# Integrated Biomedical System for Ubiquitous Health Monitoring

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**Abstract.** We propose a distributed system that enables global and ubiquitous health monitoring of patients. The biomedical data will be collected by wearable health diagnostic devices, which will include various types of sensors and will be transmitted towards the corresponding Health Monitoring Centers. The permanent medical data of patients will be kept in the corresponding Home Data Bases, while the measured biomedical data will be sent to the Visitor Health Monitor Center and Visitor Data Base that serves the area of present location of the patient. By combining the measured biomedical data and the permanent medical data, Health Medical Centers will be able to coordinate the needed actions and help the local medical teams to make quickly the best decisions that could be crucial for the patient health, and that can reduce the cost of health service.

## 1 Introduction

The aging of populations is becoming a social and economical challenge worldwide. For example, according to [1] "In the United States alone, the number of people over age 65 is expected to hit 70 million by 2030, doubling from 35 million in 2000, and similar increases are expected worldwide." On the other hand, many elderly people suffer from chronic diseases that require medication and clinic visits on a regular basis. Therefore, for this growing category of people, it is crucial to monitor the health condition all the time. Health monitoring can save lives, improve the quality of life for many, and last but not least, it can reduce the const of health care, by enabling early interventions. The cost of the health care is a growing problem too, for example, expenditures in the United States for healthcare will grow to 15.9% of the GDP ($2.6 trillion) by 2010 (Digital 4Sight's Healthcare Industry Study) as a result of the accumulative impact of chronic degenerative diseases in the elderly and their increasing dependence on the health care system.

Next generation networked medical devices and health management systems are envisioned to be ubiquitous systems of networked systems for secure, reliable,

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privacy-preserving, cost-effective and personalized quality health care, leading not only to better health-care delivery, but also to improving peoples quality of life in general. Unfortunately, current medical devices are still mostly standalone subsystems with proprietary designs. Medical workers often need to manually transfer data among several machines.

There are various research projects going on in the direction of using sensor and network technologies for health services. The closest work to our solution is *I-Living* [2,3], an assisted-living supportive system, beng developed by researchers at the University of Illinois at Urbana-Champaign. The major goal of *I-Living* is to assist elderly people to get the needed health services, while staying at home.

At the *Center for Future Health (CFH)* at University of Rochester [4] the smart medical home prototype consists of infrared sensors, computers, bio-sensors, and video cameras. The key services to be provided are medical advisory, which provides a natural conversational interface between the patient and health care expert, motion and activity monitoring, pathogen detection and skin care, and personal health care recording for consumer-provider decision support.

The *Aware Home* project at Georgia Tech [5] targets to create a home environment that is aware of its occupants' whereabouts and activities. The services provided by *Aware Home* range from enhancing social communications such as providing digital portrait of elderly people to their family members, to memory aids that assist users in resuming interrupted activities based on playbacks of past events recorded by video camera.

The smart in-home monitoring system at University of Virginia [6] focuses on data collection with the use of a suite of low-cost, non-intrusive sensors. The information collected is logged and analyzed in an integrated data management system (that is linked to the Internet). The system essentially collects information in a passive manner and does not directly interact with elderly people.

The major industry research effort is perhaps led by the age-in-place advanced smart-home system at Intel [7]. It aims to help elderly people with Alzheimer's diseases, by integrating four major technologies: sensors, home networks, activity tracking, and ambient displays. The sensors located in the home environment sense the locations of the people and the objects in the home.

Differently from the above mentioned strategies, our goal is to provide ubiquitous health monitoring, at home, and outside it, all the time. People need to have their health conditions under control not only when they are at home, but everywhere. In our technological society, we are proud of our ubiquitous communication or computing capabilities, but we think, it would be a point of even higher proud, if we could have ubiquitous health monitoring, which would improve the life quality for many. If our technology is not used to improve people's life, what is it good for?

We define the following requirements for our architecture:

1. **Reliability:** Due to the sensitive nature of our system, it should work even when various components might fail. For example, to guarantee the connectivity of the patients to the system, we propose to use complementary multiple wireless technologies.