Type d'offre : Laboratory offer

Post date : 14.11.25

Laboratoire IBISC (Université Evry Paris-Saclay)

Internship Offer - Uncertainty-informed multimodal fusion pour la segmentation du thrombus et des lésions ischémiques en IRM

Informations générales

Contract type : Stage

Contract length : 5-6 months

Contact :

Vincent Vigneron / **Hichem Maaref** / **congej@yahoo.fr**

Starting date : Sun 01/02/2026 - 12:00

Trade : Technicien

Topic : IHM et visualisation données

Laboratoire IBISC (Université Evry Paris-Saclay) :

Research conducted at the IBISC laboratory focuses on the modeling, design, simulation, and validation of complex systems, whether living or artificial. The laboratory is organized into four teams (AROBAS, COSMO, IRA2, SIMOB), enabling two cross-disciplinary research areas to be defined: ICT & Life Sciences (computational biology, bioinformatics, personal assistance, signals and images for biomedicine) and ICT & Smart Systems (autonomous and intelligent systems, open and secure systems). IBISC not only has platforms referenced and supported by Genopole: EVR@ (Virtual and Augmented Reality Environments) and the EvryRNA bioinformatics software platform, but also various platforms related to intelligent systems: two-wheeled vehicles, drones, robots.

Détail de l'offre (poste, mission, profil) :

Partners

IBISC, South-Francilien Hospital Center (CHSF), Johns Hopkins University
Duration: 5–6 months
Period: February – August 2026
Monthly allowance: ~€670

Title of the Internship

Uncertainty-informed multimodal fusion for thrombus and ischemic lesion segmentation on MRI in acute ischemic stroke

The project leverages **SWAN/PHASE**, **DWI/ADC**, and **TOF-MRA** sequences to synthesize hypoperfusion-relevant information and improve clinical decision support [1–5].

Context

Stroke is the leading cause of acquired disability in adults and the second leading cause of death worldwide [6].
In ischemic stroke, a thrombus blocks a cerebral artery, depriving downstream tissue of oxygen.

Treatment selection (thrombectomy or thrombolysis) requires:

- precise clot localization, and
- reliable estimation of the ischemic area from hyperacute multimodal MRI [1–5].

However, signal variability, partial redundancy across modalities, and low-contrast / high-noise regions create **segmentation uncertainty**, which limits clinical accuracy [7–9].
Recent cross-modal attention approaches demonstrate high thrombus detection rates (≈0.97) but only moderate segmentation performance (Dice ≈0.65), highlighting the need to explicitly incorporate uncertainty into multimodal fusion.

Objectives of the Internship

Design and implement an **uncertainty-aware multimodal segmentation system** to improve thrombus and ischemia segmentation.

1. Uncertainty map generation

Compute voxel-wise uncertainty maps (entropy, Bayesian variance) to highlight ambiguous regions such as thrombus boundaries:
[
U_{\text{entropy}}(x) = -\sum_c p_c(x) \log p_c(x)
]
Using Bayesian deep learning tools for calibrated uncertainty [7–9].

2. Uncertainty-guided attentive fusion

Inject uncertainty maps as attention masks to:

- reinforce cross-modal fusion in high-uncertainty areas,
- leverage complementary evidence from secondary modalities.

Compatible with modern biomedical backbones such as U-Net [10].

3. Localized diffusion regularization (“focused blurring”)

Apply a Gaussian blur weighted by local uncertainty and train a diffusion model on blurred images to strengthen contextual learning around the thrombus:
[
I_{\text{blurred}}(x) = (I * G_{\sigma(x)})(x), \quad \sigma(x) \propto U(x)
]
Using recent denoising diffusion frameworks [11].

4. Backbones & estimators

- 3D U-Net
- Cross-modal attention networks
- Diffusion models
- Uncertainty estimation: MC-dropout, deep ensembles, Bayesian learning [7–9]

- Information-theoretic analysis (Mutual information & PID) [12,13]

5. Experimental comparison

Compare focused vs. global blur; evaluate Dice, sensitivity, and clinical precision, with modality-specific contributions from SWI/PHASE, DWI/ADC, and TOF-MRA [1–5].

Applications & Expected Impact

Datasets & environment

Multimodal MRI from stroke patients (SWAN/PHASE, DWI/ADC, TOF-MRA).
Experiments on CHSF, MATAR, and ISLES2022 datasets.
Environment: **PyTorch/Python, RTX 3090**, CHSF–IBISC collaboration.

Clinical utility

Improved segmentation of thrombus and ischemic regions will:

- enable more reliable estimation of penumbral “mismatch,”
- support reperfusion triage when symptom onset is uncertain,
- enhance treatment benefit prediction.

Deliverables

1. Prototype of the uncertainty-guided multimodal segmentation model
2. Quantitative analysis linking uncertainty and mutual information
3. Visual reports of clinically high-uncertainty regions

4. Draft of a manuscript targeting IEEE TMI or *Frontiers in Neuroinformatics*

Expected outcomes

- Functional prototype of the proposed model
- Statistical link between uncertainty and cross-modal information
- Visualization tools for uncertainty hotspots
- Manuscript preparation

Candidate Profile

We are seeking highly motivated candidates:

1. from mathematics, physics, computer science, or engineering programs
2. with a strong background in linear algebra, analysis, probability, statistics, machine learning, and deep learning
3. with solid programming skills (preferably Python)

Knowledge of medical imaging (especially MRI) is a plus, but not required.
Basic knowledge of optimization is also appreciated.

Practical Information

The intern will be mainly hosted at the **UFR Science & Technology** (40 rue du Pelvoux, Evry city center).
Some periods may take place at the **Corbeil Hospital**.

Monthly allowance: ~€670.

Application procedure

Send your:

- motivation letter
- CV
- academic transcripts (from BSc Year 1 onward)

to: **Vincent Vigneron** / **Hichem Maaref**

What We Offer

- Hands-on experience with cutting-edge AI techniques for medical imaging
- Work on real-world, high-impact healthcare problems
- Close mentorship from experienced researchers at IBISC
- Opportunities to co-author publications and present at conferences
- Possibility to continue into a PhD

Références

[1] E Mark Haacke, S Mittal, Z Wu, J Neelavalli, and Y-CN Cheng. Susceptibility weighted imaging (swi). Magnetic Resonance in Medicine, 52(3) :612–618, 2009.

[2] Àngel Rovira, Pilar Orellana, and José Alvarez-Sabín. The “susceptibility vessel sign” on t2-weighted mri in acute ischemic stroke. Stroke, 40(2) :554–557, 2009.*

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[4] DC Tong et al. Quantitative diffusion mri of acute ischemic stroke : Adc values predict tissue outcome. AJNR American Journal of Neuroradiology, 19(1) :104–110, 1998.

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[6] Valery L Feigin et al. Global, regional, and national burden of stroke and its risk factors, 1990–2019. The Lancet Neurology, 20(10) :795–820, 2021.

[7] Alex Kendall and Yarin Gal. What uncertainties do we need in bayesian deep learning for computer vision? In NeurIPS, 2017.

[8] Yarin Gal and Zoubin Ghahramani. Dropout as a bayesian approximation : Representing model uncertainty in deep learning. In ICML, pages 1050–1059, 2016.

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[12] Paul L Williams and Randall D Beer. Nonnegative decomposition of multivariate informa- tion. arXiv :1004.2515, 2010.

[13] Amer Makkeh, Dirk O Theis, and Raul Vicente. Broja-2pid : A robust estimator for bivariate partial information decomposition. Entropy, 23(10) :1274, 2021.

URL de l'offre : https://www.dataia.eu/sites/default/files/sujet_stage-JPC.pdf

Lien vers l'offre sur le site dataia.eu :https://da-cor-dev.peppercube.org/node/1460