

## **RASimAs: First Results of Excellence**

**Erik Smistad and Frank Lindseth of SINTEF Medical Technology, Norway, have been awarded at the MedViz Conference 2015**

**Aachen, 08.07.2015 – In 2013, the European Union has granted 3.3 million Euros under the Seventh Framework Programme for the Regional Anaesthesia Simulator and Assistant (RASimAs) project, which aims at establishing Regional Anaesthesia in Europe’s daily routine of patient care. Regional Anaesthesia has several benefits for the patients such as earlier mobilization and release from hospital as well as a strong economic impact: savings of up to 100.000 Euros per operation theatre per year have been estimated for the health systems in Europe.**

The RASimAs project has gathered experts from ten countries in a consortium of academic (scientist specialized in medical imaging, computer science or virtual reality), industrial (specialized in medical devices) and clinical partners (specialized in anaesthesia). After half of the projects duration, the first results of excellence now have been acknowledged by the scientific community.

Dr. Erik Smistad, a young researcher in Norway and part of the RASimAs team has presented a poster at MedViz Conference 2015 in Bergen, Norway, 15th -16th of June, 2015. MedViz “from vision to decision” is a cluster of groups performing interdisciplinary research in advanced image analysis and visualisation bridging the gap between “bench and bedside”. Erik presented novel methods for segmenting structures such as the femoral artery and nerve in ultrasound images of the femoral region, together with registration of a CT-based 3D model used to guide the user to the target area – a key component of RASimAs that has been developed under guidance of Dr. Frank Lindseth, a senior researcher at SINTEF.

“From the first moment, I was fascinated by the RASimAs idea to fuse state-of-the-art algorithms, hardware technology and medical models for patient’s benefit”, stated Erik, who submitted his PhD thesis on medical image segmentation for improved surgical navigation at the Norwegian University of Science and Technology (NTNU), before he became a full time researcher at SINTEF Medical Technology, Trondheim, Norway. “Hence, I was happy when being offered the research position in this project and immediately accepted.” “We are happy that Erik has joined our team, since he is indeed contributing to the state of the art in medical sciences and technology”, added Dr. Frank Lindseth, who already advised the PhD work of Erik. Prof. Dr. Thomas Deserno, Uniklinik RWTH Aachen, Germany, who leads the European RASimAs consortium, adds: “For sure, this will not be the last award we will receive for our most-innovative work in RASimAs” when congratulating Erik and Frank for their outstanding research.

## An assistant for improved ultrasound-guided regional anaesthesia of the femoral nerve

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### Introduction

The use of regional anaesthesia (RA) is increasing due to the benefits over general anaesthesia (GA) such as reduced mortality and morbidity, reduced postoperative pain, earlier mobility, shorter hospital stay, and lower costs. Despite these clinical benefits, RA remains less popular than GA. One reason for this is that GA is far more successful and reliable than RA. Ultrasound has been employed to increase the success rate of RA. However, ultrasound-guided RA can be a challenging technique, especially for inexperienced physicians and in difficult cases. Good theoretical, practical and navigational skills are needed in order to achieve confidence in performing RA and to keep complications to a minimum. Studies indicate that RA education focusing on illustrations and text alone is not sufficient.

The RASimAs project (Regional Anaesthesia Simulator and Assistant) is a European research project which aims at providing a simulator to improve the training of doctors performing RA, as well as an assistant to lessen the cognitive burden and help performing RA procedures. The assistant will guide the user to: 1) find a good probe placement and view of the target (femoral vein), 2) insert needle and 3) inject local anaesthesia. In step 1, segmentation of the structure of interest and registration of the 3D model will be used to guide the user to the target vein. Visual cues will be given to the user indicating which direction the probe should be moved to reach the target vein. After the target vein has been located, the assistant will guide the needle insertion by visualizing the needle in both the ultrasound image and the 3D scene. In the final step, the user tracks local anaesthesia which will be displayed in the augmented ultrasound image. Although the assistant is applicable for different ultrasound-guided RA applications, the focus in this project has been on the femoral nerve (see figures 1 and 2).

