



Interdisciplinary Project (IDP) Kickoff-Presentation

A mixed reality application for needle targeting with trifocal stereo in real-time

Date: 12. January 2018
Student: Thomas Sennebogen
Supervisor: Benjamin Busam
Supervisor: Christoph Hennersperger

A mixed reality application for needle targeting with trifocal stereo in real-time

Background information:

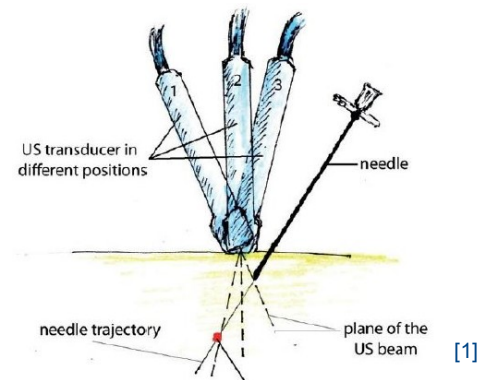
- More and more surgical needle interventions
- Use Cases: Cancer Screening, Neurology, Sentinel Lymph Node Biopsy, ...
- Punch Biopsy with Ultrasound transducer

Problem:

- Needle tip location difficult to estimate
- Needle path and bending uncertain

Solution:

- Needle tracking with real-time visualization
- Estimation of the needle bending
- Result: ▶ increasing safety and efficiency,
▶ faster healing by minimally invasive surgery



[1] M. Esposito, B. Busam et al.: "Cooperative Robotic Gamma Imaging: Enhancing US-guided Needle Biopsy", MICCAI, 2015 (11.1.2018)

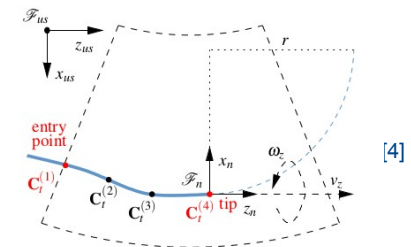
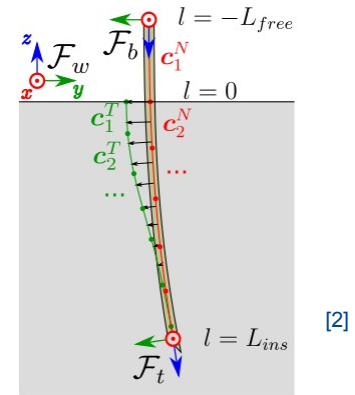
State of the art

Procedures and today's systems:

- Ultrasound-guided biopsy, Open surgical biopsy, Stereotactic biopsy
- Procedure: anesthetic, using ultrasound image for insertion, getting tissue sample, evaluation by radiologist
- Companies e.g. Siemens Health: real-time ultrasound images with previously-acquired 3-D computed tomography images

Research status:

- „Online prediction of needle shape deformation in moving soft tissues from visual feedback“
 - ▶ Using visual feedback and a Kalman filter
- „Inverse real-time Finite Element simulation for robotic control of flexible needle insertion in deformable tissues“
 - ▶ Needle steering in deformable tissues (phantoms)
- „3D ultrasound-guided robotic steering of a flexible needle via visual servoing“



[1] Ultrasound-Guided Breast Biopsy, <https://www.radiologyinfo.org/en/info.cfm?pg=breastbius> (11.1.2018)

