Demo Abstract:
A Spreadsheet Toolkit for Streaming Sensor Data

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Categories and Subject Descriptors

H.4.1 [**Office Automation**]: Spreadsheets

General Terms

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Keywords

Networked sensors, Excel, SQL server, data streams analysis and visualization

We demonstrate an Excel interface that enables novice users to access and process networked sensor data in real time as well as to retrieve archived data for analysis and visualization. The spreadsheet provides application users an intuitive and familiar interface for sensor network programming and user-interaction.

This approach builds upon a multi-tier system architecture (Figure 1), which consists of sensor motes, field access points (such as T-mote Connect), gateway servers, and back-end database. By tasking the sensor motes and the gateway server, Excel can obtain streaming sensor data from selected sensors. These data are converted into easy to use XML format by the gateway node. Using built-in XML support in Excel, users can map the data to desired locations in the spreadsheet. The users then have full data processing and visualization capabilities provided by Excel. At the same time, raw and processed data can be stored into a SQL server for archiving. Through Excel, users can send queries in SDL to retrieve data from the database for later analysis.
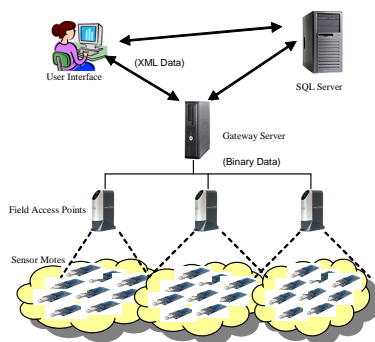

Figure 1: A multi-tier architecture for sensor data collection and analysis.
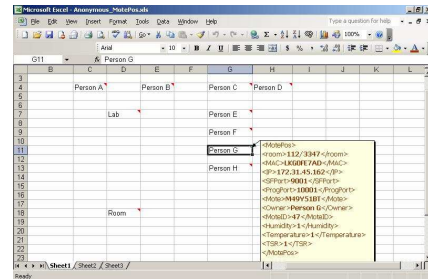
Figure 2: Selecting sensors to gather data from.

Figure 3: Streams of data displayed in Excel spreadsheet.

The system extensively uses XML as data representation format. Figure 2 shows an interface for selecting a subset of sensors among the motes. Each sensor configuration is stored as a XML document that contains node ID, sensor configuration, and network address. We extended Excel program to convert these selections into task graphs for the gateway server. The gateway server has a component-based runtime system that supports dynamic configuration of software services. In this particular example, the set of services create filters for wireless sensor packets, convert binary TinyOS packets into XML data format, and send them to Excel.

Using Excel's XML mapping feature, users can load corresponding XML schema and layout data in the spreadsheet. For example, a stream of data from a sensor can be put into a column, which is dynamically updated to display the latest packets, as shown in Figure 3. As sensor data stream in in real time, any Excel functions or charts based on these data are dynamically refreshed to reflect the latest state. As an example, the temperature data in Celsius in the 3rd column is computed from the raw sensor readings of the 2nd column using a sensor manufacturer provided conversion coded as a simple Excel function. History data are also archived in SQL server as a XML database for later retrieval.