Ph.D. scholarship on: Empowering Federated Spiking Neural Networks (SNNs) with Approximate Computing for Wearable Health Monitoring

Project Outline:

Wearable devices, integrated with IoT sensors, continuously gather physiological data such as heart rate, temperature, and activity levels from patients within healthcare systems. Also, Convolutional Neural Networks (CNNs) have emerged as a popular tool in Machine Learning (ML) for modeling, training, and analyzing this data.

The inherent efficiency of Spiking Neural Networks (SNNs) positions them as an appealing option for wearable health monitoring. SNNs operate through event-driven processing and sparse activation, resulting in lower power consumption compared to traditional CNNs. This energy-efficient approach aligns well with the constraints of wearable devices, ensuring prolonged usage and minimal impact on user experience. Another technique to reduce power consumption in SNNs for wearable health monitoring is Approximate Computing. This approach empowers resource-constrained wearable devices to achieve computational efficiency, enhancing the longevity and usability of health monitoring devices.

Federated learning forms the backbone of this research, promoting a decentralized approach to model training. By leveraging federated learning, individual devices collaboratively contribute to collective intelligence without exposing raw, sensitive health data. This privacy-preserving architecture upholds ethical considerations in healthcare applications, safeguarding user confidentiality and complying with data protection regulations.

In this research, we aim to employ a federated SNN to analyze data collected from wearable devices within healthcare systems. Approximate computing will serve as the underlying technique in SNNs. Therefore, through this project, you will conduct research on personalized health monitoring through the collaborative integration of federated Spiking Neural Networks (SNNs) and approximate computing techniques.

Supervisory Team:

Dr Mahmood Fazlali, Cybersecurity and Computing Systems Research Group, School of Physics Engineering and Computer Science

Dr Somayeh Timarchi, Cybersecurity and Computing Systems Research Group, School of Physics Engineering and Computer Science

Dr Alexios Mylonas, Cybersecurity and Computing Systems Research Group, School of Physics Engineering and Computer Science

Candidate Specifications

Essential

- Motivated MS graduate in a relevant discipline such as Computer Science or engineering, Electrical engineering, or maths.
- Knowledge of one programming language such as Python or Hardware Description Language.
- Knowledge of machine learning and deep learning.
- Ability to implement specialized innovative ideas into code.
- Ability to work collaboratively and manage time independently to meet deadlines.
- Problem-solving skills and attention to detail.
- Excellent oral and written English communication skills, including the ability to communicate with clarity on complex information.

Desirable

- A relevant master's degree will be an advantage.
- Previous experience with AI/ML software libraries (TensorFlow, Scikit-Learn, PyTorch, etc) or, experience in working with FPGA.
- Publications in reputable international journals and conferences.

Benefits and Contact Information:

Join us in redefining the future of personalized healthcare through innovative research in federated Spiking Neural Networks and approximate computing. The successful candidate will receive a competitive stipend and access to research facilities. For inquiries about the position or application process, please contact Dr. Mahmood Fazlali by email: m.fazlali@herts.ac.uk

References.

1- Y Venkatesha, Y Kim, L Tassiula " Federated learning with spiking neural networks IEEE Transactions on Signal Processing 69 (1), 2021
2- M Ghader, B Farahani, Z Rezvani, M Shahsavari, M Fazlali " Exploiting Federated Learning for EEG-based Brain-Computer Interface System" 2023 IEEE International Conference on Omni-layer Intelligent Systems (COINS), Berlin, Germany.
3- L Sayadi, S Timarchi, A Sheikh-Akbari " Two Efficient Approximate Unsigned Multipliers by Developing New Configuration for Approximate 4: 2 Compressors" IEEE Transactions on Circuits and Systems I: Regular Papers 70 (4), 1649-1659, 2023.
4- SAH Ejtahed, S Timarchi " Efficient approximate multiplier based on a new 1-gate approximate compressor" Circuits, Systems, and Signal Processing, 1-20, 2022.

5- Yuhang Li, Ruokai Yin, Youngeun Kim, and Priyadarshini Panda, “ Efficient human activity recognition with spatiotemporal spiking neural networks” in Frontiers in Neuroscience, 2023