Research Proposal

Title: Monitoring multiple environment variables to improve robustness of data gathering in wireless sensor networks.

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Background

A current practice for logging of environmental data across a landscape uses logging devices that have a static sample rate and hence cannot react to changes in the field. With a static sampling schedule battery resources may be wasted when needlessly sampling during periods of low variation while events generating rapid change may not be tracked adequately, or possibly missed entirely.

In [2] a protocol is described which allows for motes to increase their sampling in response to events such as rain, or to reduce sampling to conserve resources during periods of little change. In [3] the problem of using a base station to detect rainfall events and broadcast a signal setting the motes into a higher sampling rate is noted. Dynamic setting of sensor behaviour in reaction to environmental changes is described in [1], using sparsely sampled data at static sensors to facilitate more frequent spatial sampling and rapid reaction by mobile sensors. Use of correlations between sensed environmental variables at spatially distributed sensor nodes is discussed in [5]

Aim

The purpose of this project is to add the capability of monitoring multiple environmental variables by attaching more sensors to sensor motes. It will be established whether it is feasible for locally sensed data to be used by the motes to change their sampling rates. The detection of events, such as rainfall, by neighbouring nodes may also be used to trigger changes in the behaviour of the mote.

The problems to be addressed can be summarised as follows:

1. Is there a useful relationship between rain, soil moisture, and soil temperature? Can the observation of a significant event in a subset of the variables predict when changes of interest in other variables is likely to occur?

2. Can a subset of monitored variables be used to improve response to environmental change? Is it possible to use sensor data to modify the sampling behaviour of the mote to ensure that the sensor readings accurately follow the environmental changes?

3. Can additional monitored sensors be used to improve the robustness of the system? Is it possible to use the sensed data to reduce recording and transmission of false sensor readings under extreme conditions?

4. Can additional sensors be used to improve network lifetime? Is it possible to reduce costly network functions such as sensor reading and network data traffic by utilising correlations between sensor readings on and between motes? Can correlations between environmental variables be used to reduce redundancy in network data traffic?

Method

1. Modify code. Integrate multiple sensor capability into existing sensor node code. Motes to to be capable of sensing and logging soil moisture, rain and soil temperature. Written in nesC and TinyOS.
   Completion: mid April

2. Trial environment logging. Run a trial with two motes and a data logger providing ground truth. The field trials must be timed to coincide with season likely to produce variations in weather that will exercise the system's capabilities.
   Completion: mid May

3. Analyse data. Determine correlations between sensed data and investigate associated noise. Establish whether redundancy in sensed data be used to detect false readings due to mote errors and sensor limitations.
   Completion: June

4. Address issues raised in project aims and test modified code.
   Completion: August

Software and Hardware Requirements

- Hardware: (Already purchased, provided by Water Corporation and a UWA Small Grant).
  - Two MICA2 (with MDA300 sensor boards) or CSIRO Fleck motes
  - Two rain gauges
  - Two soil moisture probes
  - Four soil temperature probes.

  - ECH_2O Em5 Logger with rain gauge, soil moisture probe, and soil temperature probe.

- Software: TinyOS and nesC. TOSSIM simulator [7]. Required software is Open Source but developed software may have restrictions on further disclosure, depending on the mote platform.

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