Real-Time Nerve Segmentation and 3D Visualization System

Project Management and Software Development
for Medical Applications

General Info

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Medical Motivation

Carpal Tunnel Syndrome (CTS) is a prevalent medical condition that affects approximately 5% of the global population, causing significant discomfort through symptoms like pain, numbness, tingling, and difficulty gripping [1]. It is the second most common work-related disorder and can result in severe limitations in hand functionality if left untreated [2]. Early diagnosis is crucial to prevent long-term damage and mitigate its impact on quality of life.

Background and Motivation

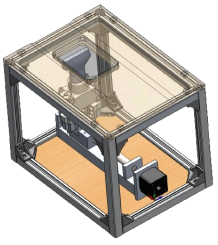
Currently, the conventional diagnostic techniques for CTS such are Electrophysiological (EP) tests, Magnetic Resonance Imaging (MRI), or CT scans. However, these are very time-consuming, expensive, and induce radiation exposure. Ultrasound (US) imaging, on the other hand, offers a more accessible alternative, which is radiation-free and provides real-time imaging.

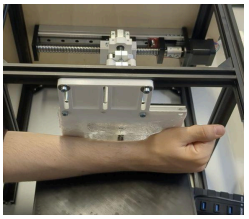
However, US imaging presents challenges, like limited visibility, artifacts, noise, and shadows, making identifying nerve structures and boundaries very challenging. With advances in Artificial Intelligence (AI), automated diagnosis using US is becoming a promising solution to these limitations, especially for rural or under-resourced areas.

Another challenge with ultrasound scanning is the operator-dependency, resulting in lack of standardization, low reproducibility and repeatability.

Therefore robotic ultrasound systems are employed to address these limitations by automatizing and standardizing the scanning process. Such autonomous systems can navigate to the standard examination planes, which are rich in diagnostic information.

This project aims to integrate together previously built AI-based robotized segmentation pipeline into an existing web page. The system consists of an AI module for unsupervised nerve segmentation, a robotic system to perform automatic and standardized scans and a simple web page. The goal is to have a complete functioning system, where the scanned area appears on the web page and by providing a prompt the AI-method is being interfaced and run in the background. At the end the final 3D volume should be displayed, with corresponding diagnostic measures of the nerve diameter sizes. Once the components are put together, the secondary goal of this project is to record volunteer data and together with our clinical partner assess the effectiveness of the system.





Student's Tasks Description

- learn how to run the latest unsupervised segmentation methods (SAM2) and extract images from robotized system.
- get familiar with an initial version of a webpage.

Please send the completed proposal to felix.tristram@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.

- integrate together the already existing robotic-AI method into the webpage.
- conduct experiments on volunteers and assess the results

Technical Prerequisites

Good Python Programming level

Optional: Experience with web development

References

[1] L. Padua, D. Coraci, C. Erra, C. Pazzaglia, I. Paolasso, C. Loreti, P. Caliandro, and L. D. Hobson- Webb, “Carpal tunnel syndrome: clinical features, diagnosis, and management,” The Lancet. Neu- rology, vol. 15, no. 12, pp. 1273–1284, 2016

[2]E. Silvestri, F. Martino, and F. Puntillo, Ultrasound-Guided Peripheral Nerve Blocks. Cham: Springer International Publishing, 2018.