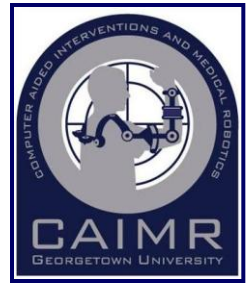




NA-MIC

*National Alliance for Medical Image Computing*

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# **An Integrated System for Image-Guided Radiofrequency Ablation (RFA) of Liver Tumors**

Kevin Cleary, Georgetown University

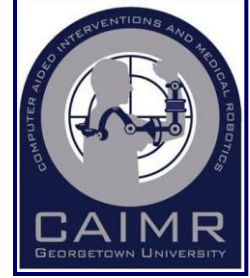
Noby Hata, Brigham and Women's Hospital

Enrique Campos-Nanez, George Washington  
University

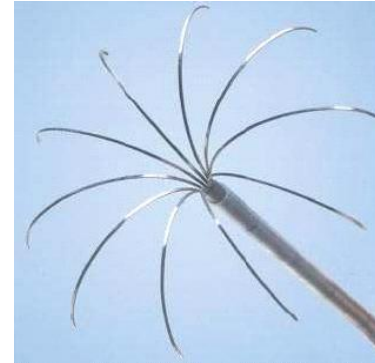
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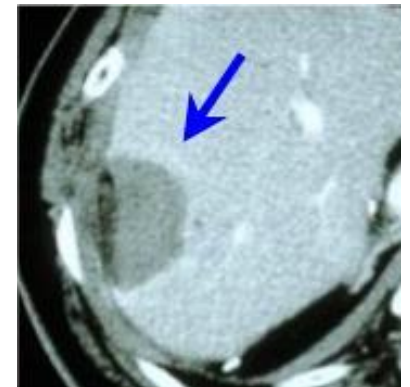
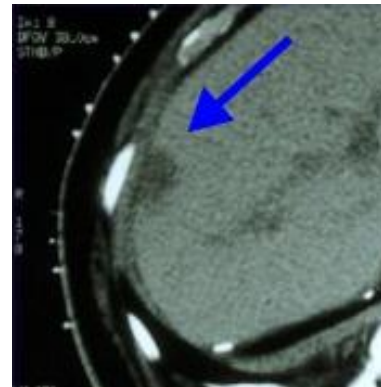
# Liver tumor RFA



- Liver cancer that cannot be resected due to extent and location of the disease or concurrent medical conditions.
- Introduce localized RF energy directly to tumor, typically through expanding metal tines within a small gauge insulated needle.



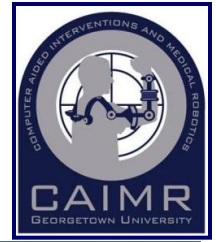
LeVein probe



Before (left) and after (right) treatment  
(courtesy of Brad Wood, MD, NIH CC)



# Project Overview



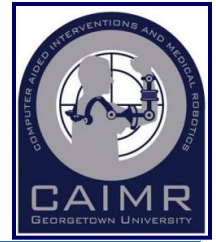
Goal: Develop an open source workstation for liver RFA planning and treatment based on IGSTK and Slicer.

Specific aims:

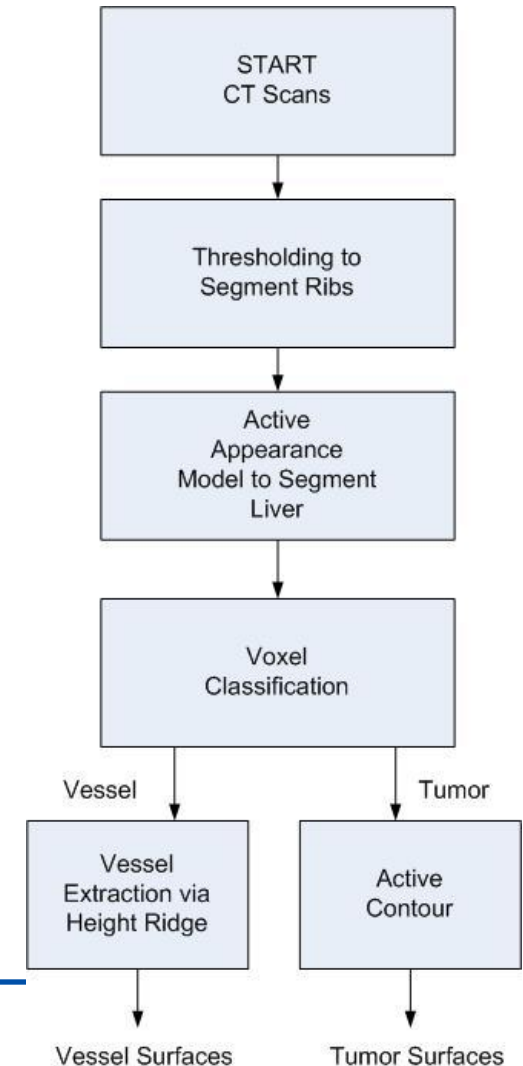
1. Develop and evaluate semi-automatic segmentation techniques for the liver, liver vasculature, and liver tumors. [Georgetown, BWH]
2. Develop a path planning module for evaluating alternative paths to the liver tumor and incorporating multiple overlapping placements as needed for larger tumors. [GWU]
3. Integrate the two capabilities developed above along with electromagnetic tracking of the RFA probe to provide a complete software environment for liver tumor planning, visualization, and execution. [Georgetown, BWH]
4. Validate the clinical feasibility of the system in a swine animal model. [Georgetown]



