

Ultrasound Needle Point Guidance using Active Echo and Mobile Imaging

Seminar Presentation

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Group 9

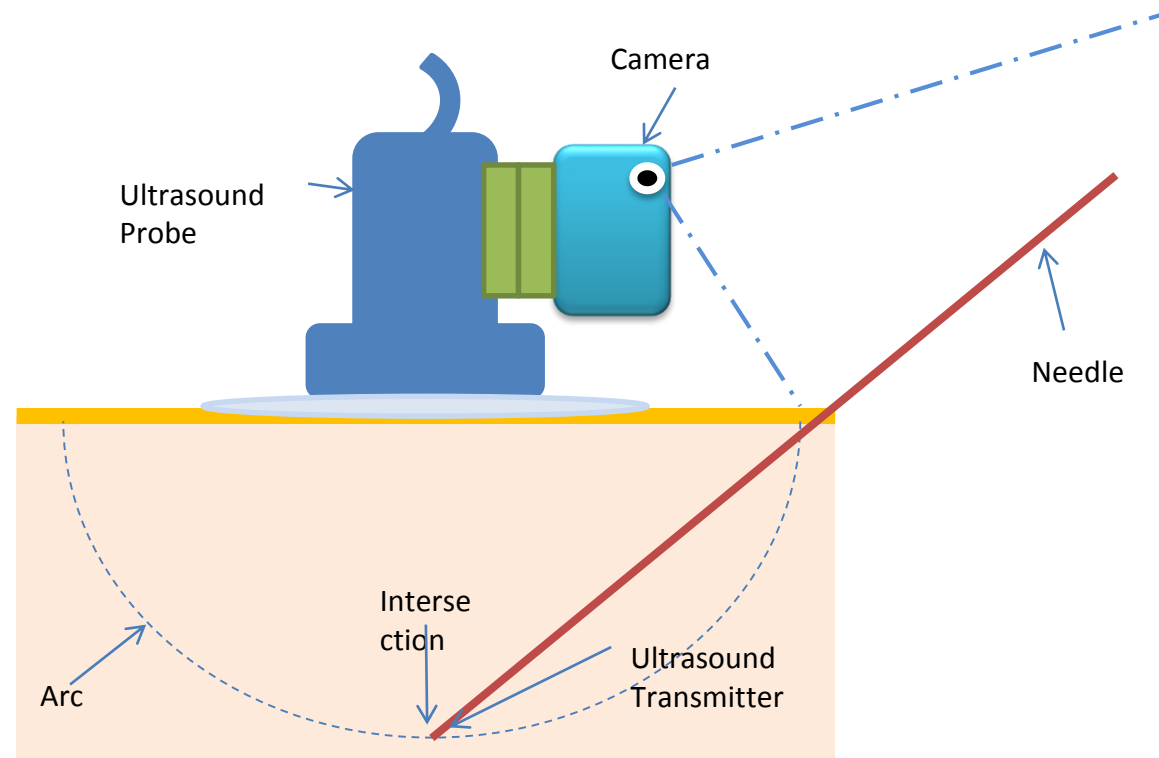
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Outline

- Project Overview
- Paper Selection
- Paper Problem Summary/Significance
- Methods
- Results
- Assessment
- Relevance

Project Overview

- Intraoperative needle guidance using ultrasound and mobile video imaging.



Paper Selection

- Beigi, Parmida, and Robert Rohling. "Needle localization using a moving stylet/catheter in ultrasound-guided regional anesthesia: a feasibility study." *SPIE Medical Imaging*. International Society for Optics and Photonics, 2014.

