Self-supervised learning of sensor signals from a digital pen developed by Stabilo for handwriting trace reconstruction purpose

Job opportunity from Institut de Recherche en Informatique et Systèmes Aléatoires (IRISA), Rennes, France

Position	Intership
Location	IRISA lab, SHADoc team 263 avenue du Général Leclerc, 35000 Rennes (France)
Duration	6 months
Desired start date	February 1, 2026
Supervisors & Contacts	Eric Anquetil eric.anquetil@irisa.fr Yann Soullard yann.soullard@univ-rennes2.fr

Keywords

> Self-supervised learning, Deep learning, Handwriting reconstruction, Pretext task, IMU sensor signals, Trajectory reconstruction, Time series

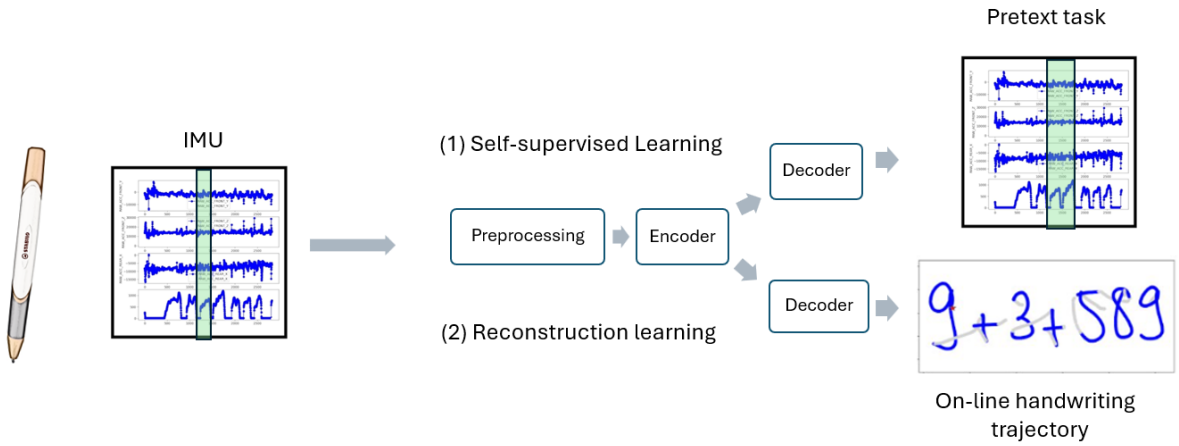
Subject

Handwriting remains a natural and ubiquitous means of interaction, yet its accurate, real-time digitization still poses significant challenges. While most of electronic styluses are marketed in conjunction with tablets, without offering compatibility between the different brands, digital pens have been developed to enable writing on paper, while keeping a digital trace. These pens integrate a camera to capture the writing trace and require the use of special dot papers.

In recent years, the company STABILO has designed a new pen, called the Digipen, with the goal to write on any surface (tablet, paper, board,...). This pen integrates IMU sensors (accelerometers, gyroscope, pressure sensor) to capture the pen's trajectory. Various research works have been conducted using this pen to study pattern recognition [Ott et al., 2020, Wehbi et al., 2020] and handwriting trace reconstruction [Imbert et al., 2025, 2024, Swaileh et al., 2023]. In our previous works, we have demonstrated very promising results for handwriting trace reconstruction, particularly through a mixture

of experts approach that distinguishes the 2D trace of the writing and the 3D trajectories related to pen-up parts [Imbert et al., 2025].

This system perform well on data on the type on which it has been trained, i.e. mainly on short texts or characters written on tablet by adults. However, it can suffer from a lack of adaptability to generalize to new contexts, children handwriting [Imbert et al., 2024], handwriting on paper or various handwriting patterns (e.g. mathematical expression, unrestricted drawing). This is notably due to the lack of supervised data with diversity that can be exploited to train the model. Indeed, having supervised examples is complex and time-consuming, as we have to 1) build an acquisition protocol, 2) design and implement the solution for data acquisition, 3) ask users to participate to the data collection. Another solution is to enable various users to use the Digipen in the everyday environment. This allow to acquire numerous data but without any supervision on what is written and it could be a solution to get numerous data with high variability.



