

Development of a miniature vibration energy harvester for battery-less tracking of honey bees

Applications are invited for a three-year research PhD studentship in microsystems and microwave technology at the *Schools of Electronic Engineering*, and *Environment, Natural Resources & Geography*, Bangor University, UK. The studentship is funded by the Knowledge Economy Skills Scholarships (KESs) (<http://www.higherskillswales.co.uk/kess/>) in collaboration with the commercial partner The Apiary Enterprise Limited, and an international research Institution, FBK (<http://cmm.fbk.eu>). It will cover tuition fees and an annual tax-free stipend at the standard RCUK rate (around £14,000 per year), as well as a travel budget for training at FBK and conference attendance. The studentship is available from 25th January 2016 or as soon as possible thereafter.

Applicants should hold a first or upper second-class honours degree (or equivalent) in microelectronics, or microwave engineering, or a related degree. Please submit a CV (max 2 pages) together with a covering letter to Dr Cristiano Palego at c.palego@bangor.ac.uk and Dr. Paul Cross at Paul.Cross@bangor.ac.uk by 17:00 on 11th December 2015.

Detailed project outline:

The recent global decline in honey bee colonies has ignited efforts to better understand the spatial interaction of bees with their environment. To date no available technology exists to effectively enable the long-term evaluation of navigation loss of bees exposed to potentially harmful pesticides such as neonicotinoids. This is because the monitoring of bee movements requires effective radio-tracking in the field which is currently constrained by transmitter size, battery life and a transmitter weight (>200 mg) which is heavier than a honey bee (~90 mg).

This research will develop the first self-sustained radio-tracking device that can be attached to the world's most economically beneficial insect: the honey bee. A micro-generator that harvests electrical energy from the bee's body vibration will power radio-wave transmission from a miniaturized antenna attached to the bees' thorax. This will eliminate the need for bulky battery-powered transmitters and provide an unlimited energy source over the insect's lifetime with negligible hindrance to its flight capacity. The transmitted signal will be captured by an array of much larger and collapsible receiving dish-antennae that can be attached to movable supports, such as 4X4 vehicles, for effective tracking of bees in diverse landscapes. The objectives of this studentship are therefore to:

- Design and optimize 1) the micro-scale harvester whose fabrication will be undertaken under FBK personnel's training/guidance, 2) the transmitting antenna with integrated circuitry for power storage and regulation, and 3) the receiving foldable antenna-array.
- Test the achievable generation, transmission and detection capacity in a lab environment with different transmitter units and receiver antennae size/spacing to demonstrate single bee resolution and multiple bee simultaneous tracking capacity.
- Test the system capability for detecting bee movements in the broader landscape by gluing the microtransmitter units to bees that are released and monitored in the University research farm with properly positioned receiving antennae.

Background to the schools:

The School of Electronic Engineering achieved the UK's fourth highest score for Electronic Engineering research output in the 2014 Research Excellence Framework, acknowledging its world leading research activities in the areas of photonics, organic/green electronics and microwave medical devices. The School of Environment, Natural Resources & Geography is internationally renowned for its cross-disciplinary research on sustainable land use, and has a broad expertise in the fields of agriculture and environmental sciences. The project will build on a number of relevant existing and forthcoming projects at Bangor on self-sustainable insect telemetry and wireless sensor networks. We have state-of-the art facilities for field-based training and experiments (e.g. apiaries, detailed habitat mapping data resources, electrical characterization). Additionally, we routinely sponsor research exchanges with the Massachusetts Institute of Technology (USA) in concurrent and related programmes.

Knowledge Economy Skills Scholarships (KESS) is a pan-Wales higher level skills initiative led by Bangor University on behalf of the HE sector in Wales. It is part funded by the Welsh Government's European Social Fund (ESF) convergence programme for West Wales and the Valleys.