A Study on Reconstruction of Breast Medical Images to Serve as Training for Biopsy Procedures Guided by Ultrasound

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Agenda

- Overview
- Problem
- Related works
- Discussion
- Proposal
- Conclusion
- Future works

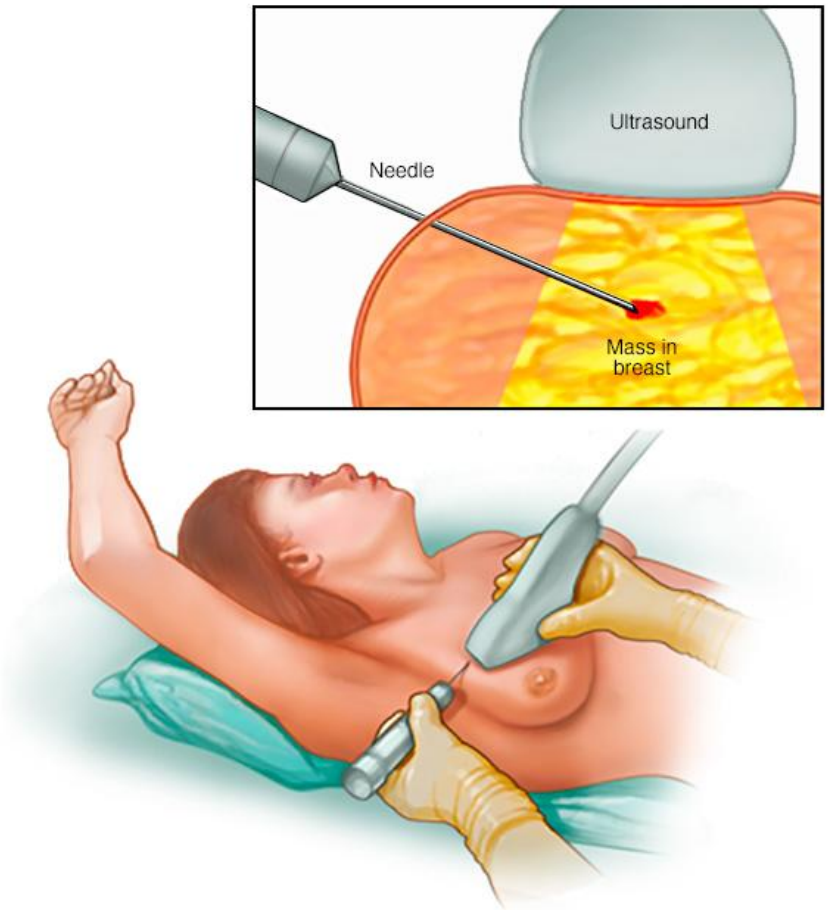
Overview

- Breast cancer is the second most frequent cancer in the world

- Most common on women
  - 22% of new cases each year
  - Estimated new cases 2016: 57,960 (INCA, 2017)

- Biopsy procedure is the method used when a cancer is suspected

Problem



Related works

- Images used as input
- Reconstructing the organ
- Reproducing the medical movements
- Modeling the forces

Images used as input

- 3D reconstruction (organ)
  - Mammograms (Oliveira et al., 2008)
  - X-ray images of mastectomy (Mertzanidou *et al.*, 2017)
  - Thermographic images (Araujo *et al.*, 2012).
  - Magnetic Resonance – MR (Waran *et al.*, 2014)
  - Computed Tomography – CT (Arathi e Parameswaran, 2014)
  - Ultrasonography – US (Sclaverano *et al.*, 2009)

- 3D + US (biopsy)
  - CT
  - Multi-modality fusion (US + CT) (Ni *et al.*, 2011)

Reconstructing the organ

- Use of phantoms
- Steps:
  - Segmentation and registration of medical images
- Manual
- US with different scan angles to generate a panorama and correlate with CT volume

Reconstructing the organ

- Shapelets decompose an image on different elementary shapes. Five Gaussians as the basis function (Arathi & Parameswaran, 2014)
- Fuzzy C-means clustering for image partitioning (Jalalian et al., 2015)
- Modeling US wave propagation (by reflection and absorption) based on CT data (Mastmeyer et al., 2016)
- Free-form deformations and histogram matching (Mertzanidou et al., 2017)

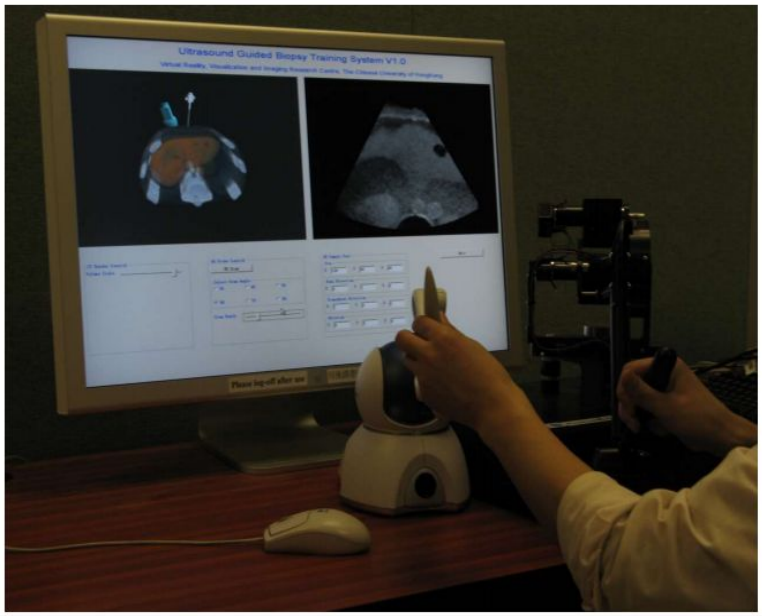
Reproducing the medical movements

- Most of the works on simulating medical procedures makes the use of haptic devices

- Haptics from 3 to 6–DOF (position and force)
  - Combining two 3–DOF to form a 5–DOF
  - One for needle and one for US

Reproducing the medical movements

- Sample using two haptics
  - 3-force DOF and 6-force DOF (Ni et al., 2008, 2011).



