Creating A Hospital-Wide Patient Safety Net: Design and Deployment of ZigBee Vital Sign Sensors

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Abstract
Advancements in wireless technologies can enable patient monitors to be far more versatile than ones that are used today. We developed wireless vital sign sensors that operate on a robust, infrastructure-independent, and instantaneously deployable wireless communication network. These sensors were easily and rapidly deployed in a diverse variety of care settings to provide continuous patient monitoring.

Introduction
With a growing number of hospital visits and fewer hospital beds and nursing staff to accommodate the patients, it is no surprise that hospitals are overcrowded, more patients are being left unmonitored, and fatalities due to the lack of monitoring are occurring [1]. Healthcare requires a major shift toward more workflow-efficient and cost-effective solutions for monitoring patients [2].

Wireless vital sign sensor networks have the potential to automate the time-consuming task of manually conducting vital sign assessments. We developed the eTag, a wireless physiological monitor that collects the patient’s pulse oximetry, temperature and EKG, and transmits this data over a ZigBee-compliant wireless mesh network. Vital signs and trend alerts, i.e. early warning scores (EWS), are accessible in real-time to authenticated users through Internet browsers as well as cellular phones and pagers. In addition, the real-time sensor data is shared with any number of external medical IT systems via secure standards-based interfaces (e.g. SOAP, HL7).

Methodology
The eTag extends upon smart dust or “mote” technologies. The mote was originally developed at the University of California Berkeley in the late 1990’s through a DARPA funded effort to create tiny, low-power, wireless sensor networks for surveillance during military operations. Applying the concept of motes to the medical domain, we developed vital sign monitors that self-organize into mesh networks that can support a high density of nodes, thus providing a robust solution for rapidly outfitting wireless vital sign monitoring for an entire hospital of patients.

The system was demonstrated at a Montgomery County Homeland Security mass casualty drill to increase the patient care capacity of medical providers at the scene of the disaster, after only 10 minutes of personnel training. It was also deployed at the Washington Hospital Center Burn ICU and SDU to continuously monitor admitted burn patients for a week; the system was operational in the hospital after only 1 hour of network setup.

Conclusion
The eTag system demonstrated increased ability to collect and share real-time patient vital sign data within diverse types of patient care settings. Initial results indicate a promising new approach for creating a cost-effective patient safety net through the use of ad-hoc mesh networked vital sign sensors. Wide adoption of eTags holds potential for dramatic improvements in the quality of patient care – leading to a predictive, continuous healthcare delivery model that is vastly different from the reactive, episodic delivery model employed today.

References

Figure 1: From left to right: (a) eTags mesh network in auxiliary care center (b) eTags mesh network on disaster scene