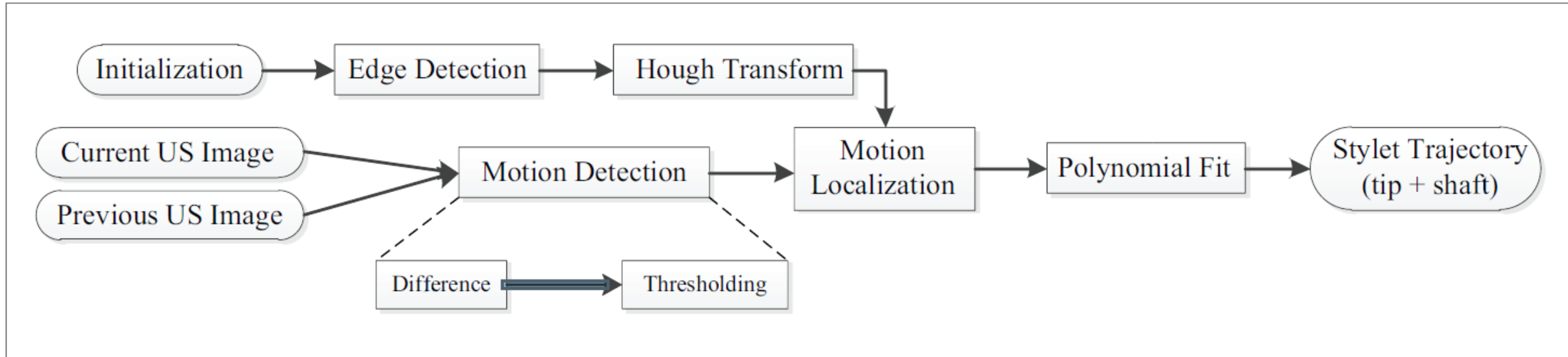
Paper Problem Summary/Significance

- Needle guidance during surgery is vital in order to hit the correct target and avoid sensitive structures
- Ultrasound is useful to use intraoperatively without radiation
- One issue with ultrasound guidance is clear needle visibility due to reflective properties of the smooth surface of the needle

Experimental Setup

- An epidural needle was placed in a water bath as well as bovine muscle
- The needle guide was mounted on an ultrasound probe in order to keep the needle in plane with the ultrasound
- The needle was filled with either a plastic stylet, steel stylet, or a plastic catheter
- The needle was kept in place while the stylet/catheter was moved in 5mm incremental steps from complete insertion to completely out, and B-mode images were taken