Modeling the forces

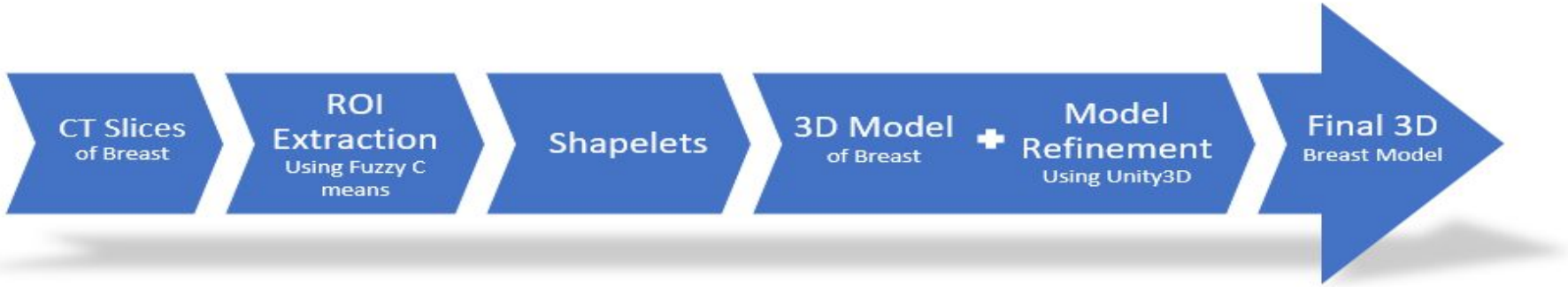
- Parametric model
- A review of many works in the field were done by (Abolhassani et al., 2007)
- Series of measurements of forces applied in the needle using markers in real exam. (Vidal et al., 2008)

Discussion

- CT exam – same position as in biopsy
- Combination of CT images and US
  - more realistic simulation
- 3D models– Unity3D engine

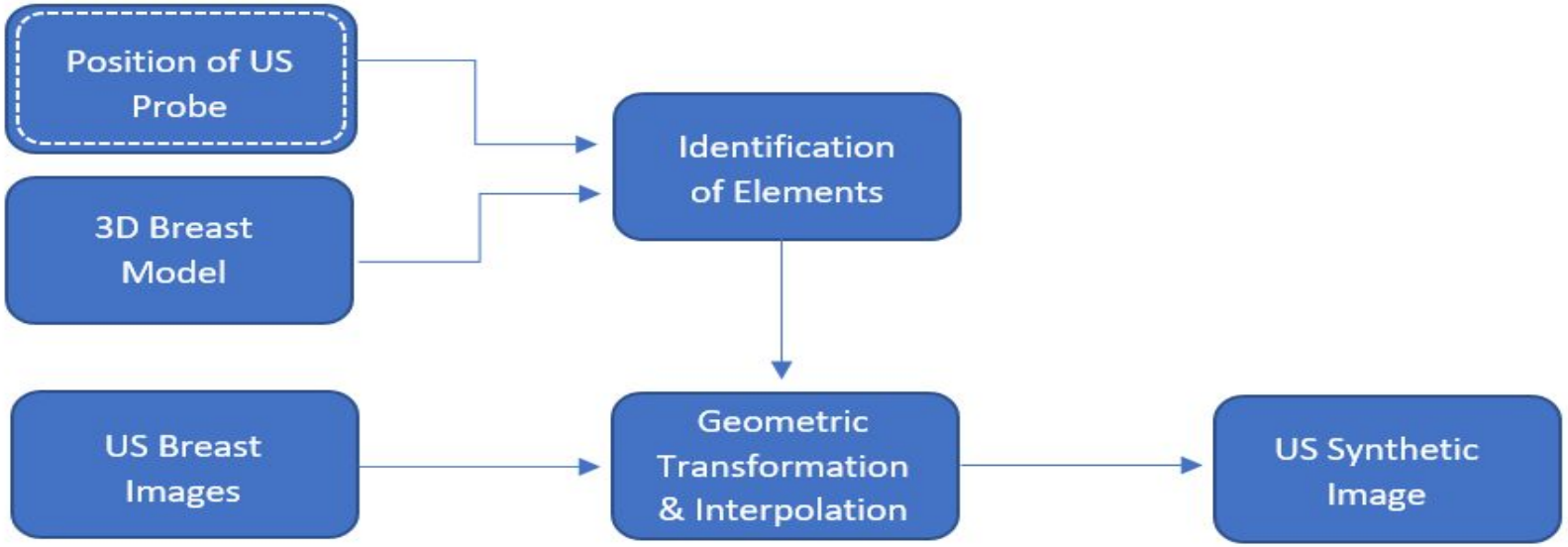
Proposal

- Steps of 3D reconstruction



Proposal

- Generating US synthetic images



Conclusion

- Method to reconstruct a 3D model of breast as well as 2D synthetic US images
- Without huge processing cost
  - Cheaper and better to real time
- Necessity of more input data

Future works

- Haptic devices and model of forces of the needle insertion
  - needle and the US–probe
- Parameterized model with variables that could be calibrated
- Simulation of breathing movements
- Online warnings as trainees do wrong movements
- Learning curve of the users