Offer #2025-08858

Post-Doctoral Research Visit F/M Tiny Digital Twins: MLops, Embedded Neural Networks and Wireless Communication Compression

Contract type : Fixed-term contract

Renewable contract : Yes

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

About the research centre or Inria department

The Inria Saclay-Île-de-France Research Centre was established in 2008. It has developed as part of the Saclay site in partnership with **Paris-Saclay University** and with the **Institut Polytechnique de Paris** .

The centre has 40 **project teams** , 27 of which operate jointly with Paris-Saclay University and the Institut Polytechnique de Paris; Its activities occupy over 600 people, scientists and research and innovation support staff, including 44 different nationalities.

Context

This position is part of the postdoctoral program offered by Inria's International Relations Department. The recruited postdoc is expected to spend one part of their time at Inria (on the Paris-Saclay University campus), and another part at Freie Universität Berlin (within the Inria Berlin initiative, see https://berlin.inria.fr/), working between two teams that have a strong collaboration in the field of embedded AI (see below).

Assignment

Topics

The postdoc focuses on novel and advanced embedded AI, combining two complementary aspects. On the one hand, *efficient data communication using AI* [2,3] with neural network models that can summarize and compress data from one

or more sensors to a server. On the other hand, *TinyML and TinyMLops* [1] which focus on the implementation of AI directly on constrained microcontrollers.

TinyML aspect: The goal is to implement efficient AI model execution (TinyML) on microcontrollers, and manage AI models (MLOps: remote updates, performance monitoring – here secure TinyMLOps) on hardware such as Nordic nRF52, STM32, ESP32, or RISC-V. Networking will use IoT technologies such as BLE, 802.15.4, or LTE-M.
On top of this hardware, prototypes will be developed in conjunction with an open-source operating system written in embedded Rust (Ariel OS [4]) or embedded C (RIOT [5]).
These prototypes will be co-developed and tested with Freie Universität Berlin. This project follows up on RIOT-ML (see below [6]), also linked to concrete industrial use cases for efficient sensor-to-server communication (Digital Twins).

Communication aspect: Neural models will be used to both preprocess and compress data [2]. The objective is to maintain an up-to-date view of distant systems and objects on servers, using data from sensors (e.g., position, vibration, images, etc.). Ideally, all sensor data would be sent in real-time, but energy and network constraints prohibit this. Instead of classic compression (e.g., Lempel-Ziv, ZIP), neural networks can be used to extract and transmit “essential information,” reconstructing it server-side [3] (a concept also generalized as “semantic communications” [7]). Some open questions are how to best select, design, train such models, and for which tasks, and further, how to synchronize data between the real world and the server.

The overall goal is to propose novel solutions, to design and implement such an innovative system, that optimizes the entire chain: sensors – communication – cloud. It will combine embedded systems and AI aspects.

[1] Capogrosso, L., Cunico, F., Cheng, D.S., Fummi, F. and Cristani, M., 2024. "A machine learning-oriented survey on tiny machine learning". IEEE Access, 12, pp.23406-23426.
[2] Bernard, A., Dridi, A., Marot, M., Afifi, H., & Balakrichenan, S. (2021, September). "Embedding ML algorithms onto LPWAN sensors for compressed communications." In 2021 IEEE 32nd Annual International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC) (pp. 1539-1545). IEEE.
[3] Zhang, M., Zhang, H., Fang, Y., & Yuan, D. (2022). Learning-based data transmissions for future 6G enabled industrial IoT: A data compression perspective. IEEE Network, 36(5), 180-187.
[4] Ariel OS: https://ariel-os.org
[5] RIOT: https://riot-os.org
[6] Huang, Z., Zandberg, K., Schleiser, K., & Baccelli, E. (2025). RIOT-ML: toolkit for over-the-air secure updates and performance evaluation of TinyML models. Annals of Telecommunications, 80(3), 283-297.
[7] Chaccour, C., Saad, W., Debbah, M., Han, Z., & Poor, H. V. (2024). Less data, more knowledge: Building next generation semantic communication networks. IEEE Communications Surveys & Tutorials.

Responsibilities

The researcher will be responsible for the design and development of the conceptual parts (AI, model, protocols) and for an implementation with an application to digital twins, including both a backend and a low-power microcontroller component. This task would typically includes dataset generation and using this dataset – along with other existing ones – applied to an use case of a digital twin optimizing wireless communication between a fleet of small IoT devices (microcontrollers) and a backend system (implementing the digital twins).

Coordination/Management

The recruited person will be the main point of contact between Inria, Freie Universität Berlin, the maintainers of Ariel OS and/or RIOT, including software engineers we collaborate with at Campus Cyber, and last but not least, the involved industrial partners deploying the use case.

Main activities

Main activities :

- Interaction with experts in machine learning and secure low-power IoT networking protocols;
- Implementation and testing of software prototypes involving / running on low-power hardware;
- Dataset generation;
- Using datasets to design/train/fine-tune models deployed on microcontroller;
- Interaction with industry partners for real-world deployment;
- Experimental evaluation, and theoretical evaluation (where applicable);
- Research paper writing & publication.

Complementary activities:

- *Upstreaming of open source code (e.g. in the Ariel OS or the RIOT ecosystems);*
- *Contributions to standardization (e.g. IETF).*

Skills

Technical Skills and Level Required:

- Machine Learning (theory and practice) and MLOps;
- Embedded Rust, and/or C;
- Knowledge of low-level software optimization techniques;
- RTOS or bare-metal experience on 32-bit microcontrollers (ARM Cortex-M, RISC-V, ESP32);
- Knowledge of network protocol stacks (BLE, NB-IoT, TCP/IP, TLS, 6LoWPAN...);
- Open-source software workflows;
- Git.

Languages & Interpersonal skills :
- Good command of scientific English (written, spoken, reading);
- Working in distributed teams.

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Remuneration

Monthly gross salary : 2.788 euros

General Information

- **Theme/Domain :** Distributed programming and Software engineering Software Experimental platforms (BAP E)
- **Town/city :** Palaiseau
- **Inria Center :** Centre Inria de Saclay
- **Starting date :** 2025-10-01
- **Duration of contract :** 2 years
- **Deadline to apply :** 2025-09-30

Contacts

- **Inria Team :** TRIBE
- **Recruiter :**
  Baccelli Emmanuel / Emmanuel.Baccelli@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide

impact.

The keys to success

- Be passionate about experimental research;
- Be comfortable with community-based open source software development;
- Know how to take initiatives and lead an action in this context.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

Instruction to apply

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.