

Ultrasound Needle Point Guidance using Active Echo

Bofeng Zhang and Phillip Oh

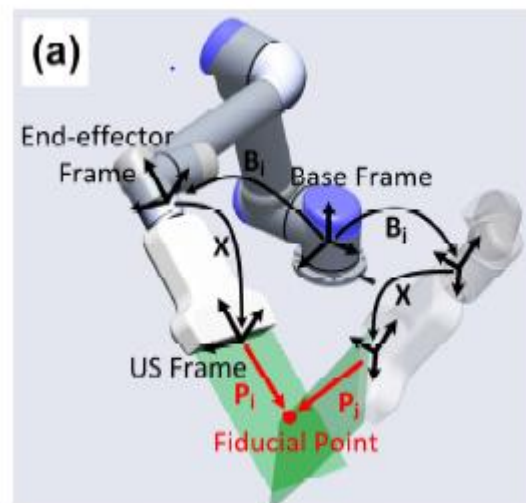
Mentors: Alexis Cheng, Dr. Emad Boctor

Overview

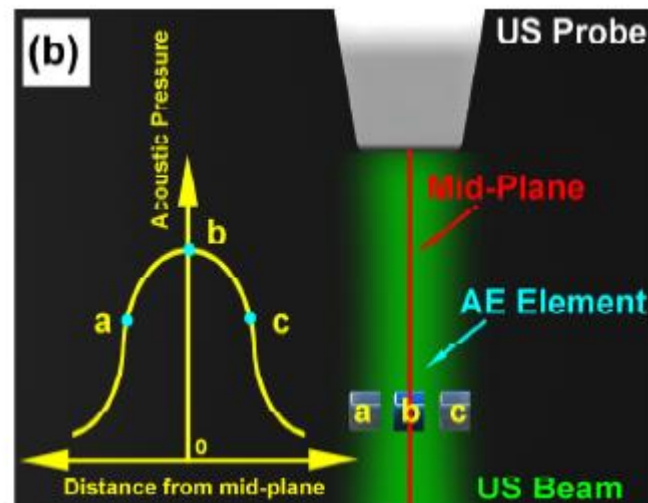
- Background and Relevance
- Technical Summary
- Deliverables
- Dependencies
- Key Dates and Timeline
- Management Plan
- Reading List

Background and Relevance

- Image guidance is useful in surgery to help surgeons track the location of their tools in very sensitive parts of the body
- One method is to use ultrasound, which provides intraoperative guidance without radiation exposure
- However, ultrasound calibration using current methods, such as an EM tracker can result in up to 3 mm error.



