Nervous Systems: Summer Internship Projects

We have 4 internship projects available for a 10-week period over the summer vacation in York, 10 June–13 September 2024. These will explore and implement various aspects of artificial neural networks, nervous systems, and their applications in neuromorphic (brain-inspired) hardware. Some projects are software only; some include a hardware/robotics component; all require programming ability and some embedded hardware skills. The current internship pay rate is £12.00 per hour, plus paid holiday.

Interns will focus on their individual projects, but may interact as a group, to allow for maximum co-learning. You will be co-supervised by members of the *Nervous Systems* project team: Mr Shimeng Wu, Dr Andrew Walter, Prof Andy Tyrrell, and Prof Martin Trefzer, and will also interact with our project partners from Ulster University.

Internships are open to any undergraduate who can spend the summer working in York. To apply, you should submit a CV (1-2pp) and a personal statement (~1/2 page) saying why you want this internship. You should rank the projects in order of preference, or state "any". Please send your application to martin.trefzer@york.ac.uk and andy.tyrrell@york.ac.uk, and contact us if you have any queries.

Deadline for submission is **Mon 29 April 2024**. Successful applicants notified by **Fri 3 May 2024**.

Projects

In complex living organisms, the nervous system is the part that detects environmental changes and internal anomalies that impact them, by transmitting signals between different parts of the organism. The nervous system works in tandem with the endocrine system, triggering appropriate regulatory or repair. In the Nervous Systems project we build bio-inspired models of spiking neural networks (SNNs) embedded in electronic hardware systems to equip them with an "artificial nervous system" that is capable of learning when faults occur in changing environments, enabling autonomous behaviour and fault tolerance.

Biological nervous systems are composed of a hierarchy of neural network structures. Recurring motifs form neural microcircuits with innate survival reflexes, e.g., the Crayfish tail escape reflex, which then compose larger networks with more complex behaviours all the way up to the brain capable of conscious thought and reasoning. It is these concepts that will be explored here.

1. Nervous Robot

The aim is to design a set of neural microcircuits with a range of reactive behaviours based on inputs from one or few sensors, e.g. avoid, approach, escape, that can then be combined into a larger architecture for more complex robust behaviours to emerge, e.g., obstacle avoidance with a faulty sensor.
Skills required: C/Python programming. Useful skills: neural networks, genetic algorithms, embedded HW.

2. Spiking Neural Network Breadboard

This project has outreach aspects. You will use a large-scale demonstrator of spiking neural networks, comprised of SNN modules (https://github.com/giant-axon/lu.i-neuron-pcb) that can be plugged together flexibly and a microprocessor for input/output signals, to create demos of functional small SNNs.
Skills required: C programming. Useful skills: neural networks, embedded processors, analogue circuits.

3. Radiation Hard Nervous Hardware

This project will model radiation-induced faults in embedded FPGA hardware and implement neural microcircuits that detect them, as well as developing mitigation mechanisms in hardware that can be triggered directly by the microcircuits when a fault occurs.
Skills required: VHDL, C programming. Useful skills: neural networks, embedded HW, FPGAs.

4. Neuromorphic MNIST with Microcircuits

Brains, and therefore SNNs, process event-based data. There is a new type of event-based sensors that produce events/spikes, rather than numerical values. This project will look at classification performance of SNNs and microcircuits using the N-MNIST dataset and/or an event-based camera (Prophesee).
Skills required: Python/C programming. Useful skills: neural networks, machine learning.