Program Specialization for Wireless Sensor Networks

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Wireless sensor networks are composed of distributed sensors nodes, called motes, that have unique hardware constraints. These limited resources consist of power, memory and speed. Typical applications include the SWE project by the University of Vermont to measure the snow water equivalent on Mt. Mansfield; and the Boeing Company who measures strain on the pitch-link of the helicopter with wireless sensors that are powered by the vibration of the rotors.

We propose to increase the efficiency of wireless sensor networks in three different ways: first to enhance the ease of programming with an improved programming abstraction, second to reduce the overall code footprint, and third to allow for better memory utilization. We began by incorporating staging, the idea of executing code at different stages in time. For example, we can manipulate data at a stage where resources are plentiful (e.g. on a laptop) and pass this pre-computed data to a later stage (e.g. mote deployment), thereby preserving the resources of the constrained mote. Finally, we created a new programming language, theoretically proven to reduce overall code footprint using abstraction. In combination with staging, our system applies generic programming to allow motes to adapt their code in-situ. The programming language is in the process of being tested empirically on wireless sensor networks using a functional programming language called OCaml. This combination of staging and abstraction will improve program efficiency when designing a system that has constrained resources.