Method



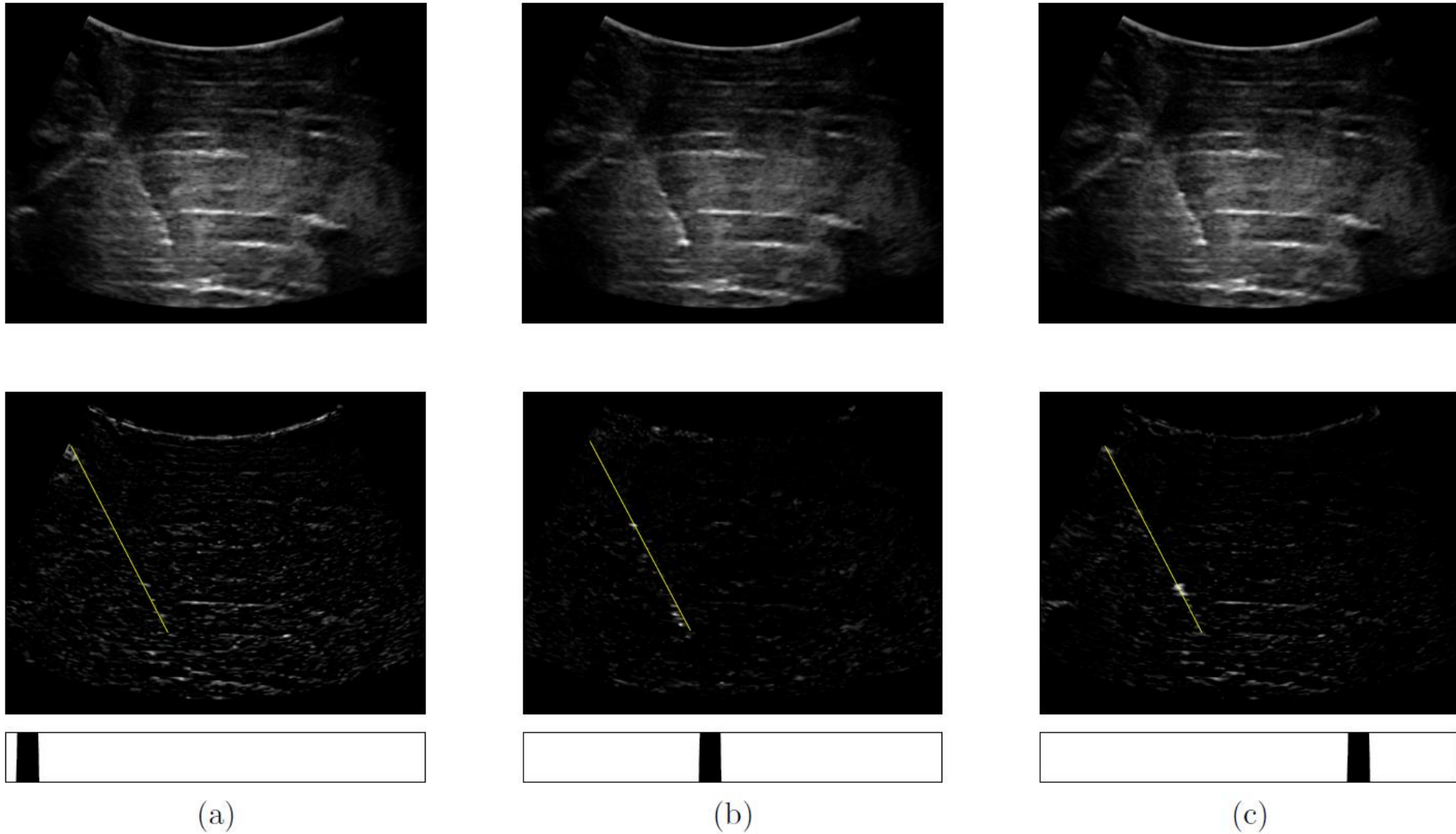
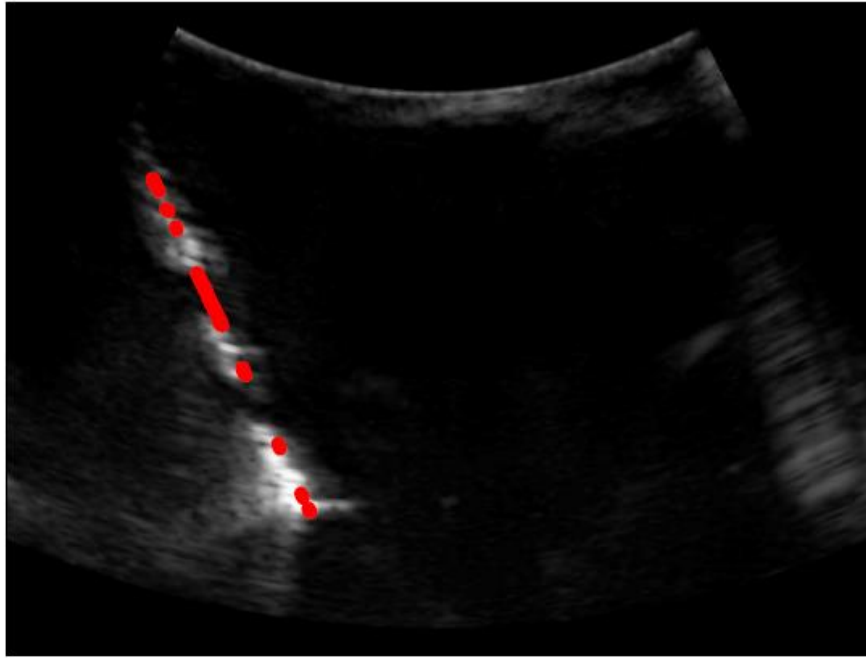
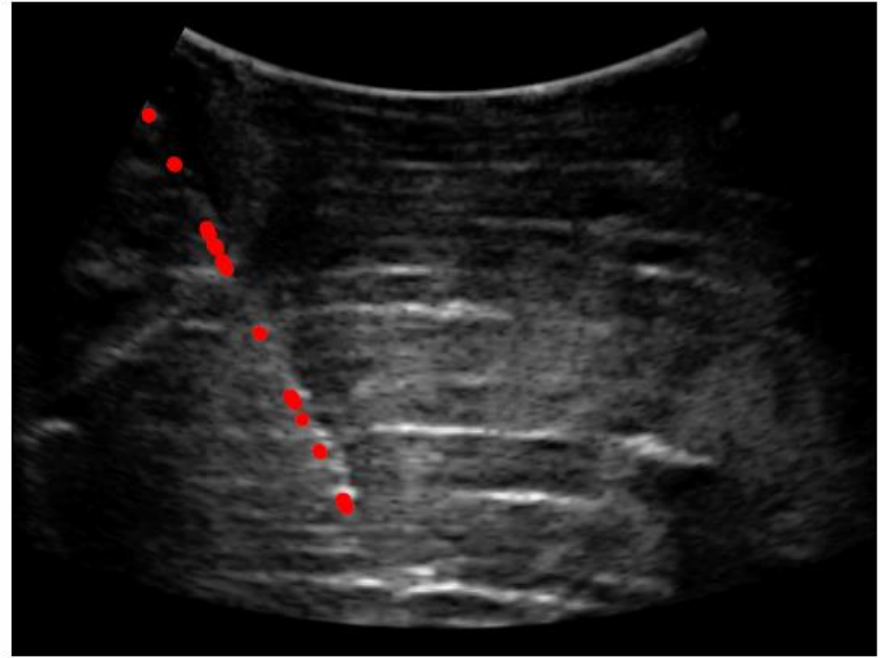


