fhSPECT-US Guided Needle Biopsy of Sentinel Lymph Nodes in the Axilla: Is it Feasible?

Aslı Okur[1,2,3], Christoph Hennersperger[1], Brent Runyan[1], José Gardiazabal[1,2], Matthias Keicher[4], Stefan Paepke[3], Thomas Wendler[4] and Nassir Navab[1,5]

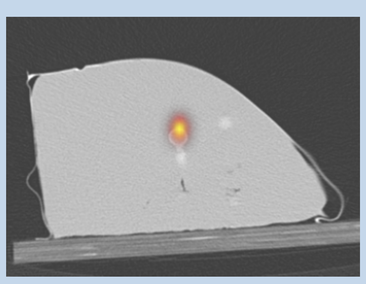
1. Computer Aided Medical Procedures, Technische Universität München, Germany
2. Department of Nuclear Medicine, Technische Universität München, Germany
3. Department of Gynecology, Technische Universität München, Germany
4. SurgicEye GmbH, Munich, Germany
5. Computer Aided Medical Procedures, Johns Hopkins University, USA

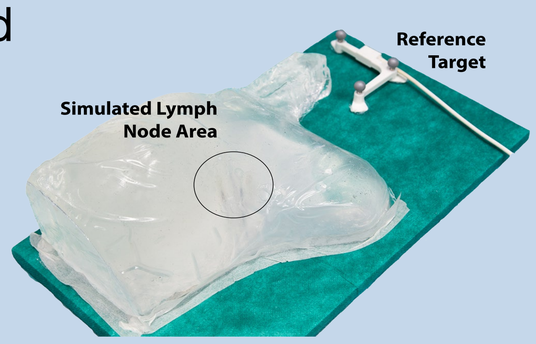
Clinical Motivation

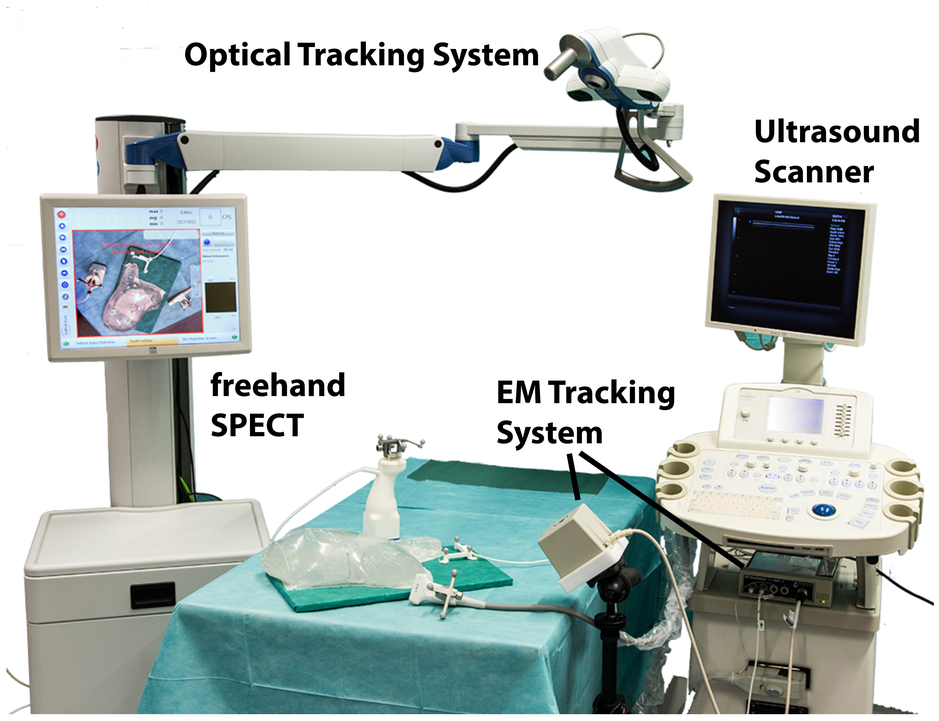
- Sentinel Lymph Node Biopsy (SLNB) is a standard **surgical** procedure in early breast cancer [1]
- However, **core needle biopsy** of the sentinel lymph nodes is not possible
- Combination of **functional** and **anatomical** information is needed
- Initial work [2] lacks 3D reconstructions
- Freehand SPECT (fhSPECT) [3] allows 3D nuclear imaging using tracked gamma probes
- Fusion of 3D fhSPECT and 3D freehand US [4] can be beneficial towards core needle biopsies of SLNs

Phantom Design

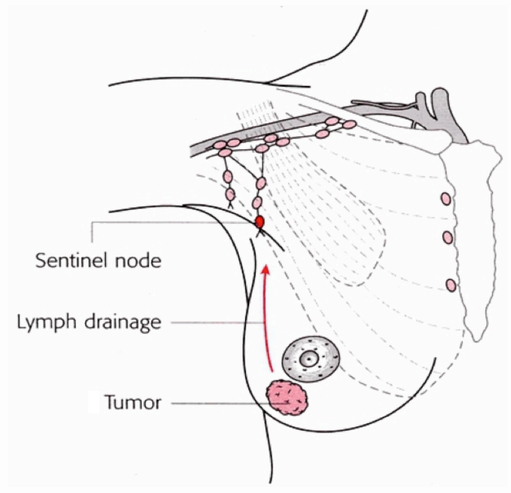
- Realistic breast biopsy phantom (Ceraflex N530 gel)
- 4 spheres (240-300 ml) mimicking lymph nodes
- 1 sphere filled with 1.1 MBq Tc-99m
- Ground Truth: SPECT-CT with reference target attached







Sentinel Lymph Node Biopsy (SLNB)



Experiments and Results

- 5 different configurations
- No user-variation

Acquisitions:

- fhSPECT: using mini gamma camera and 2 minutes scanning
- freehand US: 2 sweeps in each configuration

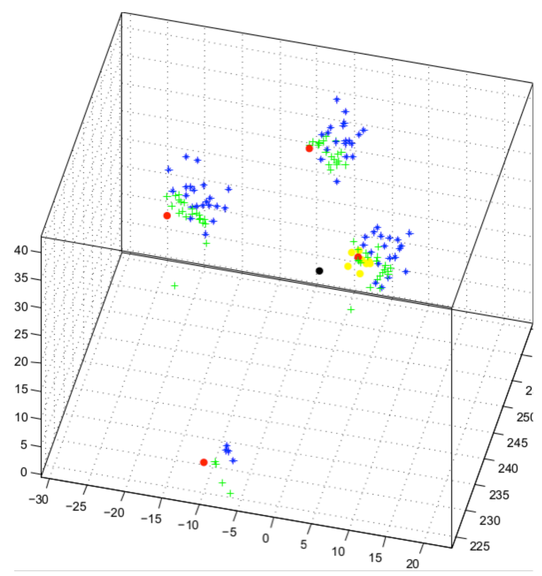
Registration to Ground Truth - CT:

- Reference target
- Point based registration
- RMS error: 0.8 mm

Segmentation of the spheres:

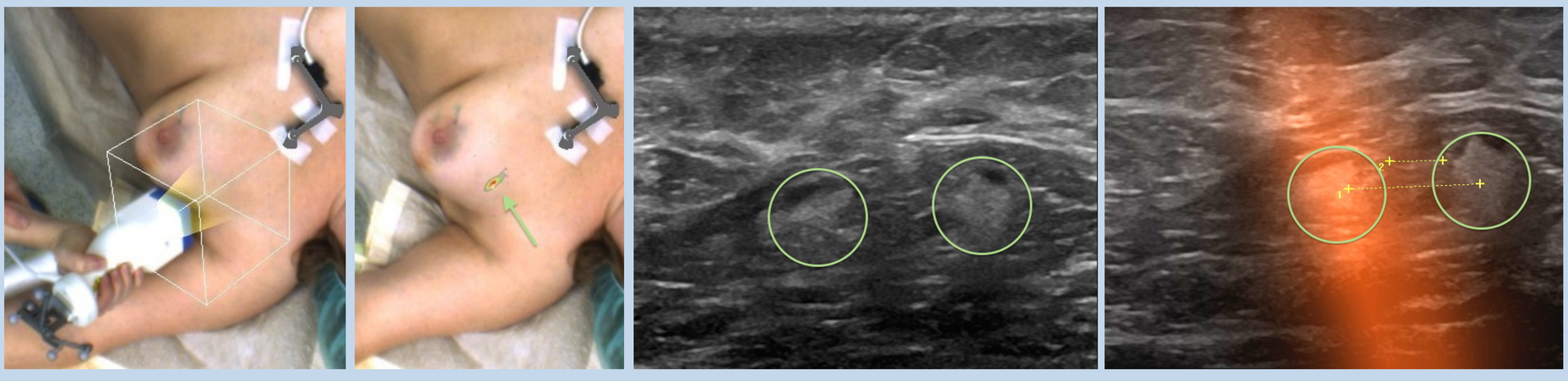
- fhSPECT: 50% thresholding and region growing (seed: global max.)
- freehand US: manual delineation

Error	Optical		EM	
In mm	Mean	Std	Mean	Std
fhSPECT 3mm voxels	2.17	1.04	N/A	N/A
fhSPECT 1mm voxels	1.73	0.67	N/A	N/A
Ultrasound	5.36	1.56	5.22	1.49



Red: CT
Blue: US EM
Green: US Optical
Yellow: fhSPECT

Patient Studies



7 patients were scanned preoperatively after radiotracer injection and scintigraphy imaging. 1 patient was scanned additionally before the surgery inside the OR. Using freehand SPECT, one lymph node identified. In US images two lymph nodes were visible in the same region (center distance 11.7 mm, border distance 4.7 mm). After the fusion the surgeon was able to identify the sentinel lymph node (red) on the images.

Discussion

- US error mainly due to deformation of the phantom
- For US both tracking technologies are comparable
- EM → easier handling
- Optical → easier integration with fhSPECT
- Results were satisfactory for the clinical application

[1] Vidal-Sicart, S. and Valdes Olmos, R.: Sentinel node mapping for breast cancer: Current situation. Journal of Oncology (August 2012).
[2] Wendler, T. et al.: Real-time fusion of ultrasound and gamma probe for navigated localization of liver metastases. MICCAI 2007.
[3] Wendler, T. et al.: First demonstration of 3-D lymphatic mapping in breast cancer using freehand SPECT. EJNMMI 37(8) (2010).
[4] Hennersperger, C. et al.: Vascular 3D+T freehand ultrasound using correlation of doppler and pulse-oximetry data. IPCAI 2014.