



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

PHD STUDENT PROJECT

Funding and application details

Funding status: Fully funded project (worldwide)

Application instructions:

Detailed instructions are available at <https://blogs.napier.ac.uk/scebe-research/available-phd-student-projects/>

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:

- DIRECTOR OF STUDY: Brian Davison (Email: B.Davison@napier.ac.uk)
- 2ND SUPERVISOR: Andreas Steyven

Subject Group: Computer science

Research Areas: Artificial Intelligence, Software Engineering, Control Systems, Robotics

Project Title: Generative navigation for autonomous robots using active inference

Project description:

Simultaneous Location And Mapping (SLAM) is a strategy that allows autonomous mobile robots to navigate their environment. Sensors on board the robot detect walls and objects and the sensor data is used to construct a representation of the physical surroundings. Early SLAM methods assumed that the environment was entirely static, but newer algorithms also take into account moving objects. Current SLAM methods represent the world in three dimensions and maintain 3D representation of objects at an appropriate resolution.

This project will build on existing work in this area with the intention of reducing the computational overheads incurred by relying mainly on image processing to track objects. Drawing inspiration from neuromorphic computing, only changes in the environment will be used to update the internal representation. Simulations based on the internal model will then be used to predict the motion of the robot and other nearby objects at speeds faster than real time. In turn, the robot's interactions with the environment will be determined by the outcome of the simulations rather than in direct response to incoming visual data.

Active inference is a framework for general brain function that was first developed by neuroscientists around 2006. It has been used successfully to model a range of natural and artificial adaptive systems. Its main mechanism is the minimisation of Bayesian surprise. In the context of autonomous robots, this is a measure of the degree to which the internal representations matches the real world. It therefore provides a means for correcting the internal model and consequently the robot's behaviour if the internal model drifts out of synchronisation with the real world.

References:

- [1] Çatal, O., Verbelen, T., Van de Maele, T., Dhoedt, B., & Safron, A. (2021). Robot navigation as hierarchical active inference. *Neural Networks*, 142, 192–204. <http://doi.org/10.1016/j.neunet.2021.05.010>
- [2] Lanillos, P., Meo, C., Pezzato, C., Meera, A. A., Baioumy, M., Ohata, W., ... Tani, J. (2021). Active Inference in Robotics and Artificial Agents: Survey and Challenges, 1–20. Retrieved from <http://arxiv.org/abs/2112.01871>
- [3] Roy, K., Jaiswal, A., & Panda, P. (2019). Towards spike-based machine intelligence with neuromorphic computing. *Nature*, 575(7784), 607–617. <http://doi.org/10.1038/s41586-019-1677-2>

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in Computer science

Subject knowledge:

- Software engineering
- Robotics

Essential attributes:

- Experience of fundamental principles of software engineering
- Competent in software project management and Linux systems
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:

- Previous experience with ROS or other relevant technologies