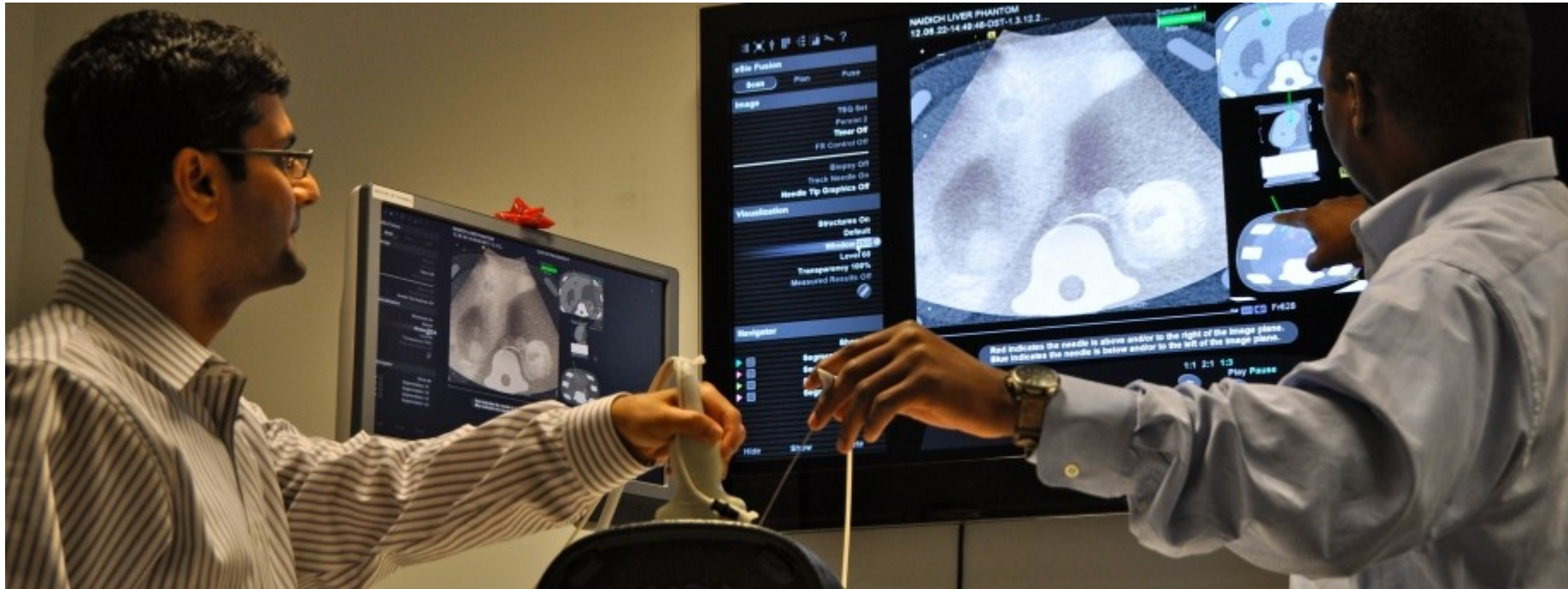
[2] Jason Chevré 1, Alexandre Krupa 2, Marie Babel 3, „Online prediction of needle shape deformation in moving soft tissues from visual feedback“, October 9-14, 2016, Daejeon, Korea

[3] Y. Adagolodjo, L. Goffin, M. de Mathelin, H. Courtecuisse, Inverse real-time Finite Element simulation for robotic control of flexible needle insertion in deformable tissues, October 9-14, 2016, Daejeon, Korea

[4] Alexandre Krupa and Nassir Navab, 3D ultrasound-guided robotic steering of a flexible needle via visual Servoing, Pierre Chatelain, Seattle, Washington, May 26-30, 2015



