The Control Loop

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Outline

- Initial MRI/MRTI Data
  - Project Goals
- Mesh Generation from MRI Data
- FEM MRTI Comparison
- Data Transfer Rates
- Priority List
Initial Data
Goals and Challenges

Laser Based Thermal Therapy over 250 km

Institute for Computational Engineering and Science
U. Texas at Austin

MRTI Facility
M.D. Anderson Cancer Center
Goals and Challenges

The Goals

- To develop mathematical and computational models of laser-induced bio-heat transfer, cell damage, and heat shock protein expression in cancer-infected glands such as the prostate.
- To dynamically control laser treatments of cancer through real-time interactions between the computational system and MRTI data of actual treatments of living subjects.
- To use these interacting systems to predict and provide unprecedented control over the outcome of laser treatment therapies.

Challenges

- Calibration, validation, verification of the computational model.
- Remote imaging, parallel adaptive methods.
- Real-time control, accurate prediction, minimum damage to healthy tissue, eradication of cancer.
Mesh Generation
MRTI FEM Comparison

FEM MRTI Comparison
MRTI FEM Comparison
MRTI FEM Comparison

time = 228 s

time = 41 s
MRTI FEM Comparison

**time** = 51 s

**time** = 71 s
MRTI FEM Comparison

![Graphs showing MRTI FEM comparison at different times.]

- Time = 125 s
- Time = 171 s
MRTI FEM Comparison

- Time = 228 s
- Time = 230 s
Data-Transfer Rate Testing: Feng, Simmons, Elliott

- **IntraNet:**
  - Type- gigE (1000 BaesT)
  - Peak Rate- 125 MB/Sec
  - Data Transfer Time- 0:00:69 sec / image
  - File Types- .JPG(2K) and .BIN(64K)

- **InterNet (Austin ↔ Houston)**
  - Type- EtherNet/Fiber Optics Back Plane
  - Peak Rate- 40 Gb/Sec
  - Data Transfer Time- ≈0.6 -1.03 sec / image
  - File Types- .JPG(2K) and .BIN(64K)

- **Conclusion:** There will be no bottle-neck issue regarding MRI/MRTI data-transfer rate in real-time control
Priority List

1. Control Logic/Performance Optimization  *(Feng, Fuentes)*
   - code profiled 50% of time in element routines

2. Automate Data Transfer  *(Feng, Rathi)*

3. Automatic Mesh Generation  *(Zhang, Hawkins)*
   - interaction w/ GMP for higher order elements

4. More Validation Tests  *(Elliott, Stafford)*

5. Stochastic Damage Field  *(Babuška, Khoshnevis)*