UNIVERSITY OF GENOA
DEPARTMENT OF INFORMATICS, BIOENGINEERING, ROBOTICS AND SYSTEMS ENGINEERING
MASTER'S PROGRAM IN BIOENGINEERING

Thesis Project Form

Title (tentative): Enhancing Pre-processing and Vessel Segmentation Techniques for Angio-MRI at 0.5 Tesla

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Description

Motivation and application domain

Until recently, the development of Magnetic Resonance Imaging (MRI) systems was driven by a strong push toward higher magnetic field strength. The rationale was clear: higher fields yield images with superior Signal-to-Noise Ratio (SNR), enabling increasingly detailed exploration of the human body. This trend led to the proliferation of high-field MRI scanners, which became the gold standard for advanced diagnostic imaging.

Recently, however, low and mid-field MRI systems have gained momentum due to their accessibility, patient comfort, and clinical versatility.

To bridge the inherent gap in SNR and resolution between high-field and low/mid-field systems, researchers are developing innovative signal and image processing techniques. These advancements aim to enhance image quality and diagnostic reliability, even at lower magnetic field strengths. Techniques such as deep learning-based reconstruction, advanced denoising algorithms, and optimized pulse sequences play a crucial role in this transformation.

One standout example of mid-field innovation is MROPEN, an MRI scanner entirely designed and manufactured in Genova by ASG Superconductors. MROPEN redefines patient accessibility by offering the largest gantry opening available on the market, making it particularly suitable for obese and claustrophobic patients. Its open architecture not only improves patient comfort but also expands the clinical applicability of MRI in scenarios where traditional closed-bore systems fall short.

Despite these advantages, mid-field MRI still faces technical challenges, particularly in angiographic imaging. High-quality MR angiography relies heavily on strong SNR, and this type of acquisition tends to suffer the most at lower fields. Overcoming this limitation is a key focus for ongoing research, with the goal of making mid-field systems viable for a broader range of diagnostic applications.

General objectives and main activities

This project aims to adapt and apply advanced post-processing techniquesâ€”originally developed for pediatric angiographic MRI imagesâ€”to a new dataset acquired at lower magnetic field strength. The primary goal is to explore how these methods can be effectively translated to enhance image quality and enable accurate vascular segmentation in a more challenging mid-field environment.

The image enhancement pipeline will focus on denoising strategies, which are critical for improving the Signal-to-Noise Ratio (SNR) and preserving anatomical detail. These techniques are particularly important in mid-field MRI, where reduced SNR can significantly impact the visibility of fine vascular structures.

The dataset provided for this work consists of raw, unprocessed angiographic images acquired using MROPEN (ASG Superconductors â€“ Genova).

One of the key challenges addressed in this thesis will be the segmentation of blood vessels from low-field angiographic imagesâ€”a task that demands both robust noise reduction and precise structural delineation. By leveraging and refining existing post-processing algorithms, the project seeks to contribute to the broader effort of making mid-field MRI a viable and cost-effective alternative for high-quality vascular imaging.

Training Objectives (technical/analytical tools, experimental methodologies)

The student will acquire skills in advanced image processing, machine learning, and deep learning applied to medical imaging. They will gain hands-on experience with Python-based frameworks, data annotation, and quality assurance workflows in MRI. These competencies are highly relevant for careers in medical imaging, AI, and healthcare technology.

Place(s) where the thesis work will be carried out: ASG Superconductors, Corso F.M. Perrone 73r, 16152 Genova.

Additional information

Pre-requisite abilities/skills: Background in image processing, image enhancement algorithms. Proficiency in Python (or MATLAB) is required.

Maximum number of students: 2