Introduction: Advances in embedded systems have led to the development of small, low-power sensor nodes (often called “motes” or “smart dust”) that consist of a simple microcontroller, a small amount of memory, a low-power radio, and various sensors that are capable of collecting, processing, and transmitting sensor data over distances of 100m or more.

Materials and Methods: The MICA mote platform (Figure 1) was developed at UC Berkeley in collaboration with Intel Research. It includes an 8-bit Atmel ATMEGA 128L microcontroller, 132K of memory, a 512K nonvolatile flash memory, and a 40 Kbps radio operating at 433 MHz or 916 MHz. The node is powered by 2 standard AA batteries. The SPEC platform[1] (Figure 2) is a next-generation mote that incorporates the functionality of the MICA on a single 5 mm^2 chip.

Fig. 1 MICA sensor node

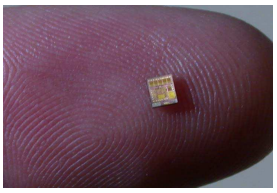

Fig. 2 SPEC node prototype

Results: We have developed a wireless, pulse oximetry sensor based on a commercial pulse oximetry module from BCI, Inc. (Figure 3). The device consists of a standard finger or ear sensor, a pulse oximetry module (BCI Micro Power Oximeter board) and a mote. The pulse oximetry module has a serial interface that relays SpO_2, pulse, and plethysmogram waveform data to the MICA node using a secure protocol. The device consumes approximately 18mA while processing and transmitting data.

1. Hill J. *System Architecture for Wireless Sensor Networks*. PhD thesis, UC Berkeley, May 2003.

Resuscitation Monitoring with a Wireless Sensor Network

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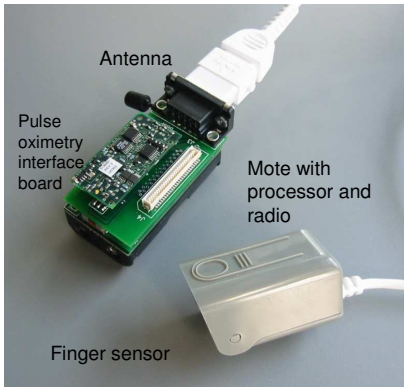


Fig. 3 VitalDust

The MICA mote transmits encrypted vital sign data along with a timestamp and unique node identifier to a receiving mote, which is connected to a PDA or PC for display. The encryption process is based on TinySec,[2] which uses the Skipjack[3] symmetric encryption algorithm. The radio communication protocol used by the MICA is capable of transmitting up to 64 packets/sec.

The receiving mote can be connected directly to a handheld device and displayed alongside other motes in the network or connected to a PC (Figure 4). When connected to a central PC, the sensor data can be transmitted via 802.11/WiFi over a longer distance and to devices not equipped with a receiving mote.

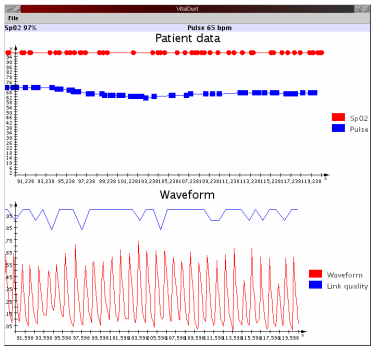


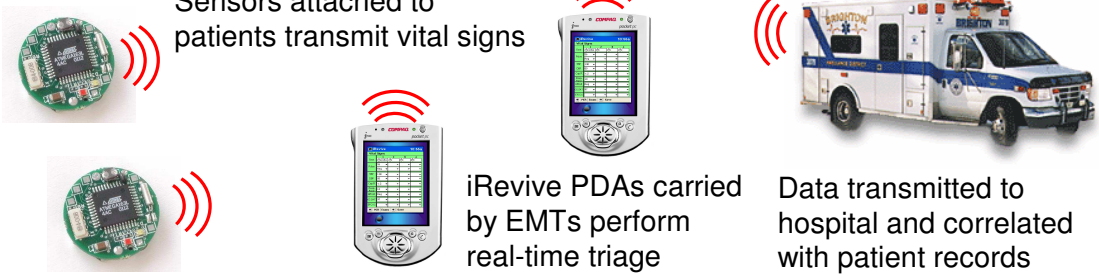
Fig. 4 VitalDust data

2. Karlof C, Sastry N, Wagner. TinySec: Link Layer Security for Tiny Devices. http://www.cs.berkeley.edu/~nks/tinysec/index.html
3. National Institute of Standards Technology, SKIPJACK and KEA Algorithm Specifications. http://csrc.nist.gov/CryptoToolkit/skipjack/skipjack-kea.htm

iRevive: 10Blade has developed a software package called iRevive that allows complete documentation of pre-hospital emergency medical services (EMS) on a mobile device (Figure 5).

Fig. 5 iRevive

VitalDust/iRevive Application



Research Challenges:

- Development of highly robust, ad hoc multi-hop routing schemes
- Prioritization of critical data, e.g. serious change in patient status
- Dynamic re-keying support for increased security

Conclusion: Sensor node and sensor network development have the potential to revolutionize patient care by allowing continuous, real-time, non-invasive, wireless monitoring of multiple patients. Relaying this information to one or more systems that are supported by the developing medical grid could yield acute, real-time triage and decision support.

For More Information:

http://www.eecs.harvard.edu/~mdw/proj/vitaldust

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