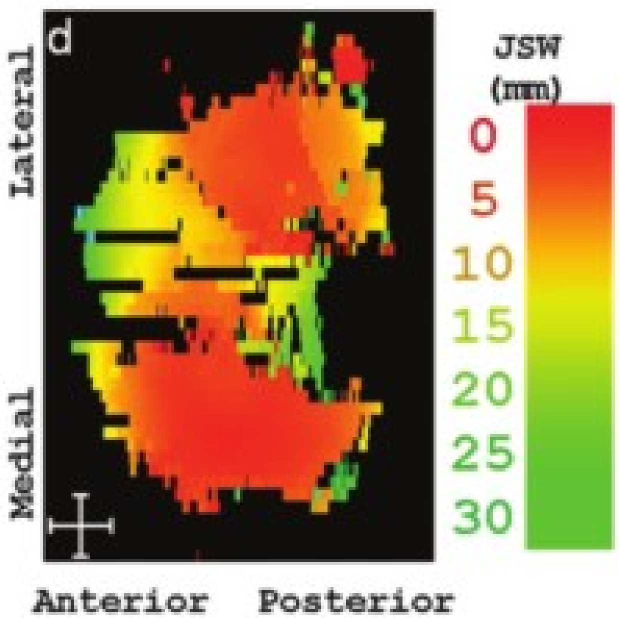


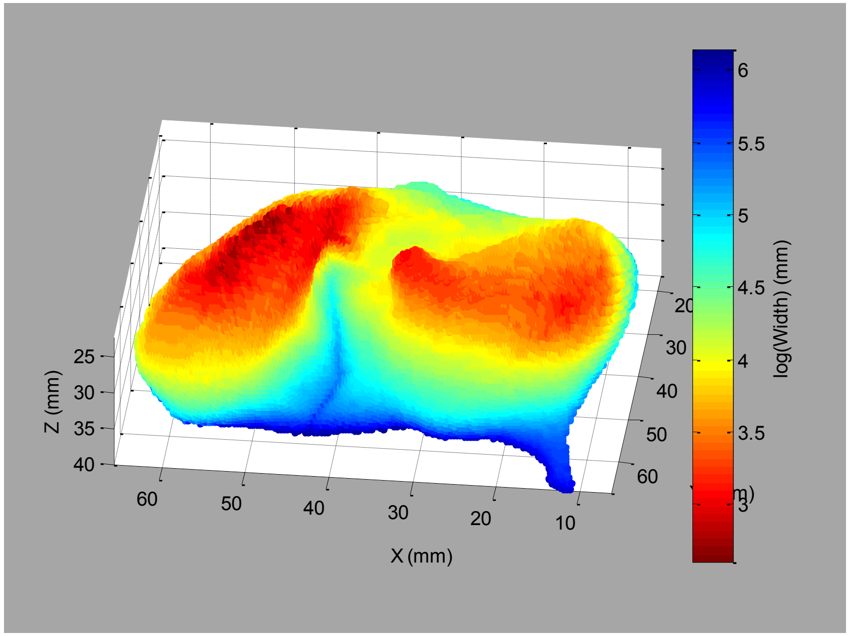


Kalinosky et al: Results



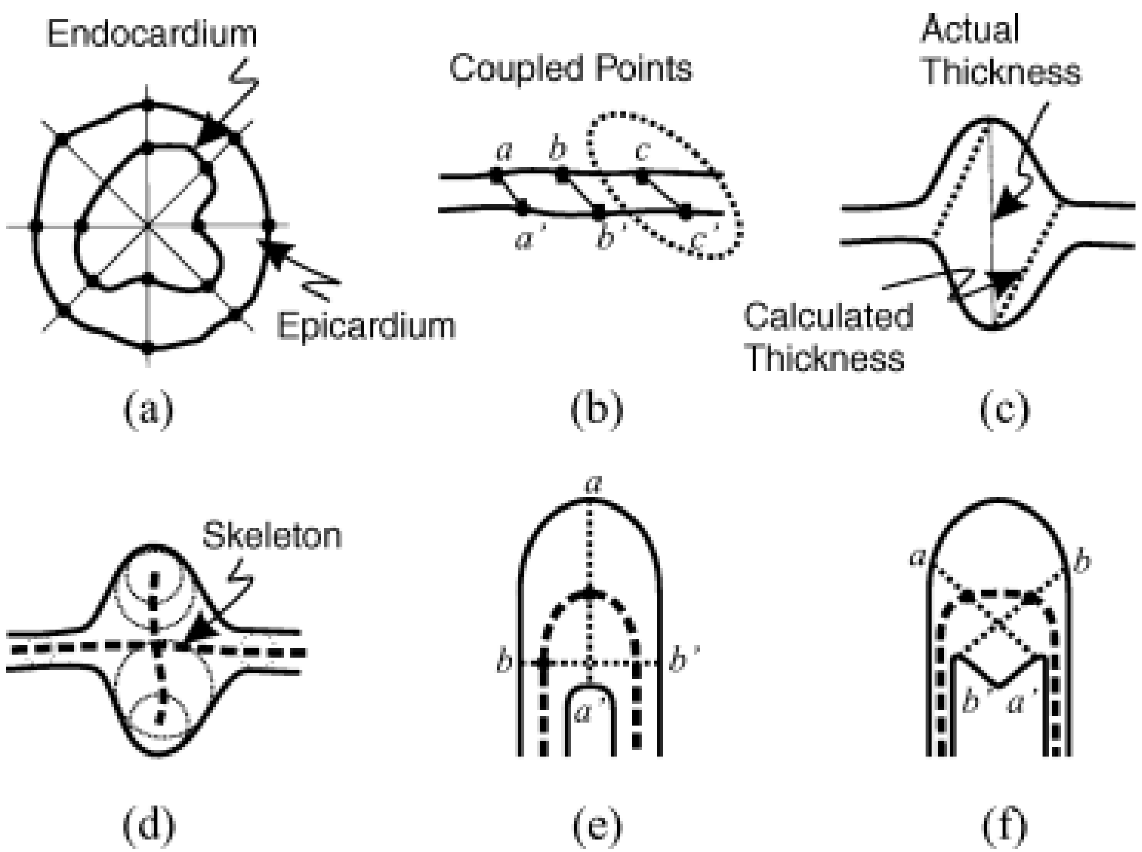
Kalinosky et al: Comparisons



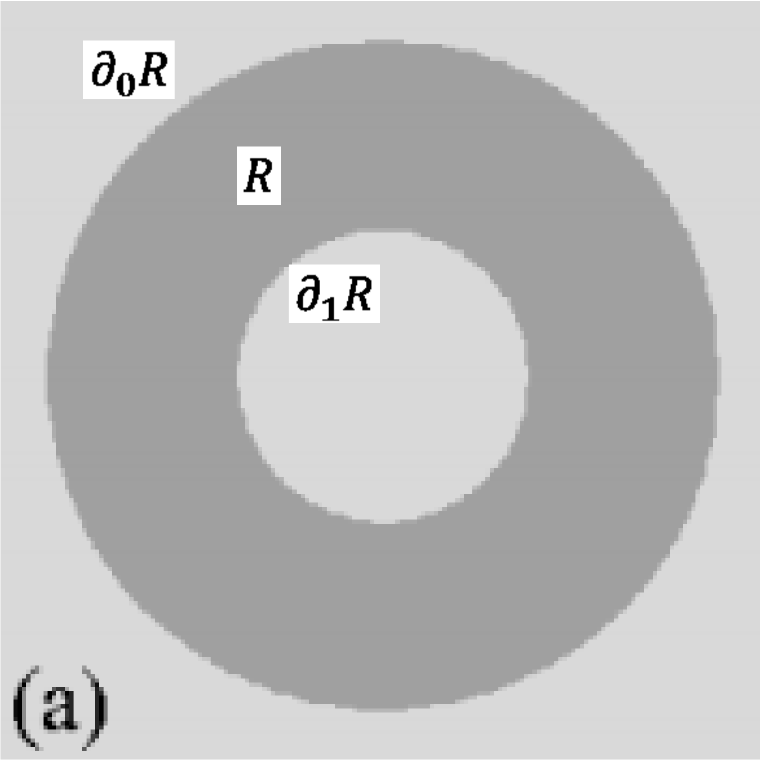


- 2D vs 3D
- Distance Measure: Intuitiveness + Clinical Utility
- Noise & Smoothness
- Computation Time
- Demands on Segmentation

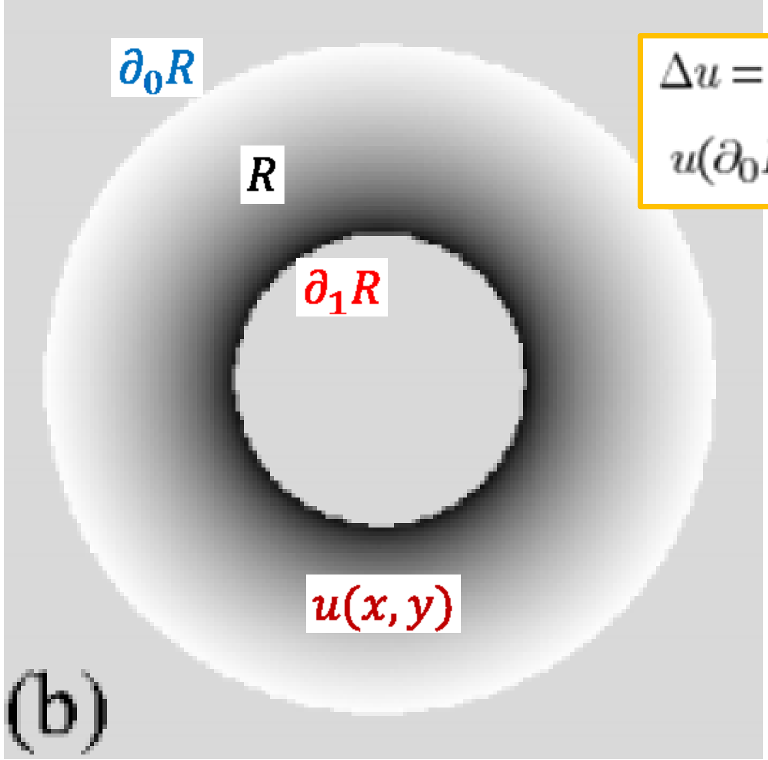
Yezzi et al: Motivation



Yezzi et al: Methods



Yezzi et al: Methods



$$\Delta u = 0$$

$$u(\partial_0 R) = 0 \text{ and } u(\partial_1 R) = 1$$

$$\Delta u = \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}$$

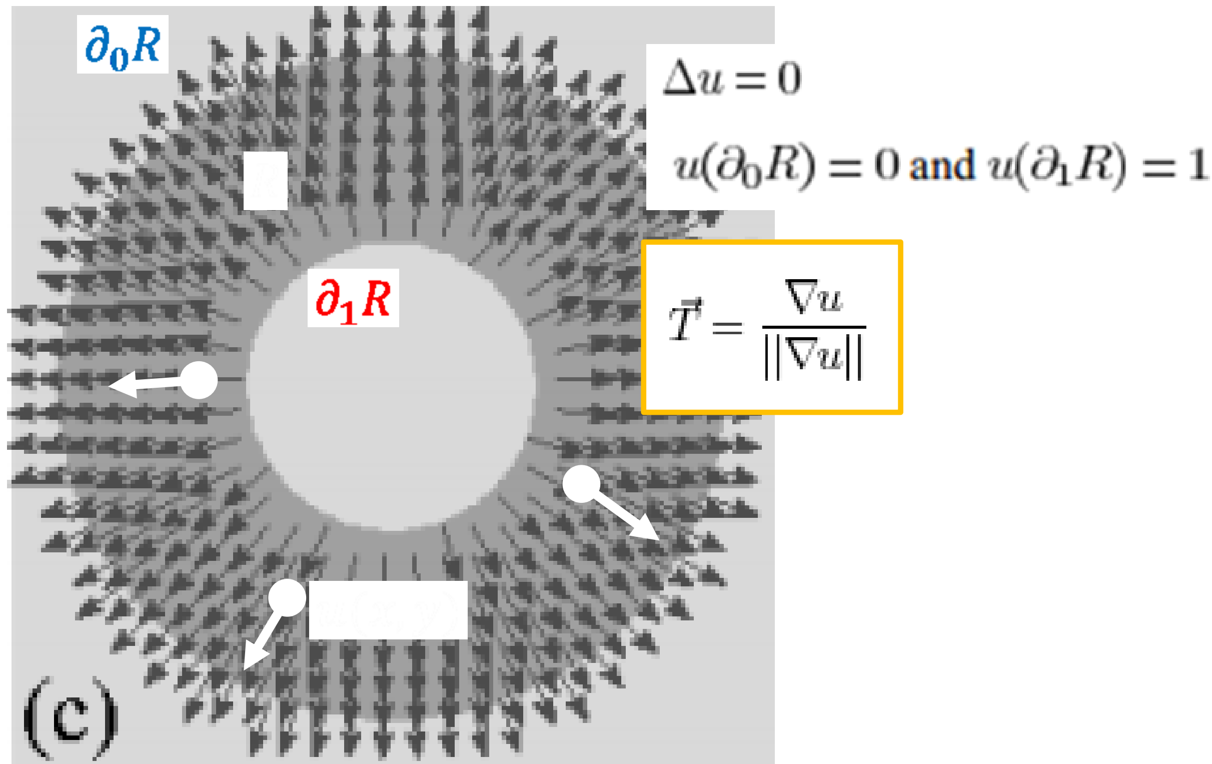
$$D_x^- L = \frac{L[i,j,k] - L[i-1,j,k]}{h_x}$$

$$D_x^+ L = \frac{L[i+1,j,k] - L[i,j,k]}{h_x}$$

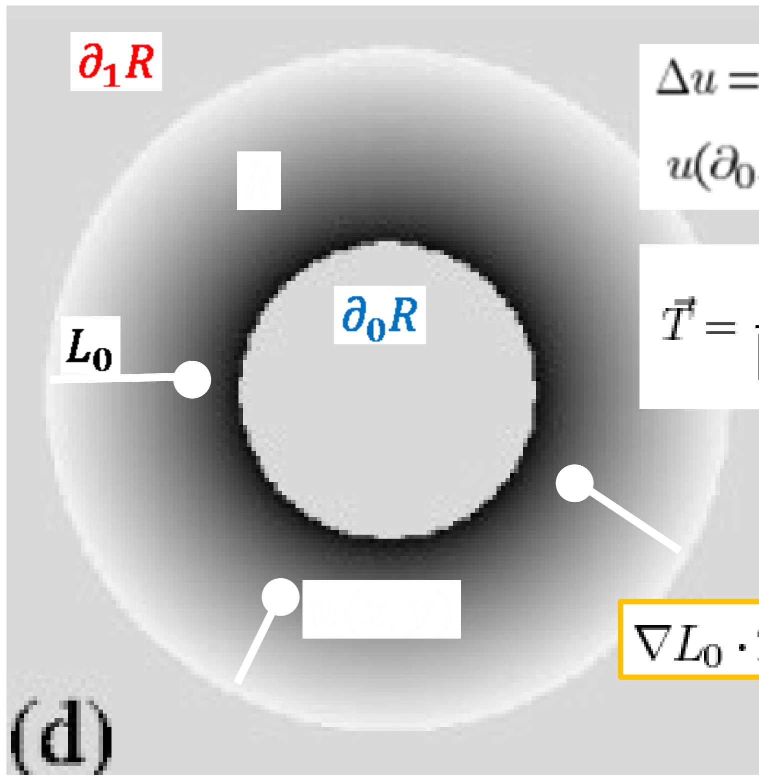
$$D_y^- L = \frac{L[i,j,k] - L[i,j-1,k]}{h_y}$$

$$D_y^+ L = \frac{L[i,j+1,k] - L[i,j,k]}{h_y}$$

Yezzi et al: Methods



Yezzi et al: Methods



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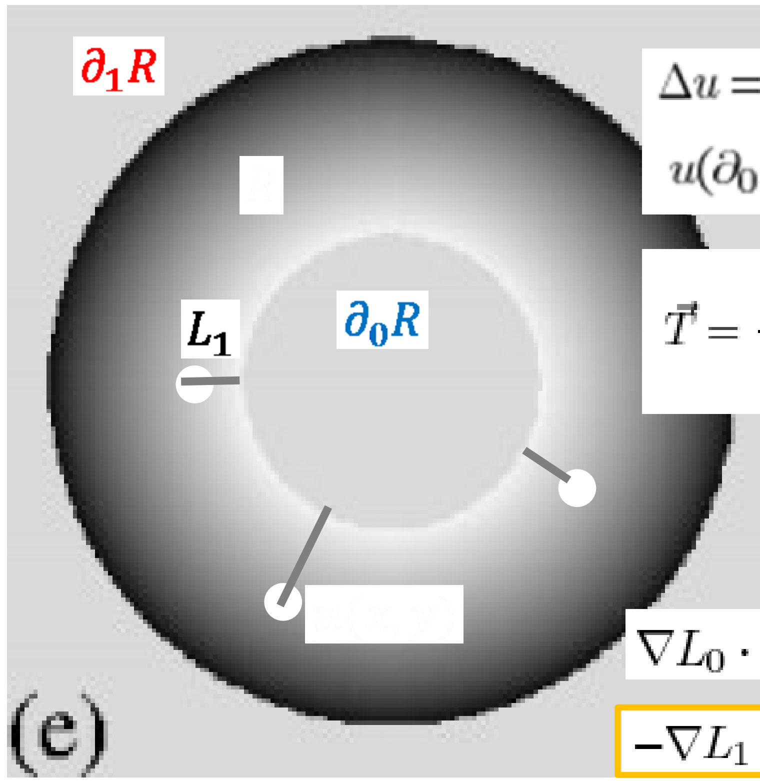
$$\vec{T} = \frac{\nabla u}{||\nabla u||}$$

$$\nabla L_0 \cdot \vec{T} = 1, \qquad \text{with } L_0(\partial_0 R) = 0$$

Yezzi et al: Methods



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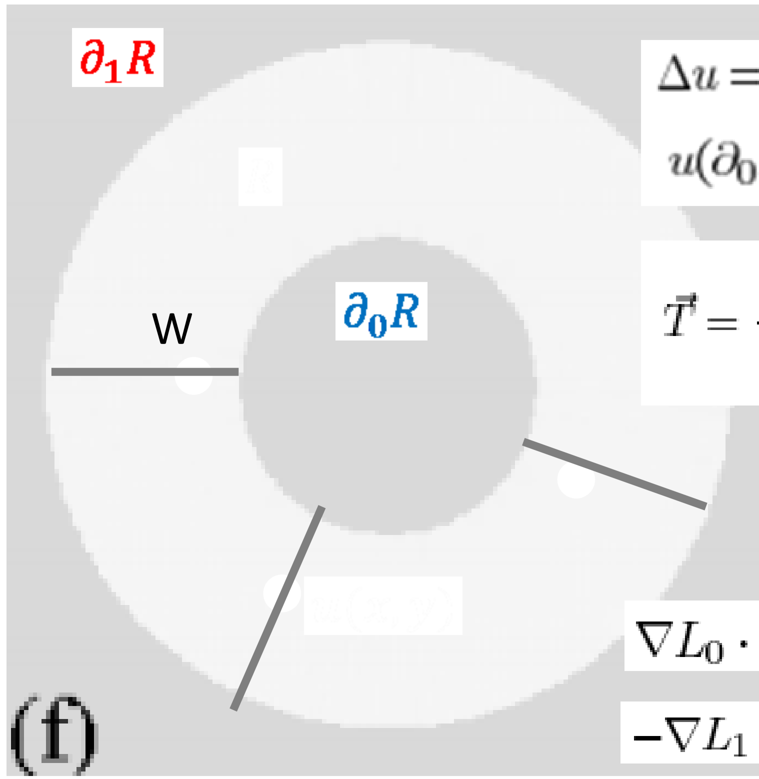
Yezzi et al: Methods



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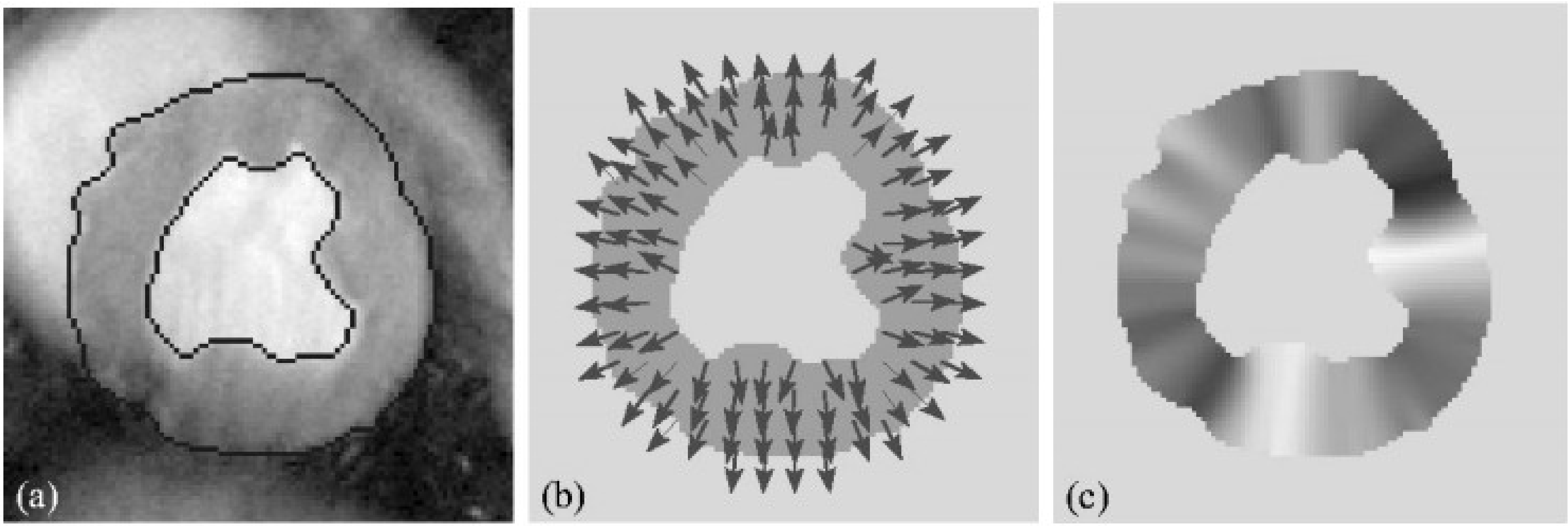
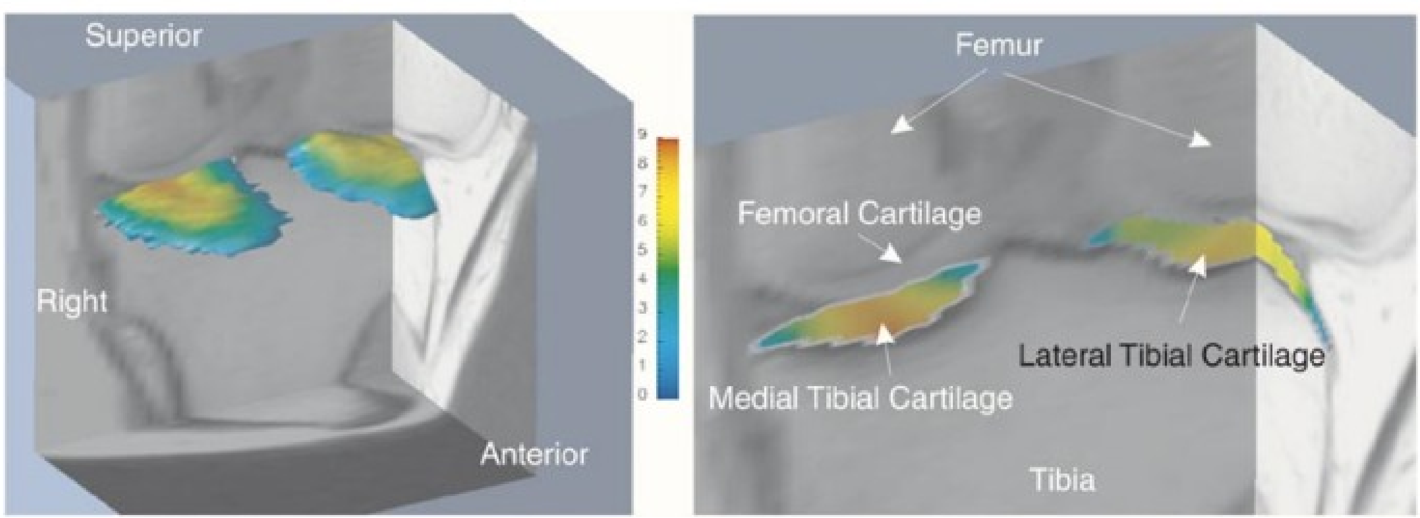
$$W(\mathbf{x}) = L_0(\mathbf{x}) + L_1(\mathbf{x})$$

Yezzi et al: Ventricular Wall Thickness



Yezzi et al: Other Applications



Yezzi et al: Relevance

Gauss's Law:

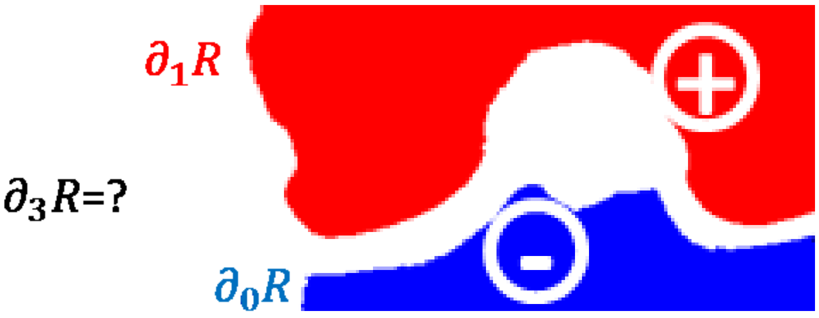
$$\nabla \cdot \vec{\mathbf{E}} = \frac{\rho}{\varepsilon_0}$$

Definition of Electric Field:

$$\vec{\mathbf{E}} = -\nabla\Phi$$

Equation to be solved:

$$\nabla^2\Phi = -\frac{\rho}{\varepsilon_0}$$



Calculation of "u"(Φ) the same.
However, boundary topology is not.

Thanks!