WIRELESS BODY AREA NETWORK FOR HUMAN MONITORING SYSTEM

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Abstract*—This project uses the wireless concept, ZIGBEE. ZIGBEE is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for wireless body area networks (WBANs), such as wireless headphones connecting with cell phones via short-range radio. The technology defined by the ZIGBEE specification is intended to be simpler and less expensive than other WBANs, such as Bluetooth. ZIGBEE is targeted at radio-frequency (RF) applications that require a low data rate, long battery life and secure networking. The project is designed in such a way that, the analog quantities which are to be recorded continuously are taken and converted into corresponding digital values using an eight channel ADC. Here we consider temperature and pulse oxymeter sensors to monitor the temperature, blood pressure and heart beat respectively. The processed data from ADC is sent to microcontroller. The microcontroller continuously monitors the status of the sensors and the X-Bee transceiver will be interfaced to the microcontroller through serial communication to pass the corresponding sensors data to the receiver LCD. The doctor can continuously check the patient's status by checking the parameters displayed on the LCD and will take the immediate action if the parameters exceed the normal values

***IndexTerms*—Wireless Body Area Networks, sensor nodes, ZigBee, Healthcare, monitoring.**

I. INTRODUCTION

Current health care systems -- structured and optimized for reacting to crisis and managing illness -- are facing new challenges: a rapidly growing population of elderly and rising health care spending. According to the U.S. Bureau of the Census, the number of adults age 65 to 84 is expected to double from 35 million to nearly 70 million by 2025 when the youngest Baby Boomers retire. This trend is global, so the worldwide population over age 65 is expected to more than double from 357 million in 1990 to 761 million in 2025. Also, overall health care expenditures in the United States reached $1.8 trillion in 2004 with almost 45 million Americans uninsured. In addition, a recent study found that almost one third of U.S. adults, most of whom held full-time jobs, were serving as informal caregivers – mostly to an elderly parent. It is projected that health care expenditures will reach almost 20% of the Gross Domestic Product (GDP) in less then 10 years, threatening the wellbeing of the entire economy [1]. All these statistics suggest that health care needs a major shift toward more scalable and more affordable solutions. Restructuring health care systems toward proactive managing of wellness rather than illness, and focusing on prevention and early detection of disease emerge as the answers to these problems. Wearable systems for continuous health monitoring are a key technology in helping the transition to more proactive and affordable healthcare. Wearable health monitoring systems allow an individual to closely monitor changes in her or his vital signs and provide feedback to help maintain an optimal health status. If integrated into a telemedical system, these systems can even alert medical personnel when life-threatening changes occur. In addition, patients can benefit from continuous long-term monitoring as a part of a diagnostic procedure, can achieve optimal maintenance of a chronic condition, or can be supervised during recovery from an acute event or surgical procedure. Long-term health monitoring can capture the diurnal and circadian variations in physiological signals. These variations, for example, are a very good recovery indicator in cardiac patients after myocardial infarction [2]. In addition, long-term monitoring can confirm adherence to treatment guidelines (e.g., regular cardiovascular exercise) or help monitor effects of drug therapy. Other patients can also benefit from these systems; for example, the monitors can be used during physical rehabilitation after hip or knee surgeries, stroke rehabilitation, or brain trauma rehabilitation.

During the last few years there has been a significant increase in the number of various wearable health monitoring devices, ranging from simple pulse monitors [3] [4], activity monitors [5] [6], and portable Holter monitors [7], to sophisticated and expensive implantable sensors [8]. However, wider acceptance of the existing systems is still limited by the following important restrictions. Traditionally, personal medical monitoring systems, such as Holter monitors, have been used only to collect data. Data processing and analysis are performed offline, making such devices impractical for continual monitoring and early detection of medical disorders. Systems with multiple sensors for physical rehabilitation often feature unwieldy wires between the sensors and the monitoring system. These wires may limit the patient's activity and level of comfort and thus negatively influence the measured results [9]. In addition, individual sensors often operate as stand-alone systems and usually do not offer flexibility and integration with third-party devices. Finally, the existing systems are rarely made affordable.