Figure 3. A steel styllet within a stationary cannula in a bovine tissue sample for styllet-cannula tip distance (a) 4 cm, (b) 2 cm and (c) 1 cm. The first row contains the B-Mode images. In the second row, difference images are displayed with the yellow line showing the styllet ray. The bottom bars show the location of the styllet along the ray after thresholding.



(a)



(b)

Figure 6. Needle trajectory obtained from a set of 10 incremental stylet movements in (a) a water bath and (b) a bovine tissue sample.

Results

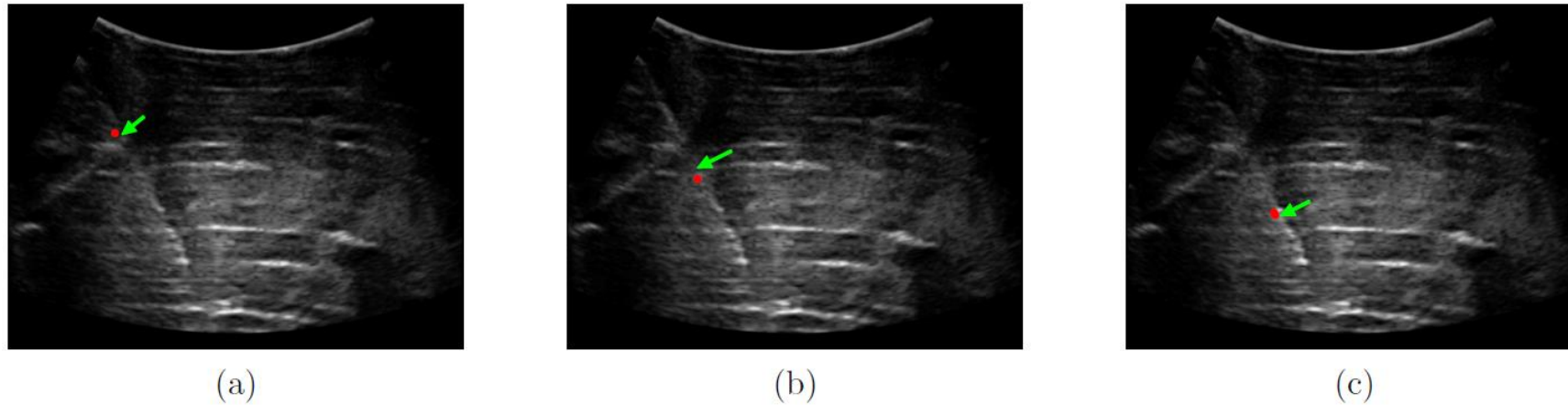


Figure 5. Stylet detection in 6 cm depth and 3 cm focus for steel stylet in a bovine tissue sample for (a) stylet-tip distance 3 cm, (b) stylet-tip distance 2 cm and (c) stylet-tip distance 1 cm. The red segment on the image displays a section of the stylet appeared in the current frame and green arrows point to the true location of the stylet tip.

Table 1. RMSE Analysis (*mm*)

Case	Shaft		Stylet/Catheter Tip		Needle Tip	
	Water Bath	Bovine Muscle	Water Bath	Bovine Muscle	Water Bath	Bovine Muscle
Plastic Stylet	0.16	0.46	3.45	5.66	0.51	0.71
Steel Stylet	0.25	0.78	0.50	2.81	0.54	1.38
Catheter	0.40	0.32	3.70	3.67	0.74	0.33

Assessment

- Pros
 - Concise but clear explanation of method
 - A little more detail in the method could be helpful
- Cons
 - Requires the needle to be within the 2D plane
 - Needle must be held in place while the tip is localized
 - That means the entire technique of moving the stylet must be repeated when the needle is moved
 - However this is a proof of concept for this type of approach

Relevance

- Another approach using ultrasound to achieve the same goal of needle guidance
- Interesting method that uses only an ultrasound and needle + stylet to solve
- Provides some ways of reducing noise when analyzing B-mode images