Department	School of Computing
Supervisors	Brian Davison, Andreas Steyven
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

Prospective applicants are encouraged to contact the Supervisor before submitting their applications. Applications should make it clear the project you are applying for and the name of the supervisor(s).

Academic qualifications

A first degree (at least a 2.1) ideally in computer science with a good fundamental knowledge of software development techniques.

English language requirement

IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

Essential attributes:

- Experience of fundamental abstract problem modelling and AI
- Competent in software development
- Knowledge of mathematics
- 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 working with robot hardware or microprocessor systems will be a major benefit.

Indicative Bibliography	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 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 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
Enquiries	For informal enquiries about this PhD project, please contact Dr Brian Davison (b.davison@napier.ac.uk)
Web page	https://www.napier.ac.uk/research-and-innovation/research-degrees/application-process