# Photoacoustic Registration and Visualization


**Computer Integrated Surgery II**

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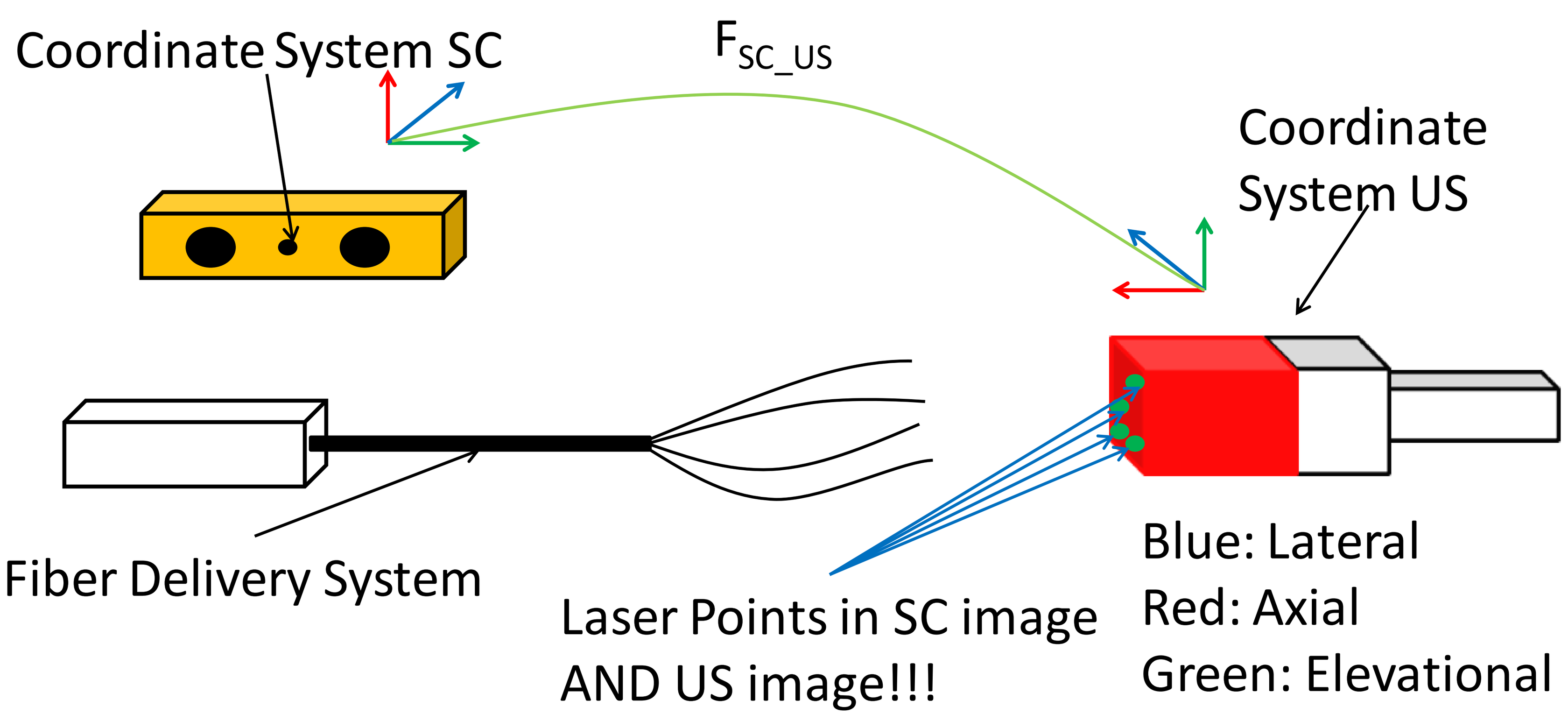
## Introduction

•Surgical Guidance systems are commonly used to aid surgeons via image overlays

•Lasers can generate 3D points in Ultrasound space due to the photoacoustic effect

•Laser spots will also appear on video and can be represented as 3D points in video space

•These two 3D point sets can be directly registered, resulting in a transformation between Ultrasound and video space