# Segmentation

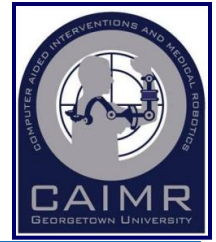


- Use established techniques:
  - Thresholding (bone).
  - Active Appearance Models (liver).
  - Height ridge traversal (vessels).
  - Active contour (tumor).
- Provide capabilities for manual correction of results.
- AAM – acquire training database that represents the anatomical variability (47 data sets to date).
- Want to integrate within Slicer GUI based on ITK library
- Focus of first year effort





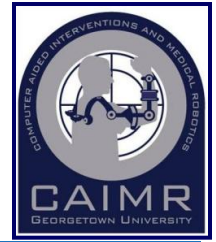
# Anonymized Database



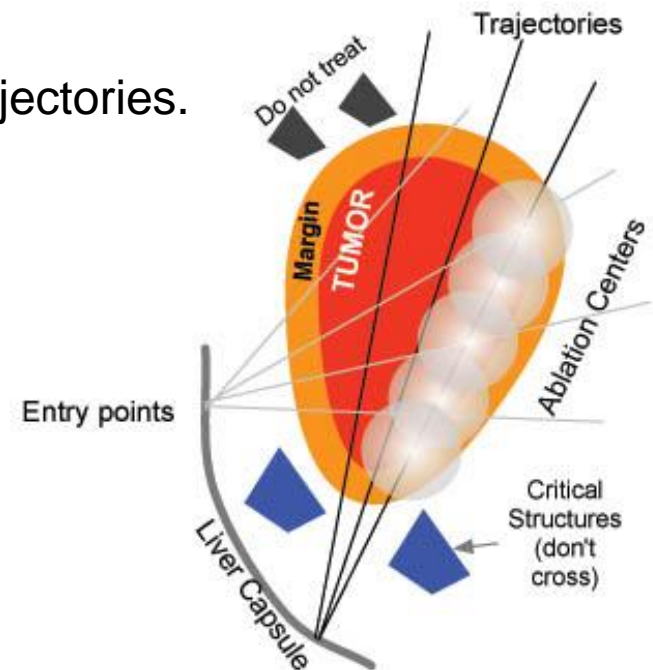
- Collecting CT liver images from Georgetown University Hospital
- Following Health Insurance Portability and Accountability Act (HIPAA) rules for anonymization of data
- Purchased “DICOM Anonymizer Pro” software for this purpose
- Creation of database and evaluation of anonymization process
- Submitting abstract to the Computer Aided Radiology and Surgery (CARS) Conference



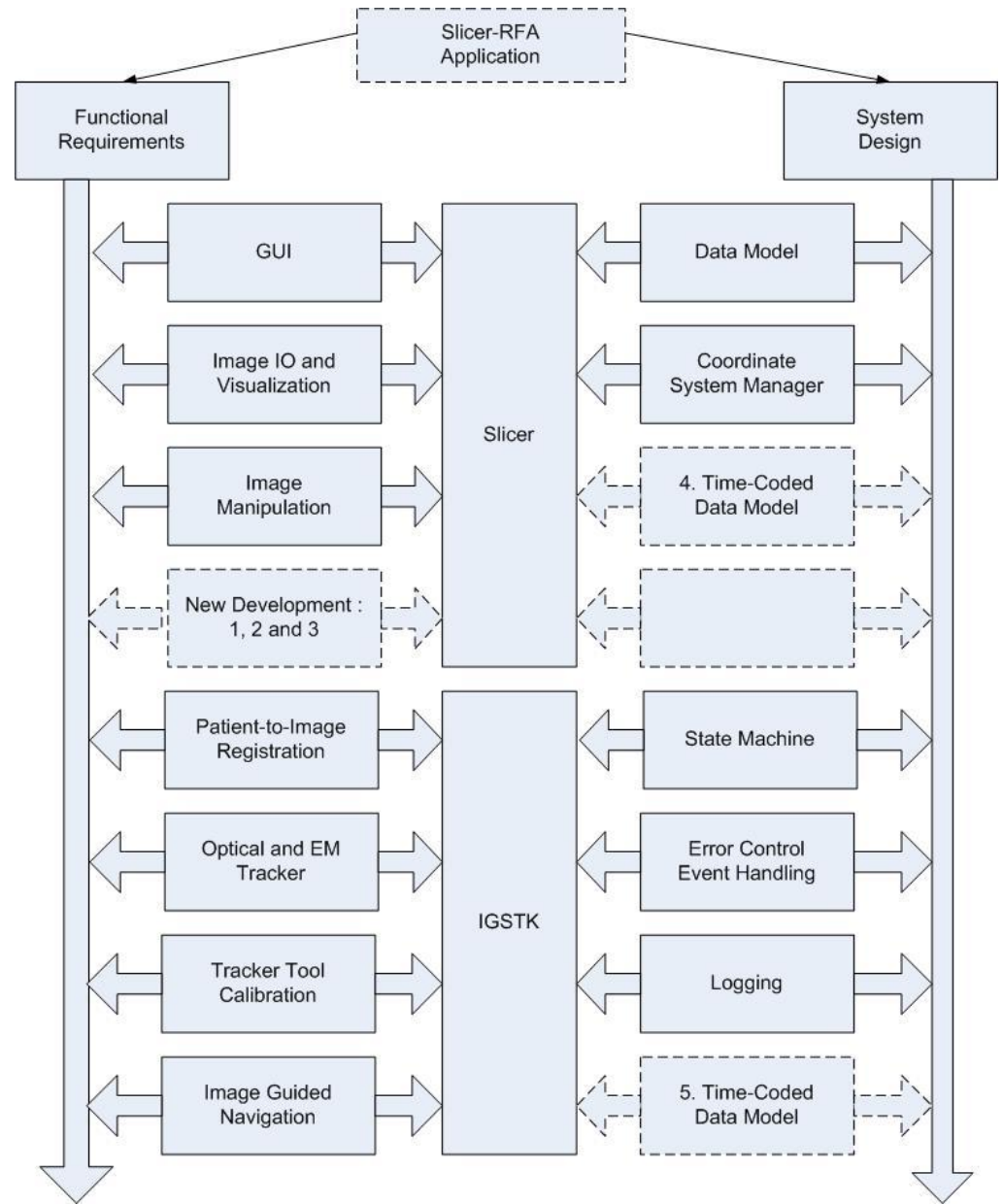
# Path planning



- Pre-emptive goal programming approach based on integer programming techniques using a discrete set of data points representing the tumor (uniform sampling):
  1. Minimize needle insertions (trajectories), minimizes the number of punctures to the liver capsule, and the number of needle insertions.
  2. Minimizing Ablations Given needle trajectories.
  3. Minimizing Damage to Healthy Tissue



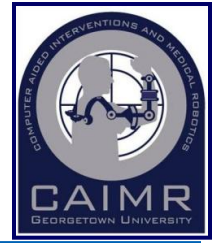
# Integrated System



- Slicer – IO, Visualization, Interaction.
- IGSTK – Tracking, Registration, Logging, Tool Calibration.



# Validation

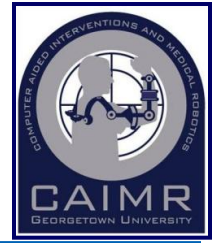


- Animal study:
  - simulated liver tumors (agar) in swine.
  - perform treatment (segmentation, planning, navigation and ablation).
  - histopathological examination of serial cross section slices of the liver lobe.





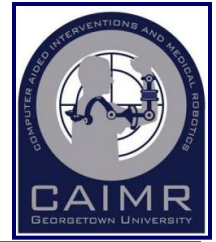
# Lung RFA animal study with IGSTK – Proof of concept



- Segmentation – manual, output is a text file.
- Planning – works, but the solution did not cover some of the tumor margin. Uses a commercial product (XpressMP).
- Visualization and IO – in house extension of IGSTK.
- Interaction – voice recognition (a.k.a. point and shout).
- Validation - histopathological examination.

