Works in Progress

Editor: Anthony D. Joseph ■ UC Berkeley ■ adj@eecs.berkeley.edu

Implantable Electronics

EDITOR'S INTRO

This month's Works in Progress department features three projects that use pervasive computing technologies to monitor or assist patients. In the first project, the researchers are exploring technologies to enable patients to record their brain activity and head movement while sleeping, and to help automate drug-use supervision. The researchers in the second project are adding ultrasound-based distance ranging to the traditional walking stick that the visually impaired use. In the third project, the researchers used RFID tags to monitor patient behaviors and movement patterns and to limit their access in a hospital. —*Anthony D. Joseph*

MICRO-NANO TECHNOLOGIES FOR MONITORING PATIENTS

***Pascal Ancey**, ST Microelectronics*
***Rafael González**, Telefonica I+D*
***Pierre-Alain Gaillard**, Aardex*
***Juha Virtanen**, GE Healthcare*

Numerous challenges exist for implementing ambient intelligence (AmI) applications, especially for those in which a personal mobile device acts as a gateway. The European Commission's cofunded MINAmI (*mi*cro-*n*ano integrated platform for transverse *AmI* applications) project aims to address these challenges by developing low-cost and low-power sensors, actuators, and circuits for target AmI applications. We present two of the applications here.

This first is a flexible data-logger patch. A patient places the patch on his or her forehead to record up to nine hours of EEG (electroencephalogram) and head movement when sleeping (see figure 1a). The patch itself integrates all the electronics (electrodes, accelerometer, amplifiers, and so forth), batteries, and up to 36 Mbytes of memory in a flexible package. When the user places the patch on its base, capacitive coupling reads the logged data and inductive coupling recharges the batteries. Patients can read the data stored in the base via USB, or they can transmit the data to a mobile phone using Bluetooth. Researchers are also developing related sleep-analysis software to detect sleep disorders.

The second application is a smart pillbox that records when patients take their medication (date and time) to help supervise drug use (see figure 1b). This handheld pillbox incorporates

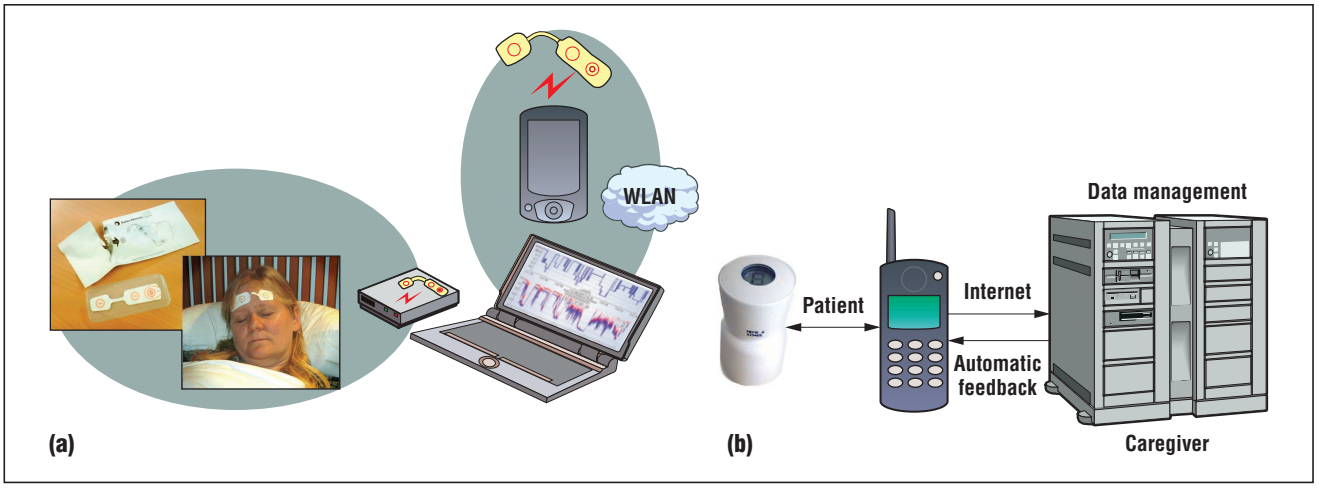

Figure 1. Two applications of the MINAmI project: (a) the ultra-light data logger and (b) the smart pillbox.

