PHD position

Intuidoc team, IRISA, France

Design of a deep neural network architecture dedicated to handwriting gesture synthesis from kinematic sensors coming from a digital pen.

Keywords

Deep learning, handwriting, synthesizing handwriting production, digital pen, signal analysis, domain adaptation

Partners

- IRISA lab (France) and Institute of Technology of Karlsruhe (KIT, Germany)
- Stabilo (Germany) and Learn&Go (France) companies

Information

- Duration : 36 months
- Place : IRISA lab, 263 avenue Général Leclerc, Rennes, Brittany, France
- Start : October 2021
- Funding: ANR (French National Agency of Research)

Context

This PhD position will take place in the IntuiDoc team (www-intuidoc.irisa.fr/en/) of the IRISA laboratory in Rennes (France). In the research team, our works are mainly focused on handwriting recognition [Corbillé 2020, Lods 2020, Soullard 2019] and document analysis [Soullard 2020, Guerry 2019]. As part of this work, we are interested in designing scalable computing engine for pattern recognition and in the ways for interacting with a stylus or gestures on touch-sensitive surfaces (tablets, touch-sensitive tables, digital pens).

This PhD position is proposed as part of **the research project KIHT** bringing together two French partners, the IRISA research laboratory and the Learn&Go company, and two German partners, the Institute of Technology of Karlsruhe (KIT) and the Stabilo company. This project aims **to extend a smart device designed for handwriting training** on tablets and used in classrooms. The goal of the KIHT project is to use a new tool, a digital pen composed of kinematic sensors, to capture handwriting gestures. Such a digital pen allows to benefit from the smart device by writing on any surface (tablet, paper, board,...). The Stabilo company works with the German institute KIT on the hardware of the digital pen and on

embedded AI algorithms. On the French side, **we will work on AI algorithms based on deep learning to synthetize on-line handwriting trajectories from kinematic sensors**. A postdoctoral position is also proposed as part of this work.

Description

The goal of this PhD position is to **design innovative and robust solutions based on deep learning to generate the on-line handwriting trajectory** (dynamics of motions with only the past) **from kinematic sensors** coming from the digital pen.

- The task is very challenging for numerous reasons: 1) kinematic sensors only extracts relative motions. This makes the synthesis task of the absolute trajectory difficult; 2) the number of kinematic sensors is of limited quantity, which limits the amount of signals used in input of the model; 3) In order to get a marketable pen for schools, low-cost sensors are used, which may provide imprecise and noisy signals; 4) Handwriting gestures provide trajectories composed of micro movements. These strokes can be rapid and not well captured. To face up to theses challenges, one way is to benefit from knowledge on handwriting into the model.

Expectations of this position:

- **Study and evaluate state-of-the-art methods.** For instance, recent works investigated syntheses of handwriting [Tang 2021, Wehbi 2020, Hsu 2019, Kumar 2018]. Experiments will be done on data given by the Stabilo company [Lai 2020, Ott 2020]. This work will be jointly done with the postdoctoral student.
- **Study recent advances in deep learning, especially on network architectures** [Nafea 2021, Shi 2020, Liu 2019] such as attention mechanisms, multi-task learning or how to benefit from knowledge to strenghten neural networks. Based on this study, you will **propose an innovative network architecture dedicated to trajectory synthesis from signals which will benefit from knowledge on handwriting.** The goal is to **tackle the challenges concerning the data** discussed above**.** The proposal will be evaluated on the model capacity in generalization and experimentations will be done on data coming from various surfaces (tablets, paper,…).
- One of the goals is to use the digital pen on any surface (tablet, paper, board,...). Thus, the trajectory syntheses must be precises and reliables on any surface. However, an unbalanced training set (according to the surface type) and handwriting gestures performed on a surface never seen in training may affect the model performance. One way to face up to this issue consists in adapting the approach to the surface. This can be done in a theoretical and application framework using domain adaptation methods [Xu 2021, Motiian 2017].

Bibliography

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Skills

- Good skills in Python
- Motivation for deep learning with an experience with at least one of the most popular deep learning libraries (Pytorch, Tensorflow, Keras).
- Knowledge and/or interest for signal analysis
- English (read, write, spoken), French is not required

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