Internship topic: Diffusion Models for Quantitative Acoustic Microscopy Image Enhancement

Keywords: computational imaging, deep learning, diffusion models, medical applications

Location: CREATIS, University Claude Bernard Lyon 1, Villeurbanne, France

Supervisors: Adrian Basarab, Full Professor, adrian.basarab@creatis.insa-lyon.fr
Lorena Leon, Postdoctoral Researcher, lorena.leon@creatis.insa-lyon.fr

Duration: 3 to 6 months

Start Date: as soon as possible, no later than May 2025

Research environment:

The internship will take place in the CREATIS laboratory located in La Doua campus of INSA-Lyon. The recruited intern will be a full member of the ULTIM research group collaborating with PhD students and permanent researchers. He/she will participate in team activities, including working groups and scientific seminars.

Subject:

Quantitative Acoustic Microscopy (QAM) is a non-invasive imaging technique that generates quantitative two-dimensional (2D) maps, revealing the acoustic and mechanical properties of soft biological tissues at microscopic resolution. In this project, QAM data is obtained using high-frequency transducers, specifically 250 MHz and 500 MHz, offering spatial resolutions of 7 µm and 4 µm, respectively. While increasing transducer frequency enhances resolution, operating at such high frequencies introduces significant sensitivity to environmental factors such as vibrations and temperature fluctuations. Furthermore, systems operating at these frequencies require complex and expensive electronic components.

Diffusion models, a class of generative deep learning models, have recently attracted significant attention for their ability to generate high-quality images from noisy data. These models reverse the gradual addition of noise, recovering clean images through a process inspired by physical diffusion. Diffusion models have shown outstanding performance in tasks like image denoising, super-resolution, and inpainting, making them ideal for enhancing medical images where noise reduction and resolution improvement are crucial.

The goal of this internship is to explore the potential of diffusion models for enhancing QAM images acquired using the 250 MHz system, with the aim of producing high-resolution results comparable to those generated by the 500 MHz system, but without the technical complexity and cost of upgrading the hardware.

Student profile:

- Master or engineering student in Computer Science, Electrical Engineering, Applied Mathematics or a related field.
- Strong programming skills in Python.
- Background in machine learning and image processing.
- Familiarity with deep learning libraries, diffusion models or related algorithms is a plus.
- Fluent English or French Spoken.

How to Apply:

Please send your CV, a cover letter, and your master or engineering school transcripts to:

- Adrian Basarab: adrian.basarab@creatis.insa-lyon.fr
- Lorena Leon: lorena.leon@creatis.insa-lyon.fr

References:

[1] A. Basarab, D. Rohrbach, N. Zhao, J. -Y. Tourneret, D. Kouamé and J. Mamou, "Enhancement of 250-MHz quantitative acoustic-microscopy data using a single-image super-resolution method," *2017 IEEE 14th International Symposium on Biomedical Imaging (ISBI 2017)*, Melbourne, VIC, Australia, 2017, pp. 827-830

[2] J. Mamou, T. Pellegrini, D. Kouamé and A. Basarab, "A Convolutional Neural Network for 250-MHz Quantitative Acoustic-microscopy Resolution Enhancement," *2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, Berlin, Germany, 2019, pp. 6212-6215

[3] C. Saharia, J. Ho, W. Chan, T. Salimans, D. J. Fleet and M. Norouzi, "Image Super-Resolution via Iterative Refinement," in *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 45, no. 4, pp. 4713-4726