Recent technology advances in integration and miniaturization of physical sensors, embedded microcontrollers and radio interfaces on a single chip; wireless networking; and micro-fabrication have enabled a new generation of wireless sensor networks suitable for many applications. For example, they can be used for habitat monitoring [10], machine health monitoring and guidance, traffic pattern monitoring and navigation, plant monitoring in agriculture [11], and infrastructure monitoring. One of the most exciting application domains is health monitoring [12] [13]. A number of physiological sensors that monitor vital signs, environmental sensors (temperature, humidity, and light), and a location sensor can all be integrated into a Wearable Wireless Body/Personal Area Network (WWBAN) [14]. The WWBAN consisting of inexpensive, lightweight, and miniature sensors can allow long-term, unobtrusive, ambulatory health monitoring with instantaneous feedback to the user about the current health status and real-time or near real-time updates of the user's medical records. Such a system can be used for computer-supervised rehabilitation for various conditions, and even early detection of medical conditions. For example, intelligent heart monitors can warn users about impeding medical conditions [15] or provide information for a specialized service in the case of catastrophic events [16]. Accelerometer-based monitoring of physical activity with feedback can improve the process of physical rehabilitation [17]. When integrated into a broader telemedical system with patients' medical records, the WWBAN promises a revolution in medical research through data mining of all gathered information. The large amount of collected physiological data will allow quantitative analysis of various conditions and patterns. Researchers will be able to quantify the contribution of each parameter to a given condition and explore synergy between different parameters, if an adequate number of patients is studied in this manner.

II. Background and Motivation

Wireless body area networks (WBANs) have gained many different applications in such areas as health monitoring, industrial automation, military operations, building automation, agriculture, environmental monitoring, and multimedia. In particular, their application to healthcare areas received much attention recently. The design and development of wearable biomedical sensor systems for health monitoring has drawn a particular attention from both academia and industry. Medical technology has been contributing to the population aging. All over the world, populations are aging fast. According to the U.S. Census Bureau [U.S. Census Bureau, 2010], the population aged 65 years or over is 13 percent of the USA's population. Also, this rate is expected to increase up to 20 percent in 2050. Fast growing population of old people will drive the increase in the expense of health care.

Developing patient-friendly medical equipment at a low price to provide the effective health care is a challenging task for medical service providers. Continuous real-time health monitoring based on body area networks (BANs) has a great potential for the care of patients. Because of this benefit, patients can be treated in a timely fashion, before some deadly event happens by constantly monitoring the condition of patients and informing both the patients and medical professionals of any abnormalities.

BANs consist of several distributed network devices containing sensor units, which collect and process data and communicate with other devices via a radio frequency channel. This wearable health monitoring system can monitor changes in a patient's vital signs and help patients maintain an optimal health status. Also, if patients wear wireless medical sensors for continuous monitoring, any emergency status detected by them can be sent to their doctors, hospitals, and other related medical entities when abnormal changes occur. This is helpful and can save the life when a patient has heart attack or treatment after surgery.

A wearable BAN can be a big part of healthcare applications. Due to the nature of medical applications, however, it has to pass the correct physical information without any data loss, error, and end-to-end delay. Also, sensor nodes should be small, light-weighted, and low-power consumed to keep good mobility of patients and to reduce the cost of healthcare services. All these issues must be resolved before wireless healthcare network application in real life.

III. Proposed Work

This project aims at monitoring the patient's health conditions continuously. The parameters like the blood pressure, temperature, heart beat are to be monitored continuously. In other words, the doctor will be diagnosing the patient continuously. This project uses the wireless concept, ZIGBEE. ZIGBEE is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for wireless body area networks (WBANs), such as wireless headphones connecting with cell phones via short-range radio. The technology defined by the ZIGBEE specification is intended to be simpler and less expensive than other WBANs, such as Bluetooth. ZIGBEE is targeted at radio-frequency (RF) applications that require a low data rate, long battery life and secure networking. The project is designed in such a way that, the analog quantities which are to be recorded continuously are taken and converted into corresponding digital values using an eight channel ADC. Here we consider temperature and pulse oxymeter sensors to monitor the temperature, blood pressure and heart beat respectively. The processed data from ADC is sent to microcontroller. The microcontroller continuously monitors the status of the sensors and the X-Bee transceiver will be interfaced to the microcontroller through serial communication to pass the corresponding sensors data to the receiver LCD. The doctor can continuously check the patient's status by checking the parameters displayed on the LCD and will take the immediate action if the parameters exceed the normal values. This project uses regulated 5V, 500mA power supply. Unregulated 12V DC is used for relay. 7805 three terminal voltage regulator is used for voltage regulation. Full wave bridge rectifier is used to rectify the ac output of secondary of 230/12V step down transformer. Description of the main components of the project is as follow:

ZigBee:

IEEE 802.15.4 and ZigBee are standard-based protocols that provide the network infrastructure required for WSN applications. 802.15.4 itself defines the physical and MAC layers, whereas ZigBee defines the network and application layers. They can be used to develop low data rate, low complexity, low power consumption, and low cost WSNs. The physical layer (PHY) supports three radio bands, 2.4GHz ISM band (global) with 16 channels, 915MHz ISM band (Americas) with 10 channels, and 868MHz band (Europe) with a single channel. The data rates are 250kbps at 2.4GHz, 40kbps at 915MHz, and 20kbps at 868MHz. The MAC layer controls the access to the radio channel by using the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) mechanism. The IEEE 802.15.4 PHY uses direct sequence spread spectrum coding to reduce packet loss due to noise and interference. Also, it supports two PHY layer modulation options. The 868/915 MHz PHY adopts binary phase shift keying modulation, whereas the 2.4 GHz PHY uses offset quadrature phase shift keying.

A ZigBee defines three types of devices: coordinator (MAC Full Function Device-FFD), Router (MAC FFD), and end evice (MAC Reduced Function DeviceRFD). An FFD can serve as a network coordinator or regular device. It can communicate with any other devices. An RFD is intended for applications that are simple, such as a light switch or simple sensor device. It can communicate only with FFD.

A ZigBee coordinator is a base station node that automatically initiates the composition of the network and controls the overall network process. It needs a large memory and high processing power. A ZigBee Router is also an FFD that links groups together and supports multi-hoping for packet transmission. It can connect with other routers and end-devices. ZigBee end devices can only communicate with an FFD. It has limited functionality. Theoretically, ZigBee can support up to 65,536 nodes. For security, it uses 128-bit Advanced Encryption Standard (AES) encryption and authentication. The transmission range is from 10m to 75m, depending on an application's power output and environmental features. Approximately, ZigBee devices are expected to have a battery life ranging from several months to years.

Heart Beat Sensor:

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

FIGURE 1: HEART BEAT SENSOR

Temperature Sensor:

A sensor (also called detectors) is a device that measures a measurable attribute and converts it into a signal which can be read by an observer or by an instrument. For example, a mercury-in-glass thermometer converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube. A thermocouple converts temperature to an output voltage which can be read by a voltmeter.

Temperature Sensor which converts temperature value into electrical signals. We used IC called LM 35 as a temperature sensor. LM35 series sensors are precision integrated-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature. The LM35 requires no external calibration since it is internally calibrated. . The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range.

The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air.

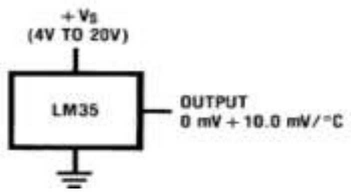

FIGURE 2: TEMPERATURE SENSOR

Blood Pressure Sensor:

The Vernier Blood Pressure Sensor is used to measure systemic arterial blood pressure in humans (non-invasively). When used with Logger Pro® 3.4 or newer, Logger Lite® 1.3.1 or newer, or LabQuest® App 1.2 or newer, it can measure mean arterial blood pressure and calculate both the systolic and diastolic blood pressure using the oscillometric method.

The following is a partial list of activities and experiments that can be performed using this sensor.

1. Measure blood pressure before and after exercise.
2. Measure blood pressure while sitting or standing.
3. Compare blood pressure after voluntary isometric contractions (weight lifting) and a rhythmic activity such as running or biking.
4. Investigate how digestion affects blood pressure.
5. Study the effect of caffeine on blood pressure.
6. Compare blood pressure between smokers and non-smokers

The active sensor in this unit is a Honeywell SSC Series pressure transducer. The sensor produces an output voltage that varies with the pressure measured in the cuff. It includes special circuitry to minimize errors caused by changes in temperature. We also provide a filtering circuit that conditions the signal from the pressure transducer. The output voltage from the Blood Pressure Sensor is linear with respect to pressure

IV. CONCLUSