Sensing Technologies for Societal Well-Being: A Needs Analysis

Elizabeth Avery Gomez, New Jersey Institute of Technology, USA

ABSTRACT

Sensing technologies by design are calibrated for accuracy against an expected measurement scale. Sensor calibration and signal processing criteria are one type of sensor data, while the sensor readings are another. Ensuring data accuracy and precision from sensors is essential, ongoing challenge, but these issues haven’t stopped the potential for pervasive application use. Technological advances afford an opportunity for sensor data integration as a vehicle for societal well-being and the focus of ongoing research. A lean and flexible architecture is needed to acquire sensor data for societal well-being. As such, this research places emphasis on the acquisition of environmental sensor data through lean application programming protocols (APIs) through services such as SMS, where scant literature is presented. The contribution of this research is to advance the research that integrates sensor data with pervasive applications.

Keywords: Business Process Modeling, Human Factors, Pervasive Applications, Sensor Data, Sensor Networks

INTRODUCTION

Sensing technologies by design are calibrated for accuracy against an expected measurement scale. Sensor calibration and signal processing criteria are one type of sensor data while the sensor readings are another. Ensuring data accuracy and precision from sensors is essential and an ongoing challenge but haven’t stopped the potential for application use. The recent advent of sensor networks as enablers for completely new classes of applications has captured the imagination of scientists and engineers from different domains (in-place). To-date sensing technology for pervasive applications (microwave ovens, dusk-dawn timers) is typically transparent to the user and has a single purpose. Technological advances afford an opportunity for sensor data integration and the motivation of our research. We focus on readings (data) from distinct types of sensor as a vehicle for societal well-being.

Leveraging the “stand alone” design of environmental sensors, which use little battery power we focus on mobile device-based services and applications. Our integration focus begins with environmental sensors and where the data recipient is a human user. The data service that initiates our research is SMS (Short Message Service) which continues as “the most popular data service over cellular networks” and one of

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the most successful wireless data services in recent years (Gomez & Bartolacci, 2011; Gomez, 2010; Zerfos, Meng, & Wong, 2006; Gomez & Bartolacci, 2006). To date, the deployment of WSNs, especially in an environmental context, for pervasive system applications is limited and lacking in resilience. The Japanese 2011 crises (earthquake, tsunami, nuclear), Haiti 2010 earthquake and Pakistan 2010 floods demonstrate the resilience of SMS as a data service when transporting sensor readings (electronic and human).

Normal operating conditions, herein societal well-being, will be the baseline for our research. This research takes a bottom-up approach using lean and agile mobile technologies to increase probability during times of crisis when technology often fails. We begin with passive sensors which are typically battery powered allowing them to prevail in times of crisis. The vulnerable point then shifts to the integration between the sensor and wireless sensor network (WSN), which causes a failure to occur before reaching its destination (i.e. human user). Recognizing there is a vulnerable point, we highlight the temporary restoration of services via mobile WSNs that are rapidly deployed by crisis response teams unlike web-base applications.

The purpose of this paper is to present the critical role sensing technologies play for societal well-being and the value of sensor data for individual users. We argue that “passive” sensing needs to be extended for ubiquitous use. We also identify the challenges in achieving this goal. We highlight the complexities when taking the same instance and extending use of sensors for crisis management (lifesaving). Sensor data for its intended purpose (data relevant to the user) and then the data associated with the sensor both play an important role for individual usage behavior. This paper begins with a review of the public health and sensor technologies literature; we then introduce the need for sensor data integration, and present our analysis approach. Conclusions and next steps will be discussed in the final section.

REVIEW OF LITERATURE

Public health, as it is known in the United States, centers on preventing disease, prolonging life, and promoting physical and mental health through organized community efforts (Gomez, 2008; IOM, 2003). The public health sector aims to prepare and protect the lives of an individual, family or group against a health-related event. These efforts span governmental, nongovernmental, and private sectors. Protecting lives against health-related events in a crisis depends on environmental factors. The increase in recent natural disasters, such as Alabama (2011 tornado), Japan (2011 earthquake, tsunami, nuclear), Pakistan (2010 floods), and Haiti (2010 earthquake) highlight the role environmental factors play when protecting lives. These same events have witnessed rapid response through the use of mobile technologies with primary emphasis on SMS data services.

We base our literature review on societal well-being in the United States beginning with the events of September 11, 2001 because of the crisis management focus that evolved. For example, President Bush’s executive order on October 8, 2001 included public health and our communities within the realm of Homeland Security. His directive states that “The Office shall work with executive departments and agencies, State and local governments, and private entities to ensure the adequacy of the national strategy for detecting, preparing for, preventing, protecting against, responding to, and recovering from terrorist threats or attacks within the United States and shall periodically review and coordinate revisions to that strategy as necessary” (Bush, 2001, 2002). Moreover, ensuring health preparedness for a terrorist attack includes current vaccinations, increasing vaccine and pharmaceutical supplies, and hospital capacity.

Moving to President Obama’s State of the Union address on February 1, 2011, a decade later, the focus shifts to “initiatives that expand “wireless coverage to 98% of Americans” and create a “nationwide interoperable wireless
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