Checkpoint:
Project 15: Mouse segmentation and optical properties for bioluminescence tomography (BLT)

TEAM: ALAN CHAM
MENTORS: KEN WANG, BIN ZHANG, JUNGHOOON LEE
Background

Small Animal Radiation Research Platform (SARRP)
- Preclinical research: mouse imaging and radiation delivery
- BLT to localize targets with low CT contrast

Bioluminescence tomography
- Reconstruct internal light source position from surface intensity measurements
- Previous experiments with implants in relatively homogeneous region (abdomen) of mouse body
Topic and Goals

**Original**
- Gather literature values of mouse organ optical properties and evaluate their distribution
- Automate the segmentation of cone beam computed tomography (CBCT) images of mice.
- Modify existing BLT reconstruction to address optical property heterogeneity.
  - Implanted light source experiments.
  - Simulated light source experiments.

**Revised**
- Gather literature values of mouse organ optical properties and evaluate their distribution
- Modify existing BLT reconstruction workflow to reconstruct simulation experiment results.
  - Investigate the effects of heterogeneity in simulated light source experiments.
**Technical Approach and Progress: Optical Property Values**

### Example

**Liver Reduced Scattering**

- **Wavelength (nm)**: 400, 450, 500, 550, 600, 650, 700, 750, 800
- **Reduced Scattering (1/cm)**: 0, 5, 10, 15, 20, 25, 30

- **Cow**
- **Human**
- **Mouse**
- **Pig**

### Milestones

**Problem: discrepancies between reported literature values**

- Gathered and tabulated \( \mu_a \) and \( \mu_s \) for adipose, bone, bowel, brain, heart, kidney, liver, lung, stomach: ○
  - Completed: 3.10
- Format data into presentation-appropriate plots ○
  - Expected: 4.11
- Case-by-case explanation of discrepancy and suggestion for usage/exclusion ○
  - Expected: 4.15
Milestones

- ○ Read MOSE manual and learn to configure/run simulation on MOSE
  • Completed: 3.15
- ○ Document and write code to homogenize regions of MOSE digimouse
  • Completed: 3.30
- ○ Document and write code to plot and record normalized surface intensity measurements for all nodes with measurements greater than relative threshold 10%
  • Expected: 4.11
- ○ Run series of simulations using \{1e3, 1e4, 1e5, 1e6 \ldots\} photons until ratio between consecutive normalized detector values are near 1.
  • Expected: 4.15
Technical Approach and Progress: Reconstruction Experiments

Milestones

- ✗ Document and write code to inter-convert NIRfast and MOSE mesh formats.
  - Completed: 3.15
- ✗ Document and write code to map MOSE simulation output ‘t.cw’ to NIRfast detector and measurement ‘.paa’ and ‘.meas’ files.
  - Completed: 3.28
- ✗ Document and write code project mouse organs to axis.
  - Completed: 4.11
- ✗ Document and adapt BLT code to reconstruct from MOSE simulation results.
  - Expected: 4.15
- ✗ Run series of experiments along heterogeneous mouse midline and record error vs. position, then error vs. fluctuated properties.
  - Expected: 4.29
## Deliverables

**Minimum**
- Tabulate literature values for optical properties
- Manually segment mouse images for atlas and simulated source
- Modify Matlab code to incorporate organ specific optical properties
- Test code under simulation conditions

**Expected**
- Workflow for registering new images to atlas set using elastix
- Matlab code for multi-classifier decision fusion strategy

**Maximum**
- Perform BLT experiment on implanted light source in specific organ
- Determine optimal optical property value sets for reconstruction

## Revised

**Minimum**
- Tabulated literature values for optical properties
  - Presentation of formatted/ploted properties
  - Documentation of point-by-point explanation/justification for suspect data points
- Documented code and workflow for generating forward-problem simulation results
  - Document results for determining optimal photon count for Monte Carlo simulation
- Documented, adapted code for reconstruction of simulation results
  - Quantify reconstruction error as function of source position in mouse and fluctuations in optical properties

**Expected**

**Maximum**
- Documentation of optimal optical property value sets for reconstruction and simulation
### Project Timeline: Significant Clarifications/Changes Made to Original

#### Key Milestones

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<th>Week of</th>
<th>Notes</th>
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#### Major Activities

- **Read elastix manual**
- **Tabulate optical property literature**
- **Read BLT documentation**
- **Run BLT on example images**
- **Read MOSE manual and learn to run/configure simulation**
- **Document and write code to homogenize MOSE digimouse**
- **Document and write code to export and record normalized surface intensities**
- **Photon count experiment**
- **Format data into presentation-appropriate plots**
- **Document and write code to convert NIRfast, MOSE meshes**
- **Document and write code to export simulation results**
- **Document and write code to project mouse organs to axis**
- **Document and adapt BLT code to reconstruct simulation result**
- **Case-by-case explanation of suspicious data**
- **Midline and fluctuated property experiments**
- **Proposal presentation**
- **Seminar presentation**
- **Checkpoint presentation**
- **Final Session**

#### Key Milestones Highlighted

- **Read Elastix Manual (2/2)**
- **Read Core literature (5/10)**
- **Project Plan – Presentation**
- **Read BLT documentation**
- **Run BLT on example images**
- **Seminar Presentation**
- **Manual Segmentation Atlas Set**
- **Checkpoint Presentation**
- **Second Literature Review**
- **Modif BLT code**
- **Task BLT in Simulation**
- **Try Elastix Parameters**
- **Multi-class segmentation**
- **Experiments with new rats**

#### Final Exam – Poster Session

1. **Completed**
   - Finished and uploaded review literature results and main reading guides.
   - Ready for final presentation for week of 4/18.
2. **Completed**
   - Able to execute existing BLT workflow and begin modification.
3. **Completed**
   - Modified BLT code to incorporate optical properties information.
   - Manual segmentation for data completed.
   - Finished optical property data gathering.
   - Ready for checkpoint presentation for week of 5/17.
4. **Completed**
   - Tested modified BLT with light source simulation.
   - On completion of Elastix registration parameters.
5. **Completed**
   - Finished experiments with new data from implanted sources.
   - Ready to produce final report and presentation.
## Dependencies: No Unresolved Dependencies

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<th>Status</th>
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<td>MOSE simulation environment</td>
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Reading List


