Identification and Authentication issues

Context-based simulator for sensor networks in domestic environments

Markus Huebscher

Imperial College London
mch1@doc.ic.ac.uk

Topic: Context awareness models and analysis

1 Project description

More and more projects are working on building context-aware applications that monitor the home and improve the lifestyle, health or security of its inhabitants. However, developing these applications usually requires setting up mock up rooms in laboratories and installing (often expensive) sensor hardware. Usually, we do not have the luxury to build an entire home as a laboratory (as [3] did), and quite often there is a lack of funds and space for smaller projects.

As a result, the goal of this project is to attempt to design and build a simulation framework for context-aware applications. For the sake of reducing complexity, we will limit ourselves to looking at domestic environments, although the framework should allow the possibility of extending these ideas to the office environment.

This simulator is targeted at developers who want to build a context-aware application, and require sensor data for testing during development but do not have the means of building a mock up home for acquiring the sensor data.

Thus, the user must be able to define home topologies on a 2D map and place sensors on it. Furthermore, unlike traditional simulators, the user should be able to describe high-level activities of the inhabitants, instead of having to specify how individual badges and devices move across the room.

The proposed model includes two distinct types of descriptions. One document describes the activities of the inhabitants at a high level, e.g. "get out of bed, get dressed, have breakfast, brush teeth, go out of home". This document completely abstracts from the actual topology of a home. The other document describes the 2D map of a home and how its layout maps to the high level activities of the former document. Based on ideas from [1], we choose to define "hotspots" in the 2D map where activities can take place. So, for example, going to bed is associated with the "bed" hotspot in the bedroom, brushing ones teeth with the "wash basin" hotspot int the bath room and so forth. As a result, it is possible to apply a document describing people's activities to different home topologies, potentially obtaining substantially different results.

For the production of sensor data, we plan to support as a proof-of-concept the Berkeley motes [2] and RFID-tag readers. However, it would be desirable to introduce a hardware abstraction layer to allow easy extensions for other sensor types. That possibility will therefore be investigated.

In particular, the Berkeley motes run an operating system called TinyOS. The researchers at Berkeley have developed a simulator for TinyOS, called TOSSIM, which allows users to compile and run TinyOS code on a PC to simulate a number of motes interacting. Applications can then connect to TOSSIM just as they would connect to a network of motes. Because TOSSIM simulates mote communication at bit-level, it is very useful for testing ad-hoc routing algorithms or data aggregation algorithms. However, it is too low-level to easily test context-aware applications, which are less interested in the inner workings of the motes and more interested in the actions that cause sensor data to change. Fortunately, TOSSIM comes with a command port that allows a running simulation to be "steered". Our simulator could therefore connect to this command port and continuously instruct TOSSIM on what data the sensors on the motes should provide (by default, TOSSIM just generates random values and is completely ignorant of the different types of sensors on the different sensor ports).

Here, the major difficulty that arises is how to map high-level activities to sensor data. This part will probably take most of the time of the project. Although the goal of the project is to design a framework for "plugging in" different types of sensors, we intend to implement some simple sensors for proof-of-concept. At the moment, we envisage implementing passive proximity IR-sensors and pressure sensors (in beds, chairs and other locations) on the motes and RFID-tags.

2 Conclusions

As the described project is being proposed for a PhD thesis, there is potentially far more work involved that can possibly be hoped to achieve within the 3-years span of a PhD. Thus, the project's main focus is the design of an extensible context-based simulation framework that allows users to describe simulations as a high-level description of people's activities plus a description of the topology of a home. While the project will be limited to implementing a few simple sensors that run on Tiny OS and RFID-tags, the framework should be extensible to allow different types of sensors to be plugged in.

References

[1] Andy Crabtree, Terry Hemmings, and Tom Rodden. Pattern-based support for interactive design in domestic settings. In *Proceedings of the conference on Designing interactive systems*, pages 265–276. ACM Press, 2002.

[2] Deborah Estrin, David Culler, Kris Pister, and Gaurav Sukhatme. Connecting the physical world with pervasive networks. *Pervasive Computing, IEEE*, 1(1):59—69, January-March 2002.

[3] Cory D. Kidd, Robert Orr, Gregory D. Abowd, Christopher G. Atkeson, Irfan A. Essa, Blair MacIntyre, Elizabeth D. Mynatt, Thad Starner, and Wendy Newstetter. The aware home: A living laboratory for ubiquitous computing research. In *Cooperative Buildings*, pages 191–198, 1999.