### Methods

The ultrasound system consists of an Analogic Sono MDP scanner with a linear probe and electromagnetic tracking (OptoTrack) of both probe and needle. The images are streamed to the assistant using the Plus toolkit and the OpenCL/CUDA protocols. So far, automatic vessel segmentation and registration methods have been developed for the assistant. The vessel is detected and tracked automatically in real-time using an elliptical vessel model, a Kalman filter and a gradient processing and (GPI). A mesh model of the surrounding anatomy was created from a CT dataset. Registration of this model is achieved by first placing the ultrasound image frame at the target site. After this initialization, each ultrasound image frame is registered to the artery model using the detected correspondence from the vessel tracking. If any bone is detected in the image, it is used to register the model in the tracked direction. The segmentation and registration methods must be able to process the image in real-time to be useful for the femoral nerve block assistant. This is achieved by implementing the assistant with the FAST framework which uses GPU and OpenCL for processing and visualization. Figure 3 shows a diagram of the different parts of the assistant.

### Results

A total of 22 ultrasound image sequences from 3 subjects were collected. The number of images per sequence ranged from 130 to 204. For each sequence, the vessel was manually segmented in a randomly selected frame. The vessel detection initiated the tracking successfully in all 22 sequences. On average, the tracking was successfully initiated after the vessel detection was run on 34 frames. Assuming 25 frames per second, the tracking is initiated in about 1.4 seconds. The vessel tracking algorithm achieved an average dice similarity coefficient of 0.90, mean absolute distance of 0.42 mm, and Hausdorff distance 1.17 mm. The average runtime was measured to be 42, 5, 0.11 and 34 milliseconds for the vessel detection, tracking, registration and bone segmentation methods respectively. Figures 4 and 5 show some results of the vessel segmentation and registration methods.

### Conclusion & future work

The presented methods are able to automatically and accurately track the femoral artery in ultrasound images and use this to register a model of the surrounding anatomy in real-time. This will be part of an assistant for ultrasound-guided regional anaesthesia of the femoral nerve. Currently we are working on segmentation of the femoral nerve, fascia lata and fascia iliaca (see Figure 6), needle insertion guidance and enhancement of the local anaesthesia after insertion. In 2016, the assistant will be clinically tested and evaluated at three different sites.

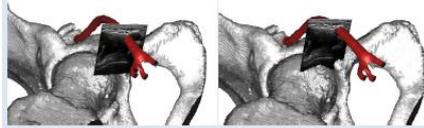


Figure 1. Left: 3D model and ultrasound image visualized after initial registration. Right: After vessel and bone registration.

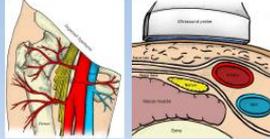


Figure 2. Diagram of the femoral nerve (left) and cross-sectional distribution of the region of interest (right). Image courtesy of H. E. Mørk (Bakerhug.com).

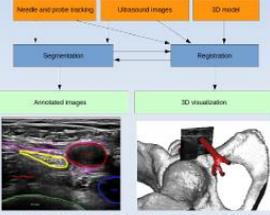
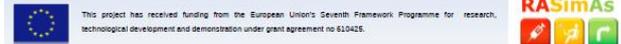


Figure 4. Diagram of the assistant. The annotated images are shown in the ultrasound and 3D scene for segmentation and registration. The 3D visualization shows the vessel and bone segmentation and registration. The user image shows a 3D visualization of the model and the ultrasound image after registration.



Figure 5. Results of the vessel detection and tracking algorithm. The yellow edges in the tracking result and the green circles in the vessel segmentation result.



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The awarded poster presented at MedViz 2015



Dr. Erik Smistad and Prof. Antonella Zanna Munthe-Kaas, Chairman of the MedViz 2015 Poster Session.

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**About Uniklinik RWTH Aachen**

Uniklinik RWTH Aachen is a supramaximal healthcare provider that combines patient-oriented medicine and nursing with world-class teaching and research. The University Hospital covers the entire spectrum of medicine with 34 specialist clinics, 25 institutes and five interdisciplinary units. Outstandingly qualified teams of doctors, nurses and scientists commit themselves competently to the patient's health. Bundling healthcare, research and teaching in one central building provides optimum conditions for intensive interdisciplinary dialogue and a dense clinical and scientific network. Around 6,000 personnel provide patient-oriented medical care and nursing in compliance with recognised quality standards. The University Hospital has 1,240 beds and treats approximately 47,000 inpatients and 153,000 outpatients every year.