State of the art

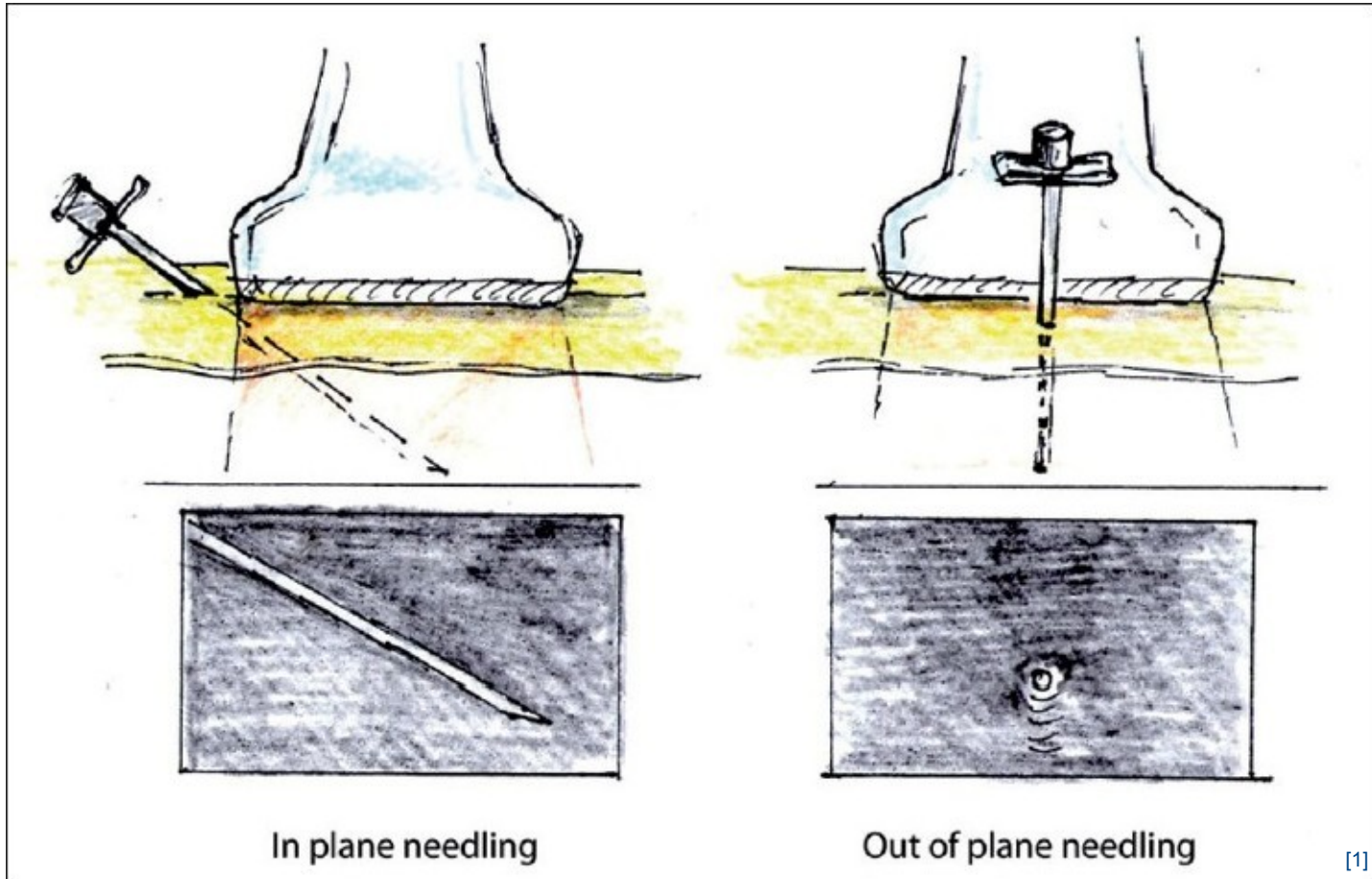


[1]



[1] Siemens Health, https://www.siemens.com/innovation/en/home/publications/health-and-well-being/medical-imaging-opening-a-3-d-window/_jcr_content/gem.adapt.916.high.jpg/1434541043734.jpg (11.1.2018)

In plane needling vs. Out of plane needling



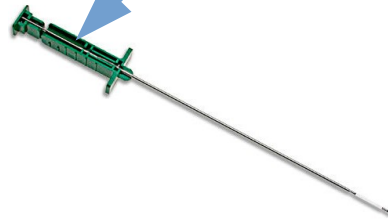
[1] In- and out-of-plane needle placement http://www.internationalshoulderjournal.org/viewimage.asp?img=IntJShoulderSurg_2010_4_3_55_76960_f9.jpg (11.1.2018)

Needle targeting operation

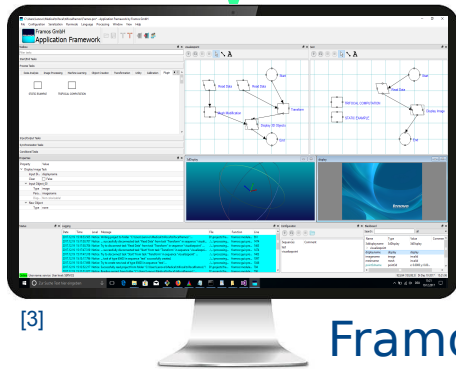
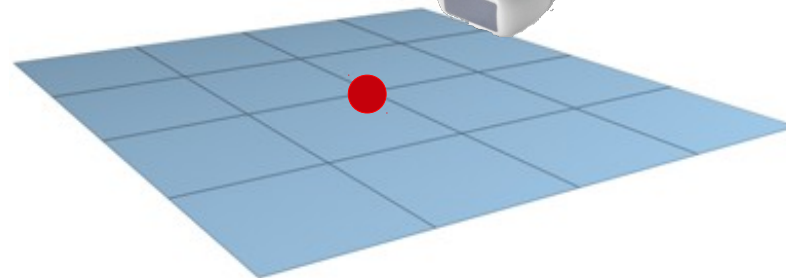
Trifocal camera system