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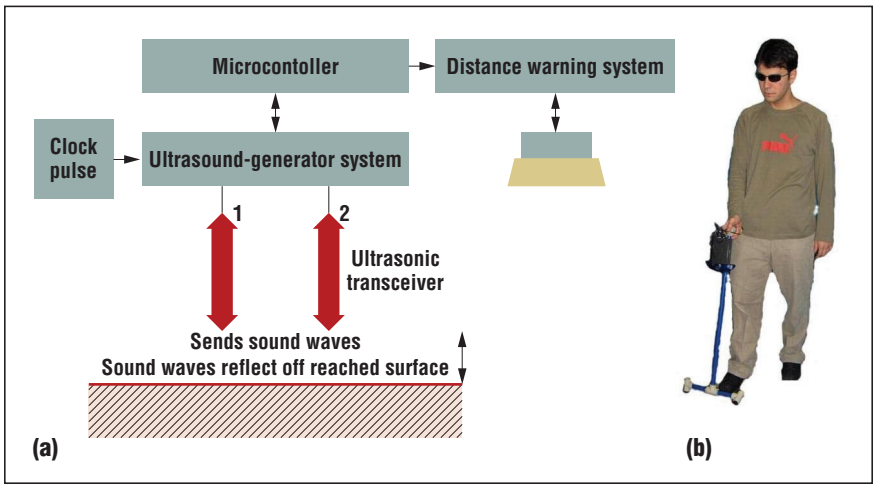

Figure 2. The ultrasonic walking stick: (a) a system diagram and (b) the walking stick in use.

a CPU, which doctors can tailor to the necessary prescription to calculate a compliance index. A mobile phone can enhance the pillbox's functionality by providing a user interface and increased processing power. The phone can also act as a gateway to a Web service that lets health specialists configure and monitor a patient's program.

For more information, contact Pascal Ancey at pascal.ancey@st.com or see www.fp6-minami.org.

AN ULTRASONIC WALKING STICK FOR THE BLIND

A. Fatih Kocamaz and Erdem Uçar,
University of Trakya

We aim to transform the white walking stick—which helps the visually impaired move independently—into an electronic device. Our system design comprises two main modules: a control mechanism with a microcontroller and an ultrasonic transceiver (see figure 2a). We use the PIC-16C84 microcontroller, which estimates the distance to an object using the time elapsed between sending and receiving sound waves. It then converts this distance into sound signals to notify the user that an obstacle is near (see figure 2b).

For more information, contact Erdem Uçar at erdem.ucar@mynet.com.

RFID TECHNOLOGY FOR PSYCHIATRIC EVALUATIONS

Erdem Uçar, Erdal Vardar, and A. Fatih Kocamaz,
University of Trakya

Our project used RFID technology to evaluate negative symptoms that schizophrenic inpatients exhibited during their stay at Trakya University Medical School Hospital for psychiatry services. Such symptoms can include social withdrawal, physical inactivity, motionlessness, or hyperactivity.

Throughout the area designated for psychiatric services, we installed RFID readers so that their impact fields intersected. We then had the patients wear stickers or necklaces with RFID tags containing ID information. The RFID readers monitored the time spent in each reader field and transitions between fields. The readers transformed the information into numerical data to determine each patient's mobility ratio and to note the time change of mobility. We plan to compare this data to the results of a professional evaluation of the patients' symptoms and the side effects of medicines (conducted independent of our study) to determine if a correlation exists.

We also plan to evaluate this technology's applicability to other psychiatry patients during their hospital stays to determine if our RFID method could measure other nonobjective psychiatric disorder symptoms. RFID technology could offer a new method for coping with the problems of objective measurement and evaluation in psychiatry.

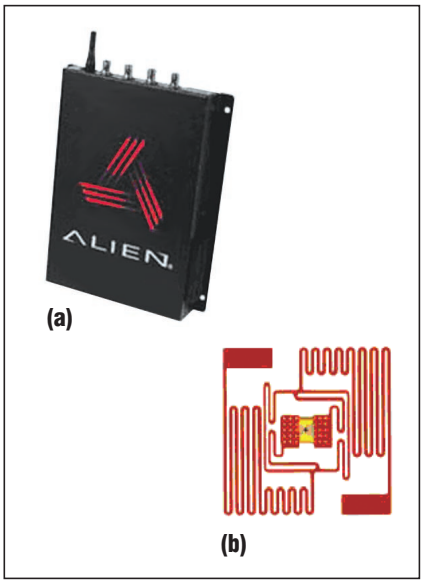

Figure 3. The RFID (a) reader and (b) tag used to evaluate and monitor psychiatric patients.

Furthermore, our system controls patient check-ins and check-outs for psychiatry services by automatically controlling facility entrances and exits. By identifying patients, the RFID readers can trigger an alarm if a patient tries to enter an unauthorized area.

The RFID cards and readers we used support ISO 18000-6C protocols and operate at ultrahigh radio frequency (866 MHz). Readers can detect a patient's RFID sticker from up to 6 meters away (see figure 3).

For more information, contact Erdem Uçar at erdem.ucar@mynet.com.