The goal of this internship will be to explore self-supervised learning in order to take advantage of unsupervised IMU signals. In this way, we will explore a pretext task that does not require manual annotation (step 1 in the figure) and where the model acquires strong modeling capabilities for the task in question (step 2 in the figure). We will first explore the literature foundation on this topic. Self-supervised learning has been widely explored [Gui et al., 2024], especially to deal with images (DINO [Caron et al., 2021]) or texts (GPT-3 [Brown et al., 2020]) but this is also a current research topic for dealing with time series [Zhang et al., 2024, Pöppelbaum et al., 2022]. In this way, there is especially recent works combining self-supervised learning and IMU signals [Tan et al., 2024, Das et al., 2025]. In a second phase, we will investigate one of this approach and adapt it to the context of handwriting reconstruction from IMU signals. Experiments will be conducted on existing datasets (adult handwriting on tablets, on paper, and children's handwriting), considering parts of the data as unlabeled.

If it is successful, this work may lead to a scientific publication and, subject to funding, a PhD thesis can be considered as a continuation of this internship in partnership with the Stabilo company and the Karlsruhe Institute of Technology (Germany) with the goal to jointly design the next generation of the Digipen.

Références

Tom Brown, Benjamin Mann, Nick Ryder, Melanie Subbiah, Jared D Kaplan, Prafulla Dhariwal, Arvind Neelakantan, Pranav Shyam, Girish Sastry, Amanda Askell, Sandhini Agarwal, Ariel Herbert-Voss,

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Expected skills

- Expected courses : Machine Learning, Deep Learning
- Skills :
  - Python programming
  - At least one experience with a deep learning environment (PyTorch, Keras, TensorFlow)

How to apply

- CV
- Master's or engineering school grades

SHADoc team

The Shadoc team (Systems for Hybrid Analysis of DOCuments) focuses on modelling man-made data for written communication: handwriting, gesture (2D and 3D), and documents, under various aspects: analysis, recognition, composition, interpretation.
The objective is to achieve a continuum between paper and digital documents with a certain readability.
We mainly focus on the following topics:

- Intelligent recognition of handwritten content: documents, writings, gestures;
- Analysis of the semantic/structural content: document structure, stages of production of diagrams,drawings, musical scores, sketches, architectural plans;
- Design of new AI, combining recognition and analysis: offer enriched experiences for digital humanities or e-education.

The roadmap of the Shadoc team is on the frontier of several research axes: Pattern Recognition, Machine Learning, Artificial Intelligence, Human-Machine Interaction, Uses and Digital Learning.
Our research is characterized by the hybridization of several AI approaches: two-dimensional grammars,deep learning, fuzzy inference systems. . . This hybridization aims at guaranteeing, beyond performance,important aspects such as: explicability, genericity, adaptability, data frugality.
Beyond hybridization, the originality of this research is to focus on user interaction. This strategy aims at answering the limits of the current approaches which are based on non-interactive treatments. The concept is to reinforce the decision processes by relying on the implicit validations or explicit corrections of a user to avoid the propagation of errors throughout the analysis. The notions of interpretation, adaptation and incremental learning are at the heart of this research, the objective being to design efficient, robust and self-evolving system.

IRISA lab

IRISA is today one of the largest French research laboratory (more than 850 people) in the field of computer science and information technologies. Structured into seven scientific departments, the laboratory is a research center of excellence with scientific priorities such as bioinformatics, systems security, new software architectures, virtual reality, big data analysis and artificial intelligence.

Located in Rennes, Lannion and Vannes, IRISA is at the heart of a rich regional ecosystem for research and innovation and is positioned as the reference in France with an internationally recognized expertise through numerous European contracts and international scientific collaboration.
Focused on the future of computer science and necessarily internationally oriented, IRISA is at the very heart of the digital transition of society and of innovation at the service of cybersecurity, health, environment and ecology, transport, robotics, energy, culture and artificial intelligence.
IRISA is a joint-venture resulting from the collaboration between nine institutions, in alphabetical order: CentraleSupélec, CNRS, ENS Rennes, IMT Atlantique, Inria, INSA Rennes, Inserm, Université Bretagne Sud, Université de Rennes. From this collaboration is born a force that comes from women and men who give the best of themselves for fundamental and applied research, education, exchanges with other disciplines, transfer of know-how and technology, and scientific mediation.