Long-term Continuous Remote Health Monitoring Using the HARMONI Middleware

Iqbal Mohomed*, Maria Ebling+, William Jerome+, Archan Misra+
*University of Toronto, Toronto, ON, Canada
+IBM T. J. Watson Research Center, Hawthorne, NY, USA
iq@cs.toronto.edu {ebling, wfj, archan}@us.ibm.com

1 INTRODUCTION

Rapid advances in sensor technology and the widespread availability of wireless networks are making it possible for long-term continuous remote health monitoring of individuals. These monitoring applications have the potential to revolutionize the administering of drugs to patients, automated emergency response and the detection and management of chronic medical conditions.

The most promising architecture [1] for remote health monitoring applications is one where on-body sensors (e.g., [2]) transmit their readings to a personal pervasive device (such as a smart phone or PDA) via a Personal Area Network (PAN) radio technology such as Zigbee or Bluetooth. The mobile device subsequently relays the sensor readings to remote servers via its (relatively) powerful wide area networking radio (such as GPRS, or WIFI). In implementing this architecture, research efforts to date relay all sensor data to the remote server, which taxes the resources on the mobile devices as well as the wide area wireless network, and makes long-term continuous monitoring impractical.

In our demonstration, we propose to show a working prototype of the HARMONI middleware, with components on the mobile device as well as the remote server, which significantly reduces the volume of data transmitted over the wide-area wireless network.

2 HARMONI

HARMONI achieves significant reductions in the transmission of sensor data to the remote server through a technique called *Context-aware Filtering*. With this technique, the system considers whether the readings that are currently being received from sensors are within the expected range for the user's current contextual situation. If so, the system reduces upload bandwidth by transmitting only a summarized version of the observed data. When the observed sensor readings lie outside the expected norm, however, all data is transmitted. Thus, context-aware filtering allows savings in data transmissions while preserving the required fidelity of sensor readings.

Consider the following example of how HARMONI works with context-aware filtering. Sal is a software developer and spends most of her day in front of a computer. As part of her daily routine, Sal goes to the gym at her office after work and spends at least an hour running on the treadmill. A heart rate sensor is attached to Sal, which transmits its readings to a remote server via her smart phone (both of which run components of HARMONI). When Sal is in the office, HARMONI expects her heart rate to be in the range of 50 and 80 beats per minute (bpm). However, when Sal goes to the gym, the system expects her heart rate to be higher - between 90 and 160 bpm. By transmitting the average of every 10 values whenever these are within the expected range, the system has the potential to achieve a 90% reduction in data transmissions to the remote server. Moreover,if Sal's heart rate exceeds 100 while in her office, HARMONI should generate some form of local alerts (e.g., audible alarms)

3 DEMONSTRATION

We propose to demonstrate the HARMONI prototype through the usage scenario described above. Rather than move users between an office and a gym, we will vary the location context of the user by plugging in one of two Bluetooth adapters into a computer. HARMONI will scan for Bluetooth devices in the vicinity, and be setup to perceive one of the devices as indicating the office, and the other indicating the gym location. We will attach a Nonin pulse oximeter sensor to the participant's hand, and display their heart rate. Participants can jump up and down to increase their heart rate, and observe how HARMONI performs context-aware filtering on the data and generates local alarms when highly anomalous behavior is suspected.

4 REQUIREMENTS

For our demonstration, we will require a table, a wireless access point, an Ethernet LAN, a power supply and a projector (if available). We will provide all other equipment.

REFERENCES

[1] D. Husemann; C. Narayanaswami and M. Nidd, P*ersonal Mobile Hub*, 8th International Symposium on Wearable Computers (ISWC 2004), 31 October - 3 November 2004, Arlington, VA, USA

[2] U. Anliker J. A. WWard, P. Lukowitcz, et al, *AMON: A Wearable Multiparameter Medical Monitoring and Alert System.* IEEE Transactions on Information Technology in Biomedicine 8, 4 (2004).