2016 YCCSA SUMMER SCHOLARSHIP PROJECT SUBMISSION

This form is for prospective project supervisors to submit their projects to be included in the YCCSA Summer Scholarships Programme for 2016.

It is the purpose of the Summer School that any projects submitted are interdisciplinary in nature.

Date	*2nd February 2016*
Supervisors' Names and Departments	*Dr Martin A Trefzer* *Electronics* *https://www.elec.york.ac.uk/staff/mt540.html* *Dr Bryce Beukers-Stewart* *Environment* *https://www.york.ac.uk/environment/our-staff/bryce-beukers-stewart/*
Project Title	*PEBBLES: Part-of-the-Environment Bio-inspired Blocks for Large-scale Effective Sensing*
Project Description	*Large-scale, distributed sensor networks are the projected weapon of choice for future pervasive computing applications such as, for example, environment monitoring, surveillance, (big) data mining and patient monitoring. However, there are a number of issues with technology that are currently overlooked: sensor networks, IoT and related Big Data technologies will not scale in an affordable, secure and low-cost manner beyond defined entities such as, for instance, a car, a house or a person. In scenarios where large numbers of expensive specialist sensors are required, possibly distributed over large geographic areas, these technologies will be unable to make critical real-time decisions. There is no power budget or feasible network infrastructure to transmit large amounts of sensor readings to a base station or a cloud-connected data centre, and it is also not possible to use radio over reasonable distance underwater. Gathering and transmitting raw data, even encrypted, poses a security risk and performing offline data fusion and analysis makes real-time alerts and decisions infeasible.* *The PEBBLES project follows a radically different approach to building and using sensor networks that draws inspiration from nature. Biological organisms are known to self-construct, self-organise and self-heal. They sense, process information and react to their environment using networks of biochemical information processing that occur within and between biological cells. Reflecting this, within PEBBLES sensor networks are perceived as spatially distributed multi-cellular organisms where each node represents a cell. Models of biochemical organisation and homeostasis incorporated within each sensor node then provide mechanisms for achieving collective emergent properties within the sensor network as a whole. The network is interfaced by formulating "questions" in the form of defining simple decision strategies local to each node that autonomously evolve into a model of how to interpret sensor input and environment spanning the entire network, and the "answers" can be directly obtained in real-time by observing the states of key network nodes. In these respects, the technology proposed here will be the anti-hero of the IoT and Big Data pipeline, while at the same time being compatible with both in that it can be*

	interfaced and linked to IoT devices, if desired. The proposed technology will fill technological gaps that IoT and Big Data in their current form can not achieve where the sensor network itself computes, analyses and reports without the need to gather, store and post-process huge amounts of data. *The aim of the project is to implement a simplified model of cellular processes and signalling on a small sensor network based on Arduino and ZigBee in order to investigate how the aforementioned biological metaphors can be usefully ported to a distributed hardware system. Sensor nodes will be enclosed in a waterproof enclosure to perform underwater sensing experiments in an aquarium. In real-life the "pebbles" would become a benign part of the eco-system after they expire—just another rock in the sea!*
Required Skills	*The project would generally suit a student with any science and/or engineering background with a keen interest in interdisciplinary work between environment, biology and computing/engineering. However, basic knowledge of how microprocessors and sensors work as well as good programming skills in C/C++ would be desirable.*
Project Dates	*The project would run for 9 weeks, starting on Monday, 11 July 2016 and finishing on Friday, 9 September 2016.*
Other Information	*Most of the work in this area has been previously applied to computational benchmark problems and robotics. Targeting sensor networks therefore brings in a degree of novelty.*
References	*Homeostatic control for a mobile robot: Dynamic replanning in hazardous environments. Arkin, R. C. (1992). Journal of Robotic Systems, 9(2), 197–214.* *An Investigation of the Importance of Mechanisms and Parameters in a Multi-cellular Developmental System.* *Tüze Kuyucu, Martin A. Trefzer, Julian F. Miller and Andy M. Tyrrell. IEEE Transactions on Evolutionary Computation, Vol. 15, No. 3 pp 313-345, June 2011.* *Evolution and Analysis of a Robot Controller Based on a Gene Regulatory Network. Martin A. Trefzer, Tüze Kuyucu, Julian F. Miller and Andy M. Tyrrell. Proceedings of the International Conference on Evolvable Systems (ICES 2010), York, United Kingdom, 6-8 September 2010.*

When complete, please email the form to sarah.christmas@york.ac.uk