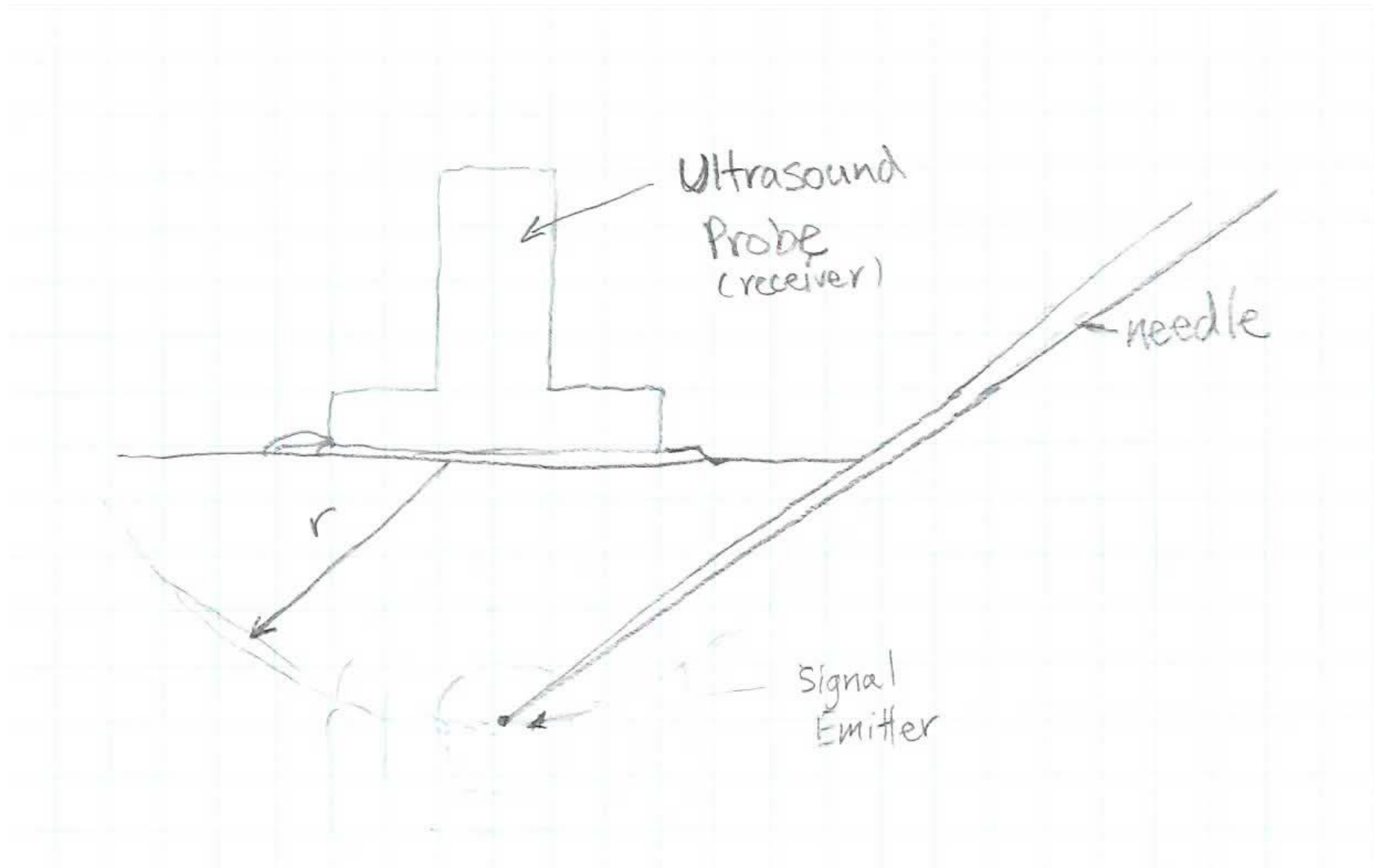
Guo 2014



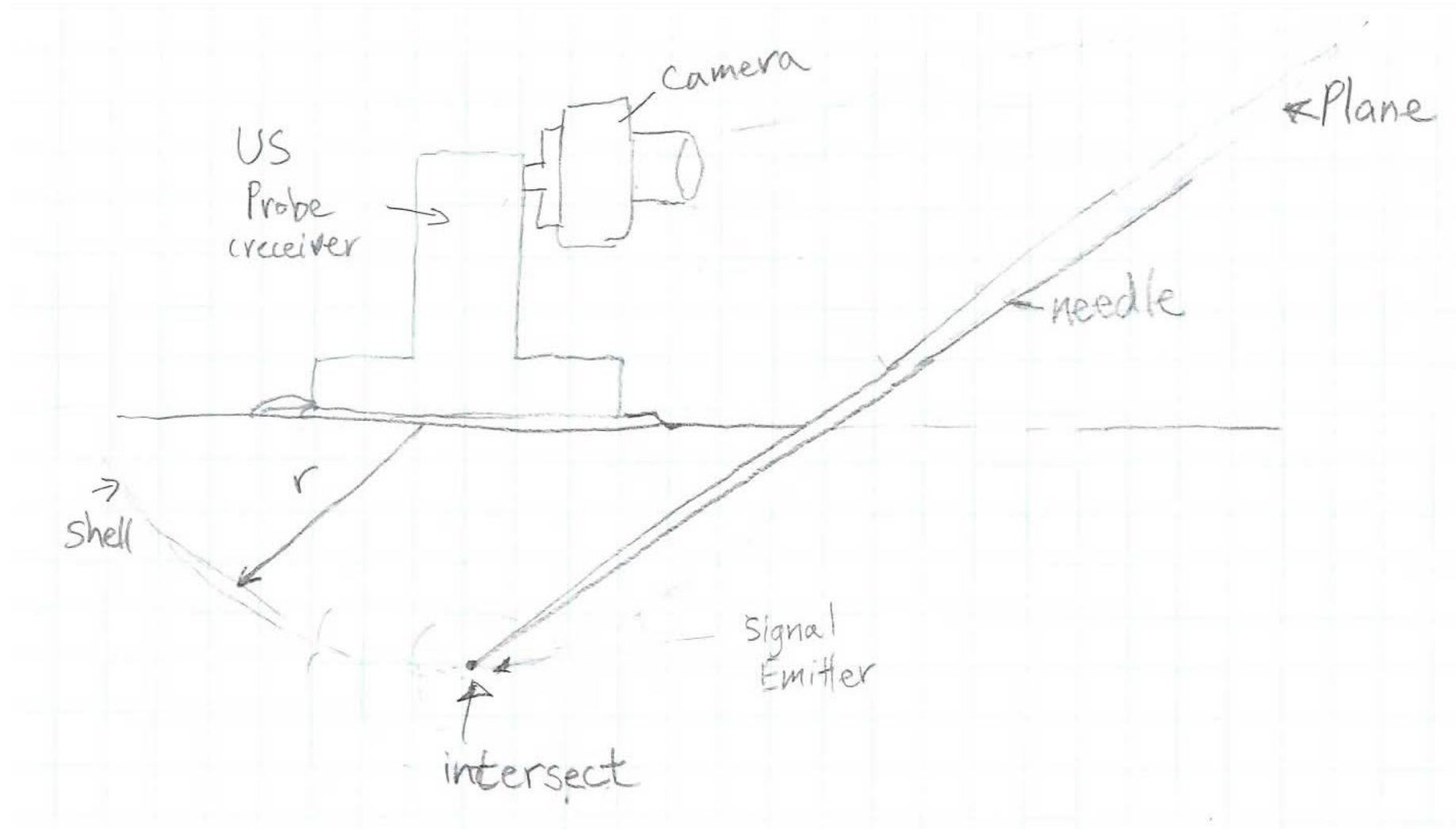
Technical summary of approach

- 1. Capture images of needle using camera (possibly webcam)
- 2. Process images: Image segmentation of needle to give the plane of the needle with respects to the camera's frame
- 3. Ultrasound Calibration using active echo from the tip of the needle and with the Active out-of-plane ultrasound calibration method

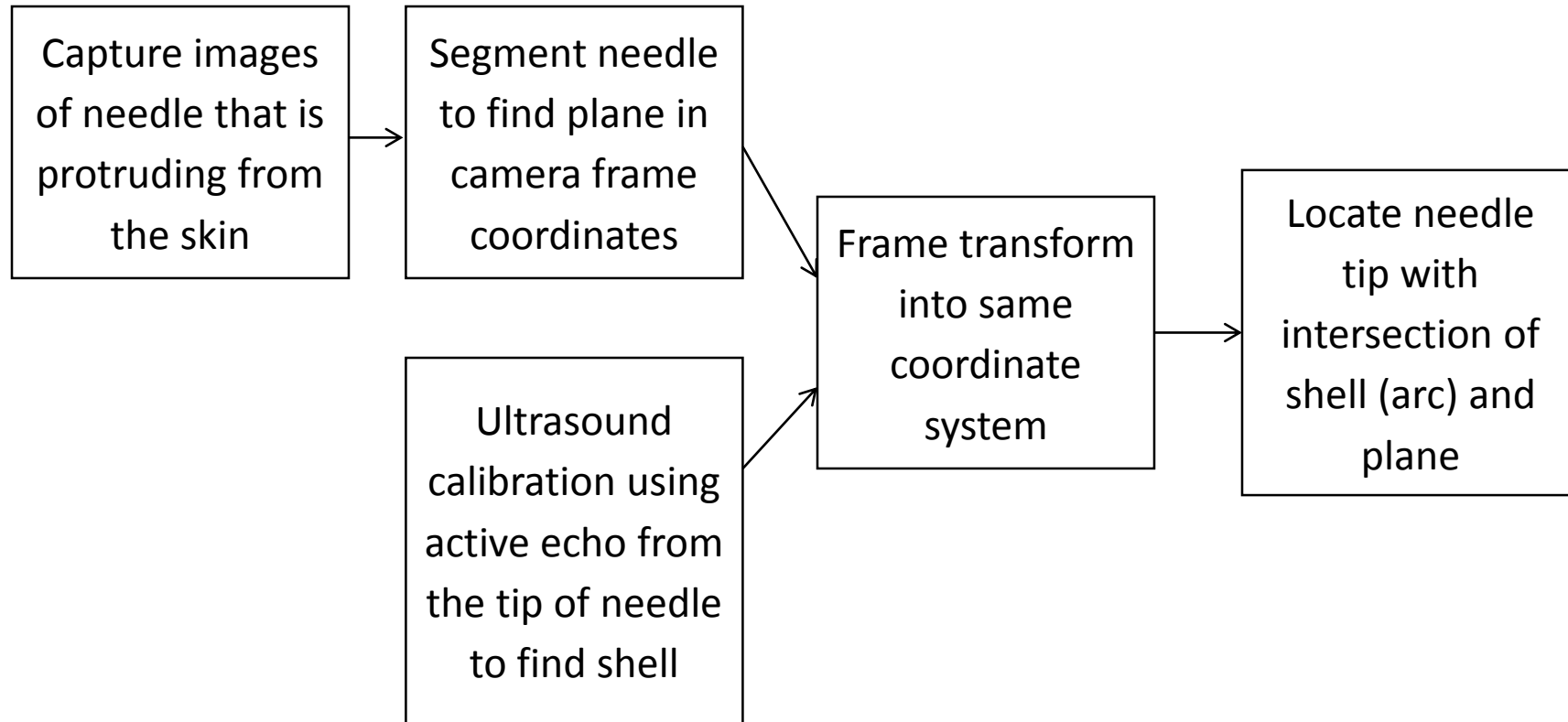
Drawing #1



Drawing #2



Work Flow



Deliverables:

- Minimum: 3D position of probe-tip offline, more specifically
 1. Segmentation of needle in images taken from webcam/iPhone
 2. iPhone mount to ultrasound probe
 3. Ultrasound calibration
 4. Recover needle-point position using US and iPhone images
- Expected: Analysis and validation of technique
- Maximum: Real-time 3D position of probe-tip using live-feed from iPhone camera and US machine.

Dependencies:

Dependency	Plan for Resolving
Access to ultrasound machine, needle, webcam, active point	Provided by MUSiiC lab (Permission given)
Wyman 3D printer access	Contact Neil Leon (by 3/1)
Access to labs: Robotorium, MUSiiC lab in Robotorium	Contact LCSR admin office (Lab access granted)
URS robot arms	Contacting Dr. Armand's Bigss Lab (by 3/1; need arms by 3/7)
Meetings with Alexis	Scheduled weekly Wed 2:30 PM
Meetings with Dr. Boctor	Biweekly

Key dates

Dates:	Important Dates / Responsibilities / Milestones
1/27 – 2/5	Presentations of possible project ideas
2/5 – 2/12	Determining project to pursue
2/15 – 2/21	2/20 Project Proposal 2/21 Paper read of Image segmentation using edge detection
2/22 – 2/28	2/24 Project Proposal Presentation 2/28 Paper read of Active point out-of-plane ultrasound calibration
3/1 – 3/7	S 3/7 CAD model of camera holder 3 3/7 Segmentation of needle image from camera
3/8 – 3/14	3/14 3-D printed camera holder 3/14 Recover needle tip positioning by combining Segmentation and Calibration – Min.
3/15 – 3/21	3/16 – 3/22 Spring Break
3/22 – 3/28	3/28 Test needle location accuracy in water via experiments
3/29 – 4/4	4/4 Analysis of the accuracy and precision of the location - Expected
4/5 – 4/11	4/11 Build test phantom
4/12 – 4/18	4/18 Test needle location accuracy in phantom via experiments
4/19 – 4/25	4/25 Implement real-time system to locate needle tip - Max
4/26 – 5/2	5/2 Explore mobile implementation of camera
5/3 – 5/9	5/8 Final Report and Poster Session Presentation

Timeline

Min

Expected

Max



	February		March					April				May	
	2/16	2/23	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20	4/27	5/4	5/5
Background Research	█	█	█										
Project Proposal	█	█											
Written Design	█	█	█										
Needle Segmentation			█	█									
CAD model of camera holder			█	█									
3-D printed camera holder				█	█								
Ultrasound calibration				█	█								
Recover needle tip position					█	█	█						
Test needle accuracy in water							█	█					
Build phantom and test needle in phantom								█	█				
Implementation of real-time system									█	█	█		
Final Report and Poster Session											█	█	█

Assigned responsibilities

- Project Lead: *Phillip Oh*
 - *Work Distribution and communication*
- Project Engineer: *Bofeng Zhang*
 - *Camera holder design and prototype*
- *Both:*
 - paper reading, algorithm implementation, and system integration.

Regular meeting times

- Semiweekly meetings between team members Phillip and Bofeng (Tuesday, Thursday 2:45pm-4:00pm)
- Weekly meetings with mentor Alexis Cheng (Wednesday 2:30pm-3:30pm)
- Biweekly meetings with mentor Dr. Emad Boctor (Time TBD)

Reading List

- Guo, Xiaoyu, et al. "Active Echo: A New Paradigm for Ultrasound Calibration." *Medical Image Computing and Computer-Assisted Intervention–MICCAI 2014*. Springer International Publishing, 2014. 397-404.
- Cheng, Alexis, et al. "Active point out-of-plane ultrasound calibration." SPIE Medical Imaging Conference, Orlando, 21-26 February 2015. 9415-30.
- Bouguet, Jean-Yves. "First Calibration Example - Corner Extraction, Calibration, Additional Tools." *Camera Calibration Toolbox for Matlab*. California Institute of Technology, 2 Dec. 2013. Web. 18 Feb. 2015.