NSF Engineering Research Center
for Computer Integrated Surgical
Systems and Technology

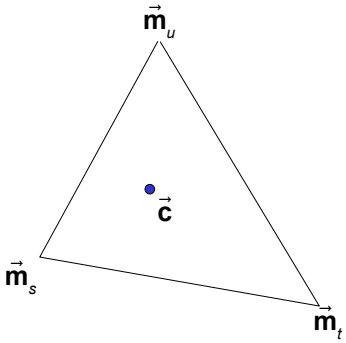
Notes for PA5: Deformable Registration to a Statistical Shape Model

WHITING
SCHOOL OF
ENGINEERING
THE JOHNS HOPKINS UNIVERSITY

Russell H. Taylor
John C. Malone Professor of Computer Science,
with joint appointments in Mechanical Engineering, Radiology & Surgery
Director, Laboratory for Computational Sensing and Robotics
The Johns Hopkins University
rht@jhu.edu

1

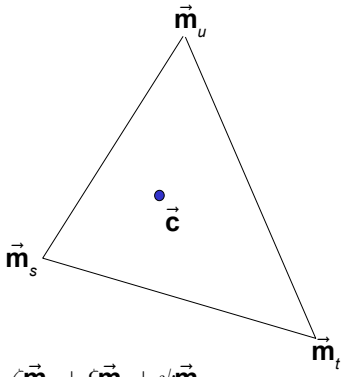
Barycentric Coordinates of Deforming Triangle



$$\vec{c} = \zeta\vec{m}_s + \xi\vec{m}_t + \psi\vec{m}_u$$

2

Barycentric Coordinates of Deforming Triangle



$$\vec{\mathbf{c}} = \zeta\vec{\mathbf{m}}_s + \xi\vec{\mathbf{m}}_t + \psi\vec{\mathbf{m}}_u$$

$$\vec{\mathbf{m}}_s = \vec{\mathbf{m}}_{0,s} + \sum_{m=1}^{Nmodes} \lambda_m^{(t)}\vec{\mathbf{m}}_{m,s}$$

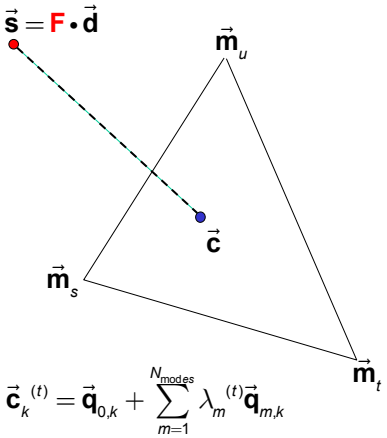
$$\vec{\mathbf{m}}_t = \vec{\mathbf{m}}_{0,t} + \sum_{m=1}^{Nmodes} \lambda_m^{(t)}\vec{\mathbf{m}}_{m,t}$$

$$\vec{\mathbf{m}}_u = \vec{\mathbf{m}}_{0,u} + \sum_{m=1}^{Nmodes} \lambda_m^{(t)}\vec{\mathbf{m}}_{m,u}$$

$$\vec{\mathbf{q}}_{m,k} = \zeta_k\vec{\mathbf{m}}_{m,s} + \xi_k\vec{\mathbf{m}}_{m,t} + \psi_k\vec{\mathbf{m}}_{m,u}$$

$$\vec{\mathbf{c}}_k^{(t)} = \vec{\mathbf{q}}_{0,k} + \sum_{m=1}^{N_{modes}} \lambda_m^{(t)}\vec{\mathbf{q}}_{m,k}$$

Deformable Registration to SSM



$$\vec{\mathbf{c}}_k^{(t)} = \vec{\mathbf{q}}_{0,k} + \sum_{m=1}^{N_{modes}} \lambda_m^{(t)}\vec{\mathbf{q}}_{m,k}$$

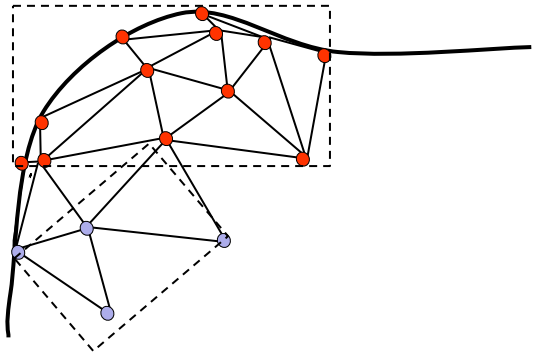
Step 1 For sample points, find closest matches to current mesh

Step 2 Solve $\mathbf{F} \bullet \vec{\mathbf{d}}_k \approx \vec{\mathbf{q}}_{0,k} + \sum_{m=1}^{N_{modes}} \lambda_m^{(t)}\vec{\mathbf{q}}_{m,k}$ for $\mathbf{F}$ and/or $\lambda_m^{(t)}$

Step 3 If change the shape parameters then update bounding boxes

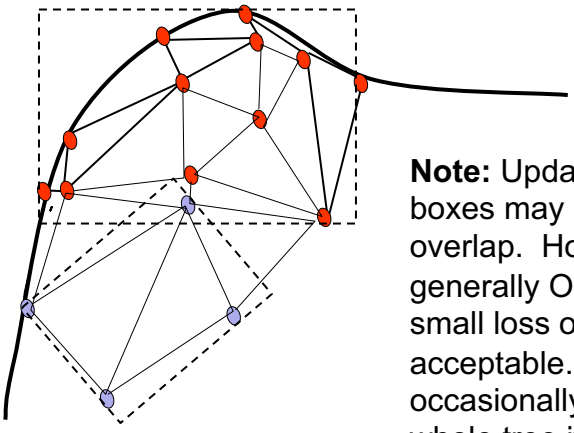
Step 4 Iterate to convergence

Updating Bounding Boxes



5

Updating Bounding Boxes



Note: Updated bounding boxes may increase overlap. However, this is generally OK, since some small loss of efficiency is acceptable. You can occasionally rebuild the whole tree if it becomes an issue.

6