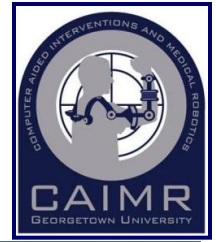


# Lung RFA (artificial nodule)





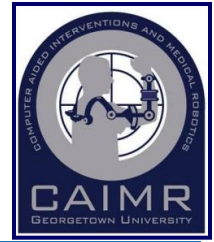
# Lung RFA (segmentation)



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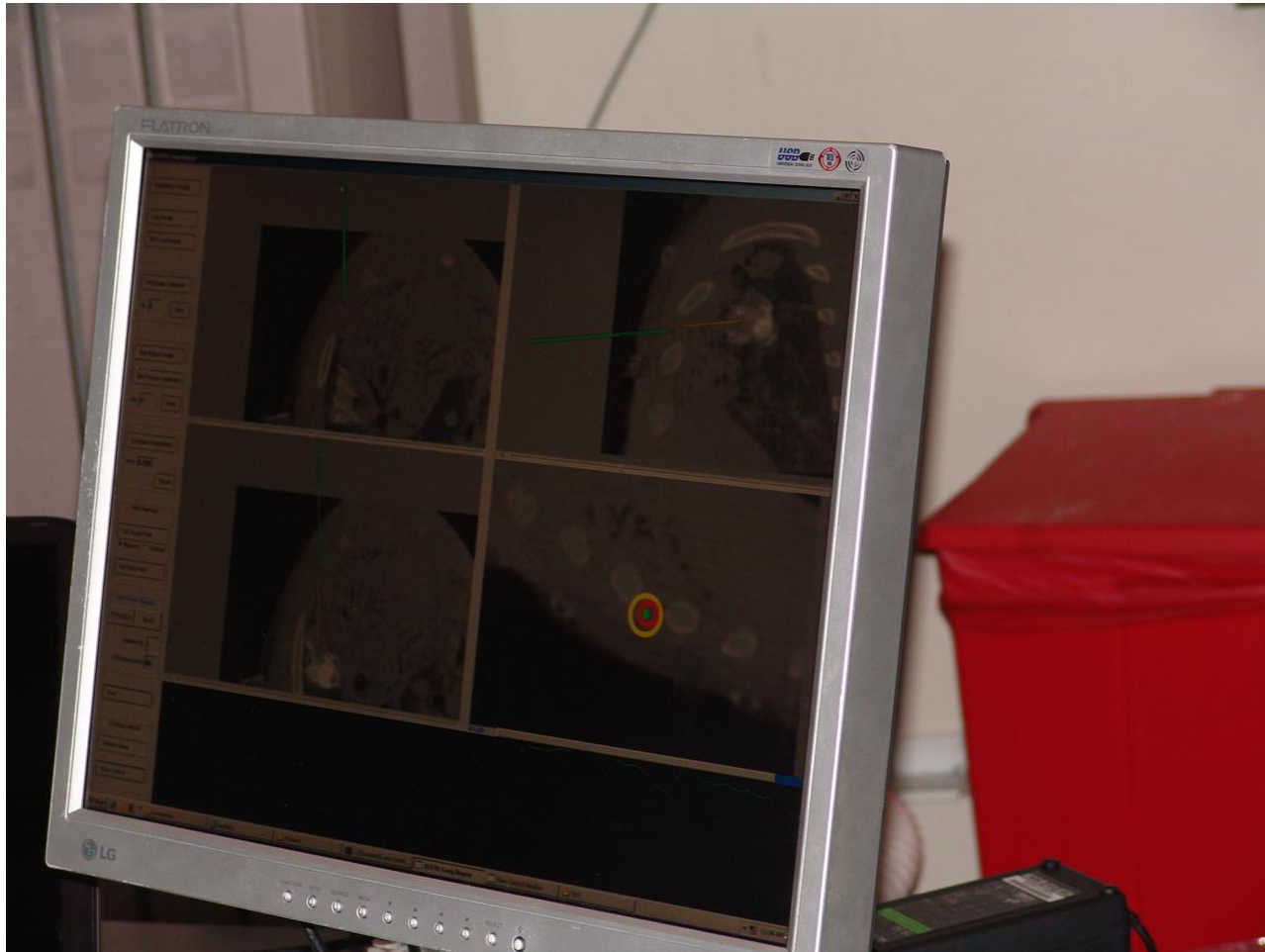
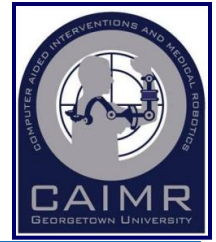


# Lung RFA (registration)





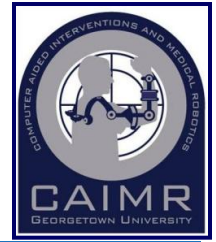
# Lung RFA (navigation)



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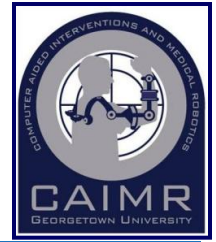


# Lung RFA (validation)





# Summary



- Goal is to develop an integrated system for RFA of liver tumors
- Some background work has been done but need to integrate pieces in an open source environment
- Focus of year one will be on segmentation and integration with Slicer