Section Sciences et Ingénierie de l'environnement
Design Project 2014 (semestre de printemps)

Proposition n° 32

Low-Power Strategies for Accurate Outdoor Temperature Measurements

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Descriptif du projet

Sensorscope Sarl, an EPFL-based startup that employs wireless sensor networks (WSNs) for environmental monitoring applications, has recently expanded into the agricultural market. Thanks to a strategic partnership with a leading company in the area of biological control measures for plant protection (Andermatt Biocontrol AG), innovative wireless technology can be combined with biologically-based solutions for pest monitoring and control. Pest attacks are responsible for a significant decrease in crop productivity, in severe cases causing billions of dollars in harvest losses worldwide. We are interested in extending sensor network technology to monitor and ultimately predict the movement of insect pests at local level. Currently we are studying the use of insect traps monitored by cameras to sense the presence of the codling moth. However, such a sensor may consume a great amount of power, and its use may be limited by other factors as well, e.g., the trap itself may degrade after being exposed to air for a long period of time. This project begins a study in how information from traditional environmental sensors, specifically anemometry, temperature, and humidity already deployable in high spatial density through standard wireless Sensorscope technology, may be used to make selective use of these "smart traps" by predicting the presence and motion of an insect swarm.

Codling moth's eclosion in Switzerland is predicted at the federal level using an operational modeling tool called SOPRA (http://www.sopra.info/), developed by Agroscope, a network of federal research stations for agriculture. The Swiss agriculture industry relies heavily on these predictions in order to precisely mitigate pest attacks. These models use environmental data from MeteoSwiss stations sparsely deployed throughout the country.

Objectif

SOPRA, and other such models, primarily make their predictions based on ambient temperature measurements. Due to heating effects from solar radiation, sensors must be actively ventilated in order to take accurate samples. Actively ventilated sensors are quite expensive and power hungry. In the interest of making wide-scale sensing feasible and maximize energetic autonomy of the wireless stations, we would like to investigate two possible strategies. The first strategy leverages uniquely passive sensors (temperature and incident solar radiation) for this purpose. The students will compare measurements from an actively ventilated sensor with those obtained by multiple passive sensing nodes and derive a calibration law applicable under a variety of weather conditions. The second strategy should instead derive a power-aware algorithm able to minimize the use of active ventilation for maintaining the measurement error below a certain bound. Both strategies should be validated and compared using real data acquired with available wireless stations. If time allows, students may interface with those from another design project working on the modeling aspect, in order to investigate the increase in pest prediction accuracy brought by their best low-power temperature measurement approach.

Descriptif tâches

The project tasks can be summarized as follows:

- understand literature regarding effects of solar radiation on temperature sensing
- perform deployments under different weather conditions
- investigate calibration strategies for the passive sensors
- investigate power-aware algorithms for controlling the active ventilation
- if time allows, investigate pest prediction accuracy using either calibrated passive sensors or power-aware active ventilation

Divers

Work breakdown: 50% theory, 50% programming
Prerequisites: Matlab
Keywords: sensor calibration, environmental sensing, solar radiation, power-aware algorithms
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