Type d'offre : Laboratory offer

Post date : 29.01.26

L2S (en collaboration avec le laboratoire SATIE)

3D Image Reconstruction in X-ray Tomography. Data-Based Approaches Integrating a 3D Object Model

Informations générales

Contract type : Stage

Contract length : 6 months

Education level : Master 2 or equivalent

Contact :

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Starting date : Wed 01/04/2026 - 12:00

Trade : IR

Topic : Autre

L2S (en collaboration avec le laboratoire SATIE) :

The Laboratory of Signals and Systems (L2S, UMR 8506) is a French research laboratory created in 1974, located in Paris-Saclay University, and jointly operated by the CNRS, CentraleSupélec and the University of Paris-Saclay. Research at L2S focuses on fundamental and applied mathematical aspects of control theory, AI, data science, information, signal and image processing, communication, and network theory

Address :

L2S, CentraleSupélec, 3 rue Joliot Curie
91192 Gif-sur-Yvette
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Détail de l'offre (poste, mission, profil) :

Context

This internship focuses on the reconstruction of 3D objects using X-ray tomography, with applications to Non-Destructive Testing (NDT) of metallic parts in the aerospace industry. Tomographic reconstruction is a classical inverse problem encountered in medical imaging and non-destructive testing. Implemented in numerous industrial scanners, recent innovations are linked, on the one hand, to the emergence of new, potentially multimodal, imaging systems, and on the other hand, to the development of new inversion techniques based in particular on statistical learning. These approaches are the subject of this internship.

In non-destructive testing for the aerospace industry, the imaged volumes correspond to industrial parts with complex geometries, produced using additive manufacturing for weight and performance gains, or using the lost-wax casting process for high-pressure turbine blades that withstand high thermomechanical stresses and incorporate internal cooling circuits. Three-dimensional imaging of these structures is essential for detecting potential faults. To this end, our partner Safran Tech is exploring new X-ray tomography modalities. These modalities are based on unconventional source and detector trajectories, optimized according to the geometry and composition of the part.

Objectives

The first objective of the internship is to establish a state-of-the-art review of data-driven inversion methods, enabling the use of a training dataset to learn the prior distribution of the volumetric image to be reconstructed, and thus guide the 3D reconstruction process in challenging situations (limited projection angles, low signal-to-noise ratios). These methods have seen significant success in the field of inverse problems (so-called ”plug-and-play” and ”unrolling” approaches), the underlying idea being to train deep and convolutional neural networks, where the network is intrinsically linked to the regularization functional of the inverse problem. These approaches often provide superior empirical results compared to classical (non-iterative) analytical methods such as the FDK method or iterative methods based on the optimization of regularized criteria. However, the reconstructed images are susceptible to ”hallucinations” when the training data is insufficient, resulting in the reconstruction of unrealistic objects. In terms of cost function optimization, data-driven approaches suffer from a lack of convergence guarantees. It is worth noting that recent work is paving the way for methods with guaranteed convergence. This state-of-the-art review aims to understand the main existing approaches, their theoretical guarantees, and their limitations.

The second objective of this internship focuses on generating training data. This is a crucial component of data-driven approaches. In tomographic reconstruction, the training dataset consists of a set of 3D volume-associated 2D radiographic projection pairs, which must be sufficiently representative of the diversity of possible 3D volumes. In non-destructive testing, CAD models are available to describe 3D

volumes using a set of shape parameters. These models allow for the generation of realistic meshes representing plausible structures and the simulation of the radiographic projection of these volumes. The goal will be to integrate a regularization technique into the image reconstruction process, taking into account the prior knowledge associated with the CAD model of the part.

Perspectives

This internship is a preliminary study within the framework of a collaborative project between L2S and SATIE with SAFRAN Tech. L2S has already collaborated with SAFRAN Tech on a CIFRE PhD thesis on iterative reconstruction methods adapted to non-destructive testing. This internship will offer opportunities for further CIFRE PhD contract with SAFRAN Tech.

Required skills:

• Master’s degree (or equivalent) in data science/signal processing.

• Strong knowledge of applied mathematics and an interest in engineering applications.

• Proficiency in scientific programming tools (Python, Matlab, C/C++, etc.) and a good level of English.

Application process or link to your job posting on your website :

Application:

Contact Charles Soussen and Nicolas Gac by sending your CV, a cover letter, a letter of recommendation (at a minimum) and your academic results from recent years,

including rankings.

Email : charles.soussen@centralesupelec.fr ; nicolas.gac@universite-paris-saclay.fr

Closing date for submitting applications : Wed 01/04/2026 - 12:00

Lien vers l'offre sur le site dataia.eu :https://da-cor-dev.peppercube.org/node/1514