Monitoring a Mote Security Deployment with MOTE-VIEW

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ABSTRACT

Wireless sensor network technology shows great promise for providing novel solutions to the security applications industry. By distributing clusters of small, intelligent intrusion detection mote hardware, a large area can be reliably monitored for trespassers at a reasonable cost. Such a system does not require wiring, can be quickly deployed in a rugged environment, and provides a diligent and automated watch guard against intruders.

We will demonstrate an end-to-end deployment of a novel wireless sensor network platform designed to detect motion and sound for security applications called the MSP410. The demonstration also highlights a software package for managing, monitoring, and visualizing sensor network deployments called MOTE-VIEW [1]. The software is designed to be a comprehensive, user-friendly solution that empowers wireless sensor network users with vivid data visualization and network health monitoring.

TOPICS COVERED

Security, Network Sensing and Control,
Detection, Classification, Estimation, Tracking

1. DETECTION HARDWARE

The MSP410 mote platform is designed specifically to detect and classify moving objects within its sensitivity domain. The MSP410 is an enhanced version of the XSM intrusion detection mote [2]; it is equipped with a magneto-meter, an acoustic sensor, and four passive infrared (PIR) motion detectors. In addition, the MSP410 is populated with quadrant detection circuitry for discerning which combination of the four PIRs triggered a detection event, and noise reduction hardware to minimize false detections from the magnetometer.

Sensor	Power [3]	Detection Range
Passive Infrared	1 mW	30 ft. (Human)
		100 ft. (Vehicle)
Magnetometer	20 mW	30 ft. (Vehicle)
Microphone	1 mW	100 ft. (Loud clap)

Table 1: Range and power characteristics of MSP410 sensors

The MSP410 hardware supports a low power sentry mode during which only the PIR and acoustic sensors remain on, monitoring motion and noise respectively. Both sensors have an adjustable threshold, which, if surpassed, will trigger a wake-up circuit on the MSP410 to power on the rest of the board. In full power mode, the magnetometer can further characterize whether the detected object is a particular type of vehicle by signal processing its magnetic signature. Furthermore, the onboard 433 MHz radio can then transmit information regarding the intrusion event over the network.
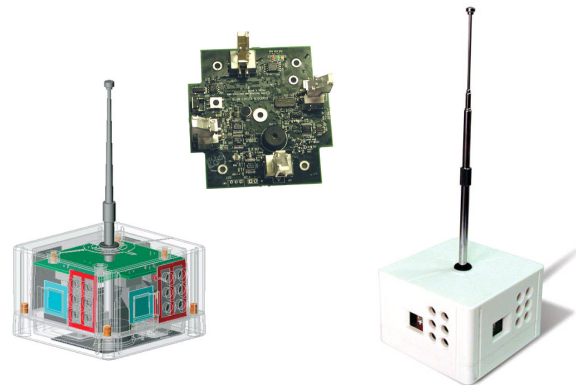
Mote Security Package: MSP410

Figure 1: MSP410 Sensor Board and Package

The MSP410 is enclosed by a 3.5" x 3.5" x 2.4" box made of molded plastic. The bottom of the package is detachable for battery replacement, and a retractable antenna stems from the top. The holes for the acoustic circuitry are protected with a moisture resistant windscreen, and the PIR windows are covered with a solid film that is transparent to infrared.

2. VISUALIZATION SOFTWARE

MOTE-VIEW has many general purpose features for visualizing sensor data, including a data grid, charts, a topological display with mesh network paths and an isobar gradient map of sensor readings [4]. In addition, it has specific plug-in enhancements for visualizing the PIR quadrant events of the MSP410, and for aggregating the PIR triggers across multiple nodes in the network to eliminate

