Breathing Compensation for Autonomous Robotic Ultrasound Abdominal Sweep

Project Management and Software Development
for Medical Applications

General Info

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Project Abstract

Ultrasound (US) imaging is commonly employed for the diagnosis and staging of abdominal diseases, mainly due to its non-invasiveness and high availability. However, high inter-operator variability and a lack of repeatability of current US image acquisition impair the implementation of extensive screening programs. Furthermore, volumetric data is useful to the clinicians to visualize and inspect internal tissues. A better 3D compounding can lead to better US interpretation and disease diagnosis. However, US compounding in real-time is hampered due to the breathing motion of the patient and breathing compensation methods are needed.

Background and Motivation

Medical ultrasound (US) systems are widely used for the diagnosis of internal tissues. However, there are challenges associated with acquiring and interpreting US images, such as operator-dependency and patient motion.

Additionally, volumetric data is useful to the clinicians to visualize and inspect internal tissues. Such data is generated from 2D US images using reconstruction techniques [1] and knowledge of the US probe pose. In order to spatially align tracked 2D B-mode images into a common 3D volumetric representation, Ultrasound compounding is used. This method not only enables a volumetric US representation of the scanned area but also reduces noise inside the volume, which help for better US interpretation and disease diagnosis.

This opens the way to a possible automation of the procedure, and recent works have exploited the use of robotic platforms for manipulatng the US probe. Automating US imaging acquisition can reduce operator-dependency and increase accuracy.

However, one difficulty when generating an US compounding in real-time is the breathing motion of the patient. Virga et al. [2] studied autonomous robotic US acquisition to automate line trajectory planning, and evaluated position compensation during breathing motions.

In this project, we want to develop a robotic US system for autonomous aortic scan with real-time breathing compensation for improved 3D US volume compounding.

Student's Tasks Description

- Setup the robot with attached US probe.

- Acquire US image stream in real-time over ROS.

- Record real-time robot trajectory.

- Develop a real-time breathing compensation algorithm based on the breathing pattern.

- Apply post-processing filtering.

Technical Prerequisites

Good C++ Programming level

Good Python Programming level

Experience with ROS (Robot Operating System)

Optional: Experience with ImFusionSuite

Please send the completed proposal to ardit.ramadani@tum.de, lennart.bastian@tum.de and tianyu.song@tum.de. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in case of acceptance.

References

[1] O. V. Solberg, F. Lindseth, H. Torp, R. E. Blake, and T. A. N. Hernes, ‘‘Freehand 3D ultrasound reconstruction algorithms—A review,’’ Ultrasound Med. Biol., vol. 33, no. 7, pp. 991–1009, 2007.

[2] Virga, Salvatore & Zettinig, Oliver & Esposito, Marco & Pfister, Karin & Frisch, Benjamin & Neff, Thomas & Navab, Nassir & Hennersperger, Christoph. (2016). Automatic force-compliant robotic ultrasound screening of abdominal aortic aneurysms. 10.1109/IROS.2016.7759101.