School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Application instructions:

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:
- PROF. BERK CANBERK

Subject areas: Computer Science/ Artificial Intelligence, Network, Data Science/Internet of Things/Machine Learning, Engineering/Communications Eng, Electrical Eng, Electronic Eng

Project Title: Low-Latency AI/ML-aided Data Pipeline Architecture for Digital Twin as a Service (DTaaS)

Funding: Funded PhD project (worldwide)

Project description:
The growth of Digital Twin (DT) has been moving towards the Digital Twin as a Service (DTaaS) approach, which provides the components within DT to be developed and deployed at independent services. This enables scalability and flexibility through supporting distributed deployments across geographically dispersed and heterogeneous infrastructures.

However, this architectural shift introduces significant challenges. The modular architecture requires continuous data exchange between different microservices, which may be deployed across wide-area networks. Meanwhile, the extensive data-driven modelling and Artificial Intelligence (AI) and Machine Learning (ML) inference at DTs bring computational challenges. Here, the size, execution time, and resource consumption of models threaten the timeliness of DTs. Furthermore, as more sensitive and detailed data are being integrated, the cybersecurity attack surface expands and the challenging nature of ensuring security further increases

with the low-latency requirements of DTs. Therefore, low-latency and scalable pipelines that integrate AI/ML are needed. Considering these, this project will focus on ML- assisted data pipelines. Here, the researcher will explore and analyze the communication and computation performance of AI/ML models and their effects on the DT performance. Correspondingly, the PhD student will work on designing lightweight and secure data transfer protocols.

Perspective applicants are encouraged to contact the Supervisor before submitting their applications. Applications should specify the project you are applying for and the names of the supervisors

References:

A. Masaracchia, V. Sharma, B. Canberk, O. A. Dobre and T. Q. Duong, "Digital Twin for 6G: Taxonomy, Research Challenges, and the Road Ahead," in IEEE Open Journal of the Communications Society, vol. 3, pp. 2137-2150, 2022, doi: 10.1109/OJCOMS.2022.3219015.

C. Alcaraz and J. Lopez, "Digital Twin: A Comprehensive Survey of Security Threats," in *IEEE Communications Surveys & Tutorials*, vol. 24, no. 3, pp. 1475-1503, thirdquarter 2022, doi: 10.1109/COMST.2022.3171465.

L. V. Cakir, M. Özdem, H. Ahmadi, T. Q. Duong and B. Canberk, "Internet of Twins Approach: Digital-Twin-as-a-Platform Architecture," in *IEEE Internet Computing*, vol. 29, no. 1, pp. 65-74, Jan.-Feb. 2025, doi: 10.1109/MIC.2024.3491915.

Candidate characteristics

Education:
A first degree (at least a 2.1) ideally in Computing or Cybersecurity with a good fundamental knowledge of Python.

Essential attributes:
- Experience of fundamental Computer Science
- Competent in Algoritmic Design, Machine Learning.
- Knowledge of Data Management, and Digital Twins
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

APPLICATION CHECKLIST

- Completed application form
- CV
- 2 academic references, using the Postgraduate Educational Reference Form (download)
- Research project outline of 2 pages (list of references excluded). The outline may provide details about

- Background and motivation of the project. The motivation, explaining the importance of the project, should be supported also by relevant literature. You can also discuss the applications you expect for the project results.
- Research questions or objectives.
- Methodology: types of data to be used, approach to data collection, and data analysis methods.
- List of references.

The outline must be created solely by the applicant. Supervisors can only offer general discussions about the project idea without providing any additional support.

- Statement no longer than 1 page describing your motivations and fit with the project.
- Evidence of proficiency in English (if appropriate)

Contact:

For informal enquiries about this PhD project, please contact Prof. Berk Canberk, b.canberk@napier.ac.uk