false detections. A unique time bar interface allows for review of historical data on the topology screen, and playback of sensor events. The playback controls allow the user to generate an animated movie of the history of occupancy within a monitored space and examine "hot spots" caused by magnetometer and acoustic events in the isobar display.
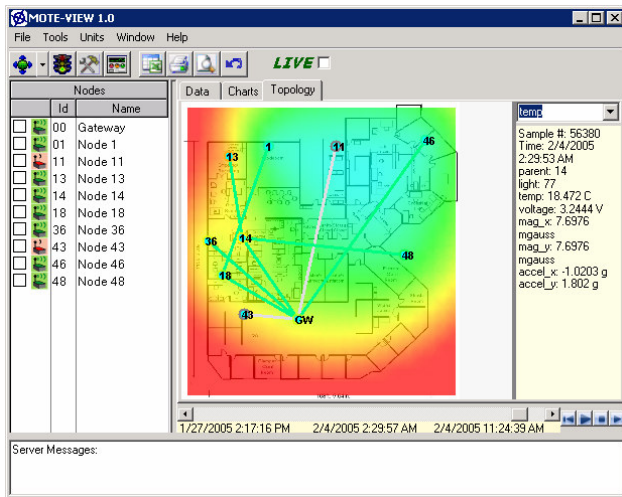

Figure 2: MOTE-VIEW topology display with IsoBar

MOTE-VIEW has an extensible plug-in architecture that allows it to easily be modified for vertical market opportunities or custom projects. Visualizing a deployment of MSP410 intrusion detection motes involves unique requirements such as displaying which combination of the four PIRs triggered a detection event. The topology view of MOTE-VIEW was extended to display the actual quadrants that fire in real-time. Also, because thermal air currents tend to trigger false detections on the PIRs, a simple aggregation algorithm was added to validate detection events only when a corresponding event is seen by at least one neighbor node within a short time window. False positives are depicted as hollowed-out wedges, whereas a validated event is drawn as a solid orange wedge pointed in the direction of each quadrant that fired. All of these modifications are part of an MSP410 specific topology visualization plug-in.

This extended topology view, customized for a network of MSP410 motes, is then used to monitor the real-time movements of humans and vehicles through a simulated hazardous area. MOTE-VIEW is running on a tablet PC and provides updated views of the state of the network every second. The correlation between the display and the real-life events is impressive. A car driving through the area lights up the display in a way that corresponds visibly with its actual path.
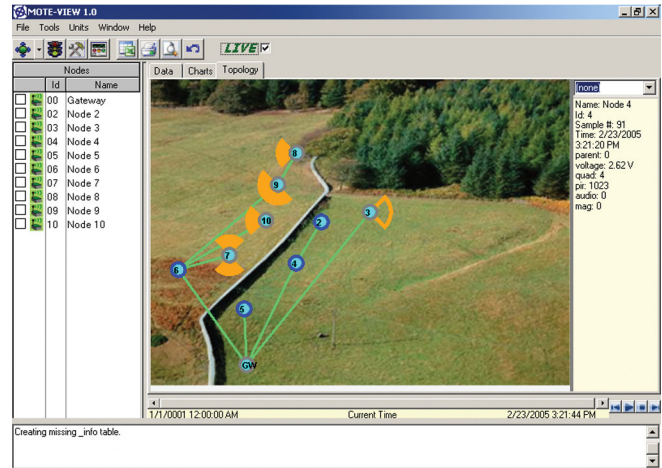

Figure 3: MOTE-VIEW tracking intrusions on a pipeline

3. DEPLOYMENT OVERVIEW

The MSP410 Security Solution enables different security applications such as remote border security, perimeter protection, intrusion detection and identification, and occupancy monitoring. A central focus of the MSP410 is for it to be simple to deploy. In a matter of minutes, a mobile or temporary electronic fence can be installed. For permanent installations, a mounting bracket is provided for screw-down mounting of the security motes. Typical deployment patterns are linear or arranged in grids and can cover acres of area or miles of perimeter depending on the number of MSP410 motes used. Detection data from multiple MSP410 motes are communicated and aggregated across the self-forming and self-healing wireless mesh network to generate tracking data. With MOTE-VIEW and a set of MSP410 motes, a rich set of security solutions can be designed and deployed quickly and easily.

4. REFERENCES

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