## Problem

•Standard surgical guidance systems have a large form factor

•They also require existing surgical tools to be modified with tracked markers

•The object of interest (Ultrasound transducer) must be calibrated with the markers

•Certain limitations such as visibility (Optical) or metal interference (Electromagnetic)

•Standard Electromagnetic or Optical trackers are limited to errors larger than 3mm

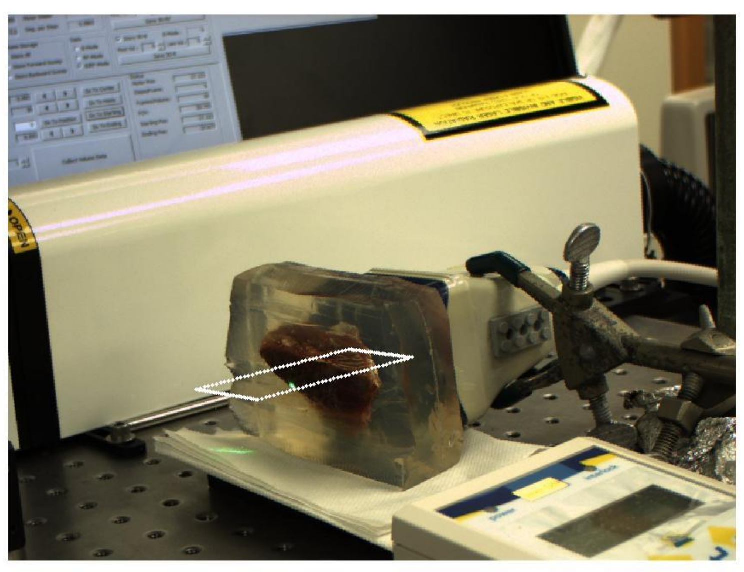
## Results

•N = 30 for Synthetic Phantom and N = 33 for Ex-vivo Tissue

•This system shows significantly lower errors (~ 1 mm) than the standard optical or electromagnetic systems (~ 3 mm)

•Allows for a more accurate representation of the Ultrasound volume in the video images

| Target Registration Error | | |
|---|---|---|
| Dimension | Synthetic Phantom | Ex-Vivo Tissue |
| Lateral (mm) | 0.39 | 0.28 |
| Axial (mm) | 0.24 | 0.95 |
| Elevational (mm) | 0.55 | 0.29 |
| Euclidean (mm) | 0.80 | 1.08 |



## Lessons Learned

•Software pipelines require many revisions

•Store all intermediate data for debugging purposes

•Project plan needs to be constantly revised

•Validate results rigorously before presenting

## Credit

•Alexis Cheng was responsible for all parts

## Solution

### Data Collection

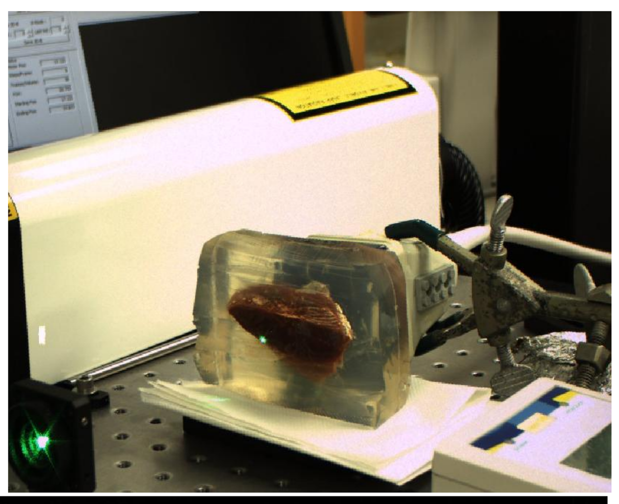
1. Project Laser Points
2. Take SC Images
3. Collect RF Data
4. Actuate Motor
5. Obtain RF Volume

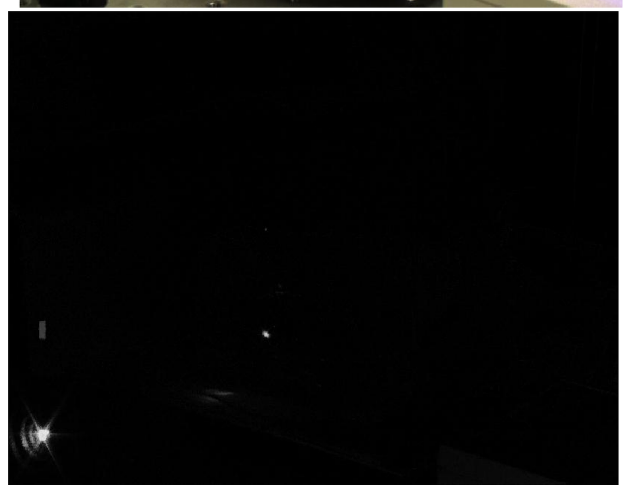
### Registration

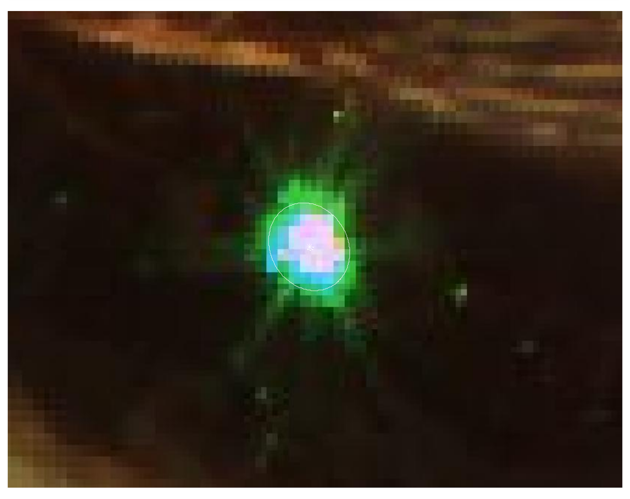
1. Leave one point out of each data set
2. Acquire rigid registration
3. Transform video points into ultrasound space
5. Compute Target Registration Errors

### Video Segmentation

1. Subtract background from images
2. Apply intensity and pixel size thresholds
3. Compute Intensity-Weighted Centroid
4. Triangulate point from left and right images

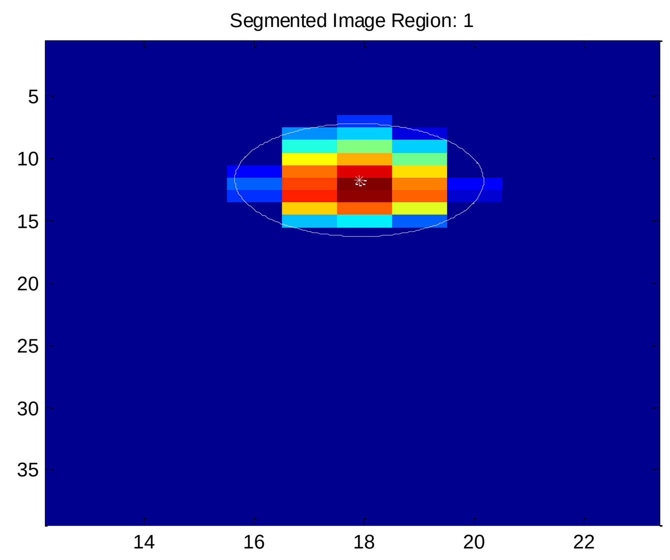






### Ultrasound Segmentation

1. Filter noise in Ultrasound Volume
2. Mean Intensity Projection along axial axis
3. Segment region
4. Compute Intensity-Weighted Centroid
5. Bilinearly interpolate axial point




•No need for markers that can be tracked by the optical or electromagnetic system

•No need for calibration between the marker and the transducer

•Transducer does not have to be visible to the camera

•No metal interference

## Future Work

•Finalize fiber delivery system

•Integrate the system with surgical robots

•Conduct more experimental trials

•Conduct in-vivo trials

## Publications

•Paper submitted to MICCAI 2012


## Acknowledgements

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