Needle [1]



Ultrasound transducer [2]



Framos software

[3]

- [1] Biopsy Needle, <https://sep.yimg.com/ay/yhst-12533177228474/needle-biopsy-soft-tissue-14x3-10-box-8.gif> (11.1.2018)
- [2] Ultrasound-Transducer, <https://mindrayamerica.com/wp-content/uploads/MINDRAY-P10-4E-Phased-Array-Ultrasound-Transducer-For-Sale.jpg> (11.1.2018)
- [3] Computer Screen, <http://www.aviatainc.com/wp-content/uploads/2014/11/imac-computer-screen-widescreen-2.png> (11.1.2018)



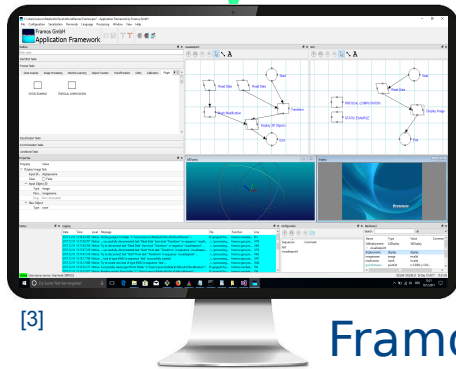
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[3] Framos software

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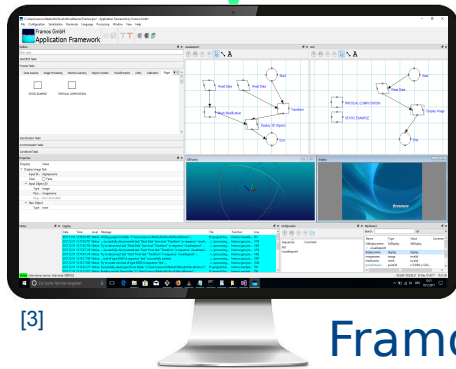
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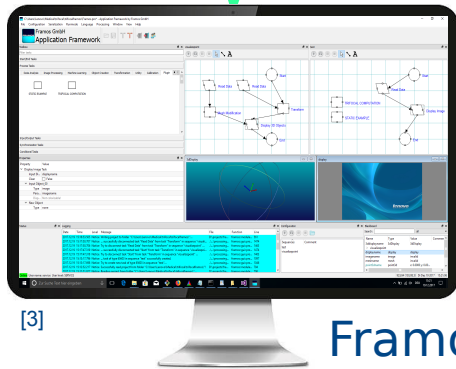
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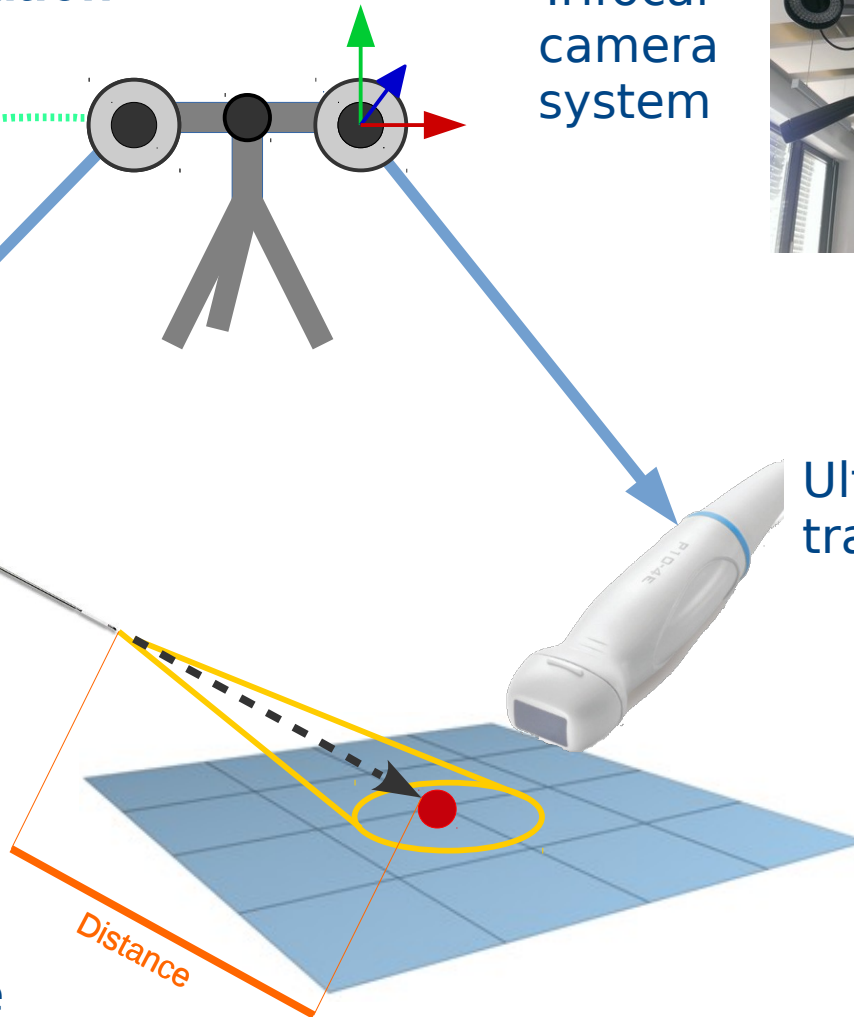


Needle [1]

Ultrasound transducer [2]



Framos software



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- [2] Ultrasound-Transducer, <https://mindrayamerica.com/wp-content/uploads/MINDRAY-P10-4E-Phased-Array-Ultrasound-Transducer-For-Sale.jpg> (11.1.2018)
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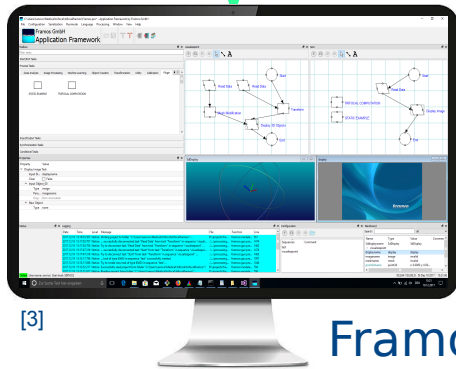
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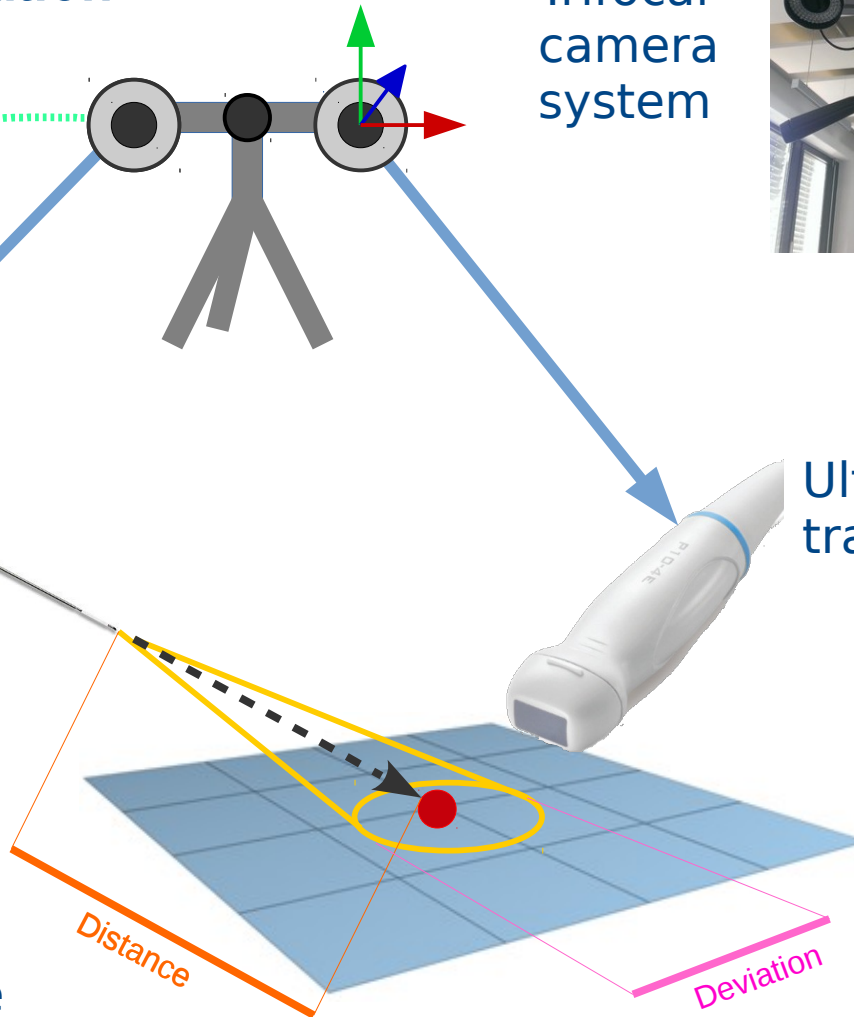


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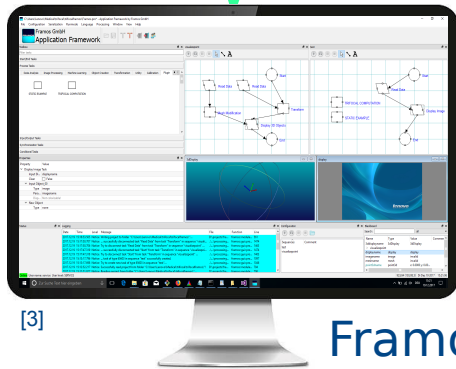
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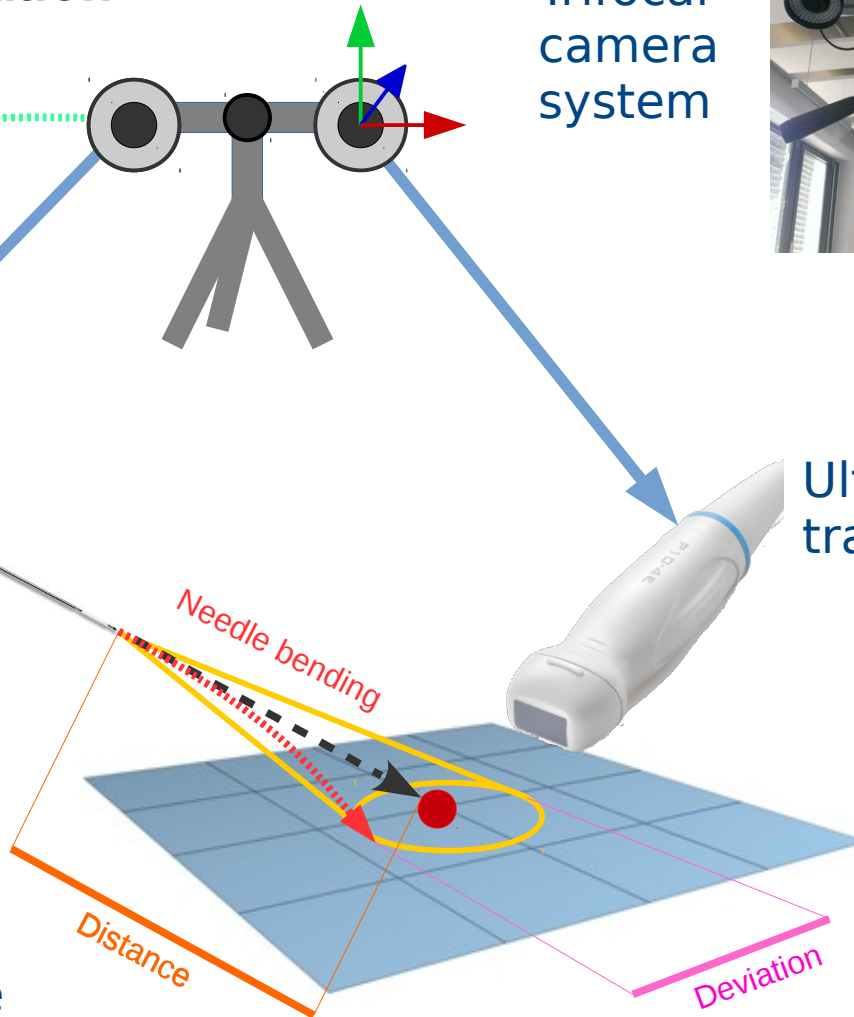


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Milestones and Project plan

- Familiarization with the topic - Alexandre Krupa:
„3D ultrasound-guided robotic steering of a flexible needle via visual servoing“
- Research on State-of-the-Art solutions
- Designing the concept
- Implementation and integration
 - Famos software framework with C++
 - 3D representation with OpenGL and OpenCV
 - Stereo tracking poses via OpenIGTLink (maybe S.I.M.P.L.E.)
 - Integrate image transfer with plugin
 - Calibrate cameras and needle
(intrinsic, extrinsic, needle, pivot, ultrasound)
 - Calculate and visualize additional information
- Build prototype
- Verification, validation and testing
- Documentation (GIT) and presentation



Time Line for the project

Concept phase:

- Research papers and state of the art
- Mockups
- Kick-Off presentation

1. Nov – 12. Jan

12. Jan

Implementation and calibration:

- Stiff needle approach
- Perform calibrations
- Software development and design
- Needle bending calculations

10. Dez – 20. Mar

Testing:

- Testing software by surgery simulation

1. Mar – 20. Mar

Documentation and presentation:

- Creating documentation
- Final presentation

21. Mar – 31. Mar



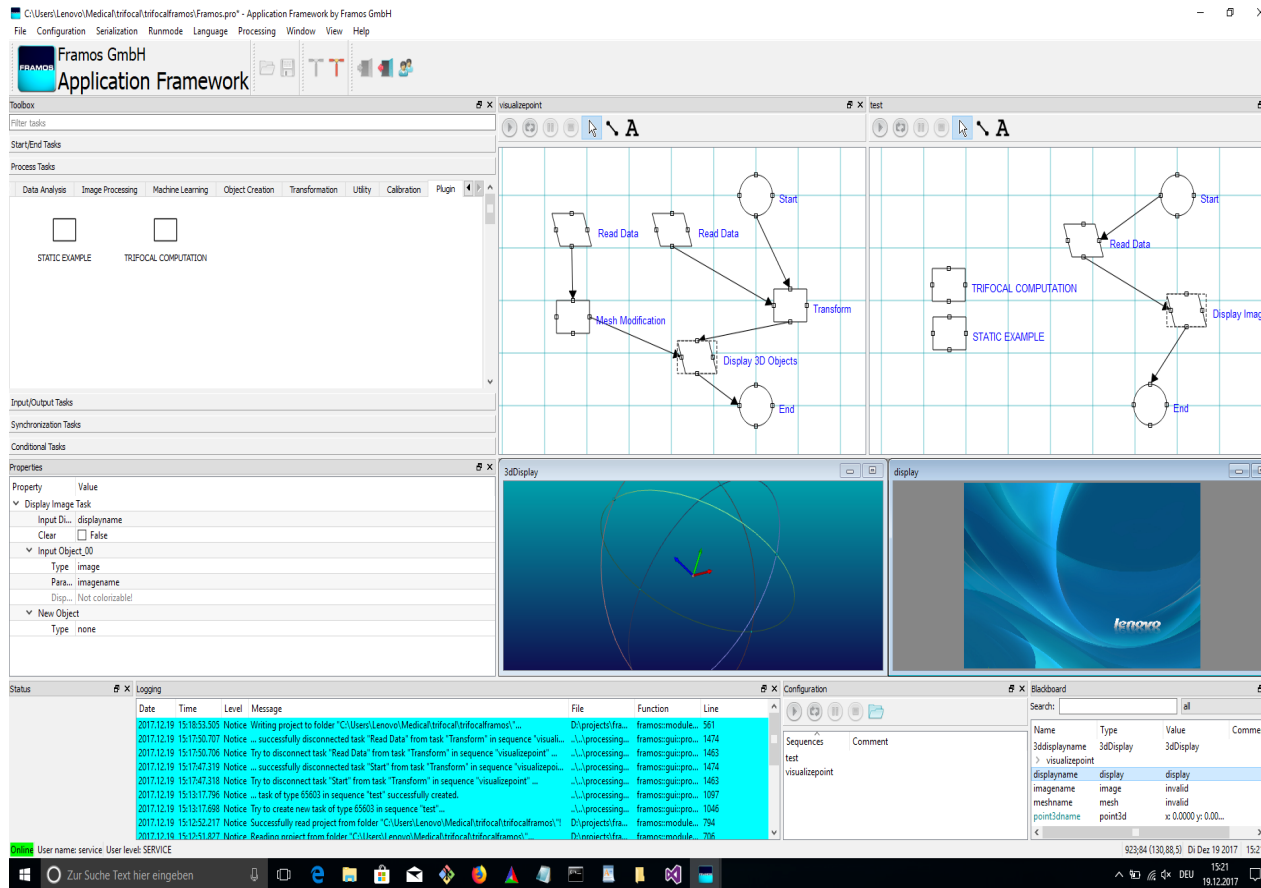
Time Line for the project – GANNT Chart



[1] Created with GanttPRO, <https://app.ganttpro.com>



Software Engineering



- [1] C++, <https://pluralsight.imgix.net/paths/path-icons/c-plus-plus-93c7ddd5cc.png> (11.1.2018)
- [2] FRAMOS GmbH, <https://www.framos.com/media/image/01/66/f6/Desktop58b848cb02ebc.png> (11.1.2018)
- [3] Visual Studio, <http://blog.parallels.com/2017/03/07/visual-studio-2017/> (11.1.2018)
- [4] OpenIGTLink, <https://www.slicer.org/w/images/thumb/3/3f/OpenIGTLink-Logo.png/250px-OpenIGTLink-Logo.png> (11.1.2018)
- [5] Point Cloud Library, <http://pointclouds.org/downloads/> (11.1.2018)
- [6] OpenGL, <https://www.opengl.org/about/> (11.1.2018)
- [7] GIT, <https://avatars1.githubusercontent.com/u/18133?s=400&v=4> (11.1.2018)



Project partners

FRAMOS GmbH

- Using the FRAMOS software framework
- Trifocal camera system



[1]

Klinikum Rechts der Isar

- Premises at the hospital: IFL
- Resources



Klinikum rechts der Isar [2]

CAMP chair:

- Interdisciplinary Project (IDP)
- Supervisors



[3]



[1] FRAMOS GmbH, <https://www.amos.com/media/image/01/66/f6/Desktop58b848cb02ebc.png> (11.1.2018)

[2] Klinikum rechts der Isar, <https://kress.de/news/detail/beitrag/136314-job-des-tages-online-redakteur-mw-in-muenchen-gesucht.html> (11.1.2018)

[3] TUM, CAMP chair, <http://campar.in.tum.de> (11.1.2018)

Additional information

Calibration with Optical Tracking System (OTS):

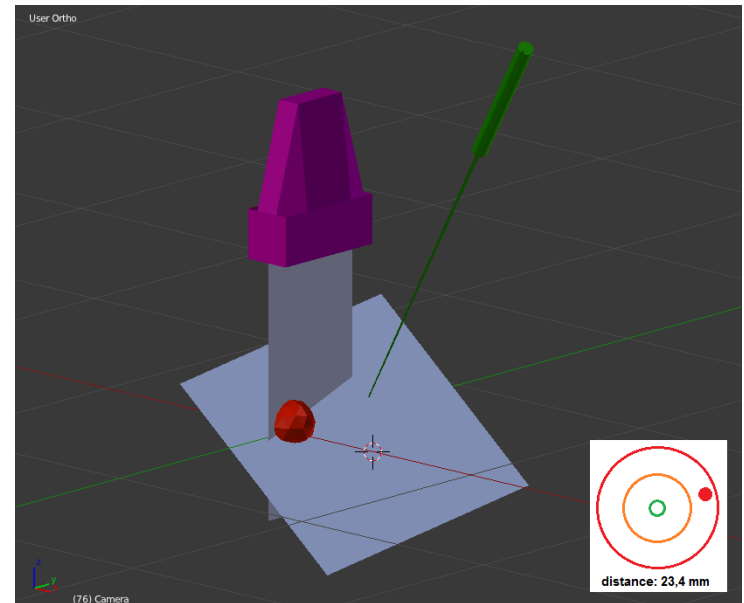
- Needle: handle, tip, needle vector
- Ultrasound: handle, plane
- Cameras: intrinsic, extrinsic

Needle bending aspects:

- Material stiffness
- Needle length
- Tissue to investigate

Future work:

- Using additional preoperative MRT
- Improving algorithms (needle bending)
- Additional software features
- Video recordings of surgery for teaching
- Robotic surgery



[1]



[1] Needle targeting 3D Sketch

Thank you for your attention!

Interdisciplinary Project (IDP)

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with trifocal stereo in real-time**

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