A MULTITIER SECURE SENSOR NETWORK FOR HEALTH CARE: REVIEW

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Abstract— This paper focuses on the study of wireless sensors and review about the design and implementation of the secure wireless sensor network for health care monitoring applications in medical field. The architecture will allow seamless and efficient interconnection of patient's body area network and the stationary wireless networks. Also it explores practical implementation challenges and presents original solutions for time synchronization, event management and for dynamic reallocation of on-chip resources for maximum energy efficiency and security.

***Index Terms*— Human Body, Security, Sensor, Telemedicine, Wireless Body Area Network.**

I. INTRODUCTION

Human body monitoring can be performed using a network of small and intelligent wireless sensors which may be attached to the body surface or implanted into the tissues of human body. It enables carers to predict, diagnose, and react to adverse events earlier than ever.

The prototype implementation of the wireless sensor network is best understood in the context of the motivating vision and proposed system architecture of a distributed ubiquitous health care monitoring system. This next subsection describes the system architecture and

the benefits it offers in light of the issues discussed in the introduction.

The architecture will allow seamless and efficient interconnection of patient's body area network and the stationary wireless networks (e.g., hospital room or ward). To begin with the architecture of a healthcare system, this bridges WBANs and Wireless Local Area Networks (WLANs).

The proposed system presents a WBAN implementation which consists of multiple intelligent physiological sensor nodes, a personal server, and a network coordinator. The sensor platforms and network coordinator will be built from off-the-shelf wireless sensor platforms. The sensors will be custom-designed intelligent physiological sensor boards, implemented as daughter cards, for ECG monitoring and motion sensing. The nodes will communicate wirelessly using standards-based on IEEE 802.15.4 and a novel power-efficient time division multiple access scheme.

This paper will also explore practical implementation challenges and present original solutions for time synchronization, event management and for dynamic reallocation of on-chip resources for maximum energy efficiency and security.

The survey of major security and privacy issues related to medical databases and potential attacks in WBANs will be also focused. In addition to this, it will also explain an unsolved quality of service problem which has great potential to pose a serious security issues in

WBANs, and then will discuss a potential future direction.

Sensor Nodes

For every personal server, a network of intelligent sensor nodes will be designed that will capture various physiological signals of medical interest. Each node will capable of sensing, sampling, processing, and communicating physiological signals. For example, we will make use of an ECG sensor for monitoring heart activity, an EMG sensor for monitoring muscle activity, an EEG sensor for monitoring brain electrical activity, a blood pressure sensor for monitoring blood pressure, a tilt sensor for monitoring trunk position, a breathing sensor for monitoring respiration, while the motion sensors to discriminate the user's status and estimate her or his level of activity. Each sensor node receives initialization commands and responds to queries from the personal server.

Wireless Sensor Platform - Tmote Sky

For the main processing board on the embedded sensor nodes, commercially available wireless sensor platforms from Moteiv will be used. During the course of development, it may use Moteiv's original Telos rev A, its successor Telos rev B, and finally the Tmote Sky platform. Each platform is based on an MSP430 family microcontroller with integrated RAM and flash memory, a USB interface, and an integrated wireless ZigBee compliant radio with antenna.

II. LITERATURE REVIEW

Recently, WBAN health monitoring systems have attracted researchers' attention. The WBAN is an emerging and promising technology that will change people's healthcare experiences revolutionary [1]. The growth of sensor devices in healthcare, medical and biometrics has been increased from 8 percent in 2002 to 46 percent in 2012 [4]. In compare to traditional healthcare systems, wearable healthcare systems are very cost effective. Automatic monitoring systems release patient's from long hospital stays, thus reducing medical labor and infrastructure costs. Reducing length of hospital stay is desirable especially for countries that are short of medical infrastructure and well-trained personnel

Holter monitors for ECG and EEG monitoring are among the first and most frequently used wearable sensors. Existing devices are limited, however, in that they are strictly data acquisition devices. Cardio Labs based in Franklin, TN was founded in 1995 and offers a slight variation on Holter monitors by introducing event-based monitoring. Their recorders allow extended ambulatory heart motoring and capture of cardiac arrhythmias and ischemic episodes. The devices are marketed to physicians with patients who report intermittent symptoms such as palpitations, chest pain, shortness of breath, etc., but have been unable to provide an in-office diagnosis. The patient wears the device for extended periods and when experiencing a symptomatic episode, presses the event button. The device will record up to 32 minutes of data surrounding the event. The data can then be extracted (at the physician's office) and analyzed by the physician to assist diagnosis [7].

