



## **RASimAs: Des premiers résultats fructueux !**

**Erik Smitstad et Frank Lindseth de SINTEF Medical Technology, en Norvège, ont été primé à la conférence MedViz 2015.**

En 2013, l'Union Européenne a débloqué 3.3 millions d'euros dans le cadre du programme de financement FP7 pour le projet de simulateur et d'assistant à l'anesthésie loco-régionale (RASimAs), dont le but est de développer en Europe l'anesthésie loco-régionale en routine clinique. L'anesthésie loco-régionale a en effet plusieurs bénéfices pour le patient tels que la réduction du temps d'hospitalisation ainsi qu'un fort impact économique : le système de santé européen a ainsi estimé que cette technique permet d'économiser par année pas moins de 100 000 euros par théâtre d'opération.

Le projet RASimAs réunit des experts venus de 10 pays au sein d'un consortium constitué d'académiques (scientifiques spécialisés dans le traitement d'image, les sciences de l'information ou encore la réalité virtuelle), d'industriels (spécialisés dans les équipements médicaux) et de partenaires cliniques (spécialisés en anesthésie). Arrivés à la moitié de la durée du projet, la communauté scientifique a salué des premiers résultats de grande qualité.

Erik Smistad, un jeune chercheur norvégien membre de l'équipe RASimAs, a présenté un poster à la conférence MedViz 2015 qui s'est déroulée à Bergen (Norvège) les 15 et 16 Juin 2015. MedViz "from vision to decision" est un ensemble de groupes qui planchent sur des travaux de recherche interdisciplinaires dans le traitement d'image avancé et la visualisation, faisant le pont entre le laboratoire et le chevet du patient. Erik a présenté une nouvelle méthode de segmentation de structures anatomiques telles que les artères et nerfs fémoraux dans des images ultrasons de la région fémorale, accompagnée d'un recalage de modèles 3D permettant le guidage de l'utilisateur vers une zone cible (un composant clé du projet RASimAs qui a été développé sous la tutelle du Dr Frank Lindseth, chercheur à SINTEF)

"Dès le début, j'ai été fasciné par l'ambition du projet RASimAS de combiner les meilleurs algorithmes disponibles avec du matériel de pointe et des modèles médicaux, avec comme objectif un bénéfice pour le patient" explique Erik, qui vient de soutenir sa thèse en segmentation d'images médicales visant à améliorer la navigation chirurgicale avant qu'il ne devienne chercheur à part entière dans l'équipe de SINTEF Medical Technology at Trondheim (Norvège).

"C'est pourquoi j'ai été ravi que l'on m'ait offert un poste de chercheur permanent dans le projet, poste que j'ai tout de suite accepté". "Nous sommes très contents qu'Erik ait rejoint l'équipe, puisqu'il contribue en effet au développement des techniques les plus récentes en sciences et technologies médicales." ajoute le Dr Frank Lindseth qui a déjà encadré le travail de thèse d'Erik. Au Dr Thomas Deserno de l'Uniklinik RWTH d'Aix-la-Chapelle en Allemagne qui dirige le consortium RASimAs d'ajouter : "Soyez en sûr, ce ne sera pas le dernier prix que nous recevrons pour nos innovants travaux dans RASimAs" alors qu'il félicitait Erik et Frank pour lors excellent travail.

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### RASimAs Impressum:

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## 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, faster 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 cognitive 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 simulation and not 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 structures 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 area 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 inserts local anaesthetic which will be displayed in the unimodal 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 Figure 1 and 2).

**Methods**  
 The ultrasound system consists of an Analogic Sono MDPi scanner with a linear probe and electromagnetic tracking (E-tracking) of both probe and needle. The images are streamed to the assistant using the Fire toolset and the OpenCL/CUDA protocol. To be automatic, vessel segmentation and registration methods have been developed for the assistant. The vessel is detected and tracked automatically in real-time using an optical vessel model, a Kalman filter and a graph processing and GPU. A mesh model of the surrounding anatomy was created from a CT dataset. Registration of the 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 images, it is used to register the model in the tracked direction. The segmentation and registration methods must be able to process the images 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 20 ultrasound image sequences from 7 subjects were collected. The number of images per sequence ranged from 135 to 826. For each sequence, the vessel was manually segmented in 4 randomly selected frames. The vessel detection initiated the tracking successfully in all 52 sequences. On average, the tracking was successfully initiated after the vessel detection was run on 16 frames. Assuming 25 frames per second, the tracking is initiated in about 0.6 seconds. The vessel tracking algorithm achieved an average slice 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 anaesthetic after injection. In 2016, the assistant will be clinically tested and evaluated at three different sites.

**Figure 1:** Schematic of the femoral nerve block region showing the femoral artery, vein, and nerve along with femur and the probe. Image courtesy of N. E. Mørk (HelseMidt-Norge).

**Figure 2:** Coronal CT-scan of the region of interest (image courtesy of N. E. Mørk (HelseMidt-Norge)).

**Figure 3:** Diagram of the assistant. The ultrasound image is processed by the assistant and used for segmentation and registration, providing real-time unimodal ultrasound image and 3D visualization of the surrounding anatomy. The user will then move a manual ultrasound image. The user will then move a 3D visualization of the model and the ultrasound image after registration.

**Figure 4:** Results of the vessel detection and tracking algorithm. The yellow ellipse in the tracking result and the green contour in the manual annotation are used.

**Figure 5:** Left: 3D model and ultrasound image overlaid after initial registration. Right: After vessel and bone registration.

**Figure 6:** Preliminary segmentation results of the artery, femoral nerve, fascia lata and fascia iliaca.

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*Le poster récompensé lors de MedViz 2015*



*Erik Smistad et la Prof. Antonella Zanna Munthe-Kaas, Présidente de la Session de Posters de MedViz 2015.*

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