CardioNet is perhaps the closest commercial product to our area of research. CardioNet provides systems for mobile cardiac outpatient telemetry (MCOT). The system includes a three lead ECG sensor and electrodes, a portable health monitoring device (in PDA form factor), and a service center for collecting data from various users. The electrodes are placed on the chest and the sensor (transmitter) is worn around the neck or on the user's belt. The monitor can be placed on a desk or table nearby or can be worn when the user is mobile.

Microsoft researchers in the Adaptive Systems and Interaction (ASI) Group have developed HealthGear, a system of network of embedded sensors monitoring human physiological data. Their research is focused on using the system to recognize patterns of human behaviour when faced with external factors such as workload, stress, traffic situations, exercise, diet, sleep, etc. They have used the system in a study on sleep apnea. In particular, they used a combination of motion sensors and oximeter sensors to detect irregular sleep patterns.

The Advanced telemedical MONitor (AMON) project is the product of a collaboration of European industry and universities funded by the European Union (EU) Information Society Technology (IST). The system integrates a number of advanced biosensors on a Wrist-mounted Monitoring Device and includes sensors such as heart rate, heart rhythm, 2-lead ECG, blood pressure, blood-oxygen saturation, skin perspiration and body temperature. The system monitors vital signs by collecting data from each sensor, performing preliminary analysis to determine heart rate for example, and then, using GSM / UMTS, transmits the data to a remote telemedicine system for further analysis and possible emergency care if needed.

III. SYSTEM ARCHITECTURE

The process flow for ambulatory health care monitoring is contained within a multi-tier telemedicine system as illustrated in Figure 1.

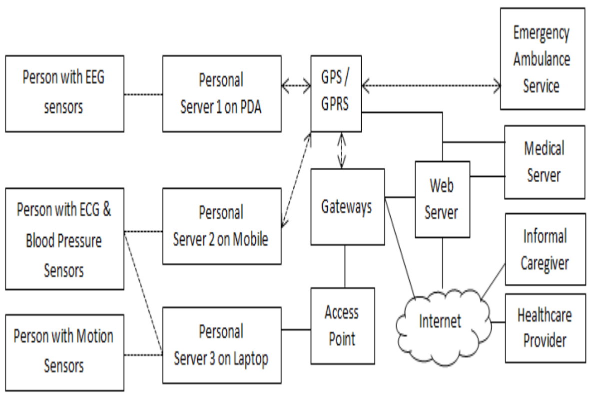

Figure 1 Process flow for Health Care Monitoring

The telemedicine system spans a network comprised of individual health monitoring systems that connect through the internet to a medical server tier that resides at the top of this hierarchy. The system is not merely a distributed data logger, which itself will provide great advantage over current systems, but provide distributed data processing and analysis functions.

Each tier in the network will intelligent and provides some form of analysis; in some cases it may be possible for on-the-spot real-time diagnosis of conditions. The top tier, centered on a medical server, will be optimized to service hundreds or thousands of individual users, and encompasses a complex network of interconnected services, medical personnel, and healthcare professionals.

Each user will wear a number of sensor nodes that are strategically placed on the body. The nodes will be designed to unobtrusively sample vital signs and transfer the relevant data to a personal server through a wireless personal network which will be implemented using ZigBee (802.15.4) or Bluetooth (802.15.1).

In this model, the personal server will be designed on a home personal computer, handheld computer, smart phone, or residential gateway, which will control the WBAN, perform sensor fusion, and preliminary analysis of physiological data. It will provide graphical or audio interface to the user, and transfer captured health information to the medical server through the Internet or mobile telephone networks (e.g., GPRS, 3G).

IV. METHODOLOGY

Wearable systems for health monitoring come in a number of forms and serve a variety of applications. Available systems range from those serving personal fitness and wellness management to those serving to provide remote monitoring or diagnostic of cardiovascular problems. A number of research programs are pursuing development of health monitoring systems as well. The Figure 2 shows 3-level proposed wireless body area network architecture for health care monitoring applications.

Medical Server

The medical server will provide a variety of differing functions to WBAN users, medical personnel, and informal caregivers. The medical server will store electronic patient records in a database, provide a high availability daemon for authenticating registered WBAN users and accepting session uploads, summarizes physiological data and automatically analyze the data to verify it is inside or outside acceptable health metrics (heart rate, blood pressure, activity) and identify known patterns of health risks. It is the responsibility of the medical server to interface the electronic patient records and insert new session data, generate alerts to the physician and emergency health care professionals when abnormal conditions are detected, and provide physician and informal caregiver portals via the internet for retrieving health summary reports remotely.

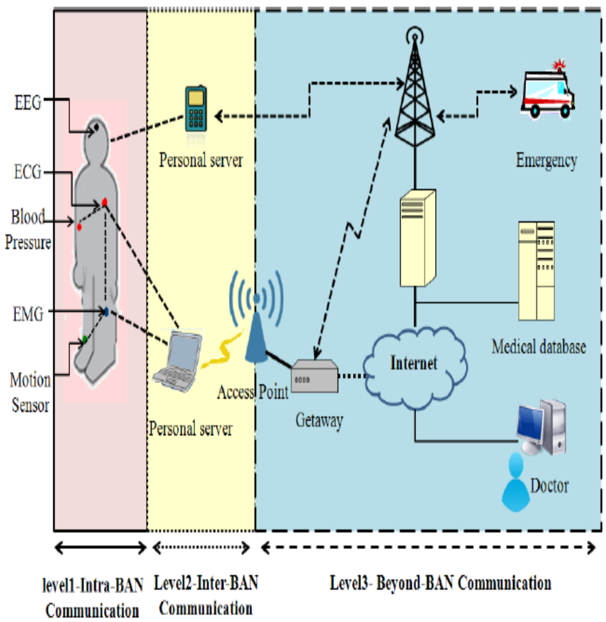

Figure 2 The3-level Proposed Wireless Body Area Network Architecture for Health Care Monitoring

Personal Server

The personal server will be placed at the second tier, which will be responsible for interfacing with the medical server via the internet, interfacing the WBAN sensors and fusing sensor data and providing an intuitive graphical and/or audio interface to the end user. The personal server application can run on a variety of platforms with a variety of wide area network (WAN) access possibilities for internet access.

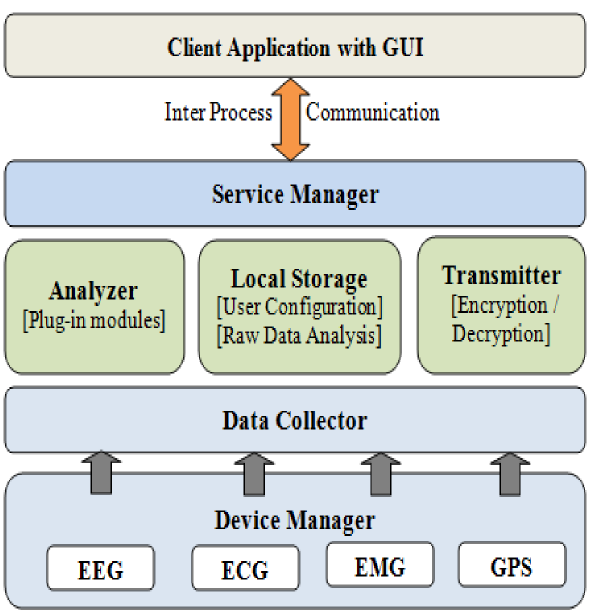

Figure 3 Components of Middleware

The Personal server will comprise of seven components arranged in a four-tier hierarchy (1) device manager at the bottom-most tier (2) data collector at the second tier (3) at the third tier there are data analyzer, local storage manager, and data transmitter and (4) a service manager at the top tier. Figure 3 shows the layered component architecture of the middle software which will run on mobile or PDA at client side.

There will be one thread per each sensor called device manager thread that will receive data from its associated sensor. The data collector thread will receive sensor data from each device manager and synchronize all the sensor data with the same time stamp into a single health record. The analyzer modules will be designer defined modules that perform domain specific tasks like user state classification using multi-modal signal processing algorithms. Back-end server will store sensor data indefinitely. In other words, the data stored on the back-end server is a complete record of a person's physical activity history and the most recent time window of this history will be stored on the mobile phone's flash storage. The last component of this application will be a service manager thread that use sockets or inter process communication (IPC) to provide the sensor data to other mobile applications running on the phone such as data visualization application.

V. CONCLUSION

Blood Pressure measurement using micro- controller based health care system for continuous mode will be user friendly, flexible and reliable for patients. We develop the health care monitoring and measurement device considering all of these facts and found our results to be accurate enough for clinical use and all other daily needs. Implementation of microcontroller and sensor network in the system has evolved a new approach of health care monitoring system. Moreover the alarming system notifies cardiovascular problems at initial stage to the hypertensive patients. The healthcare monitoring system continuously monitors blood pressure, heart rate and body temperature with reliable accuracy and alarms the hypertensive patients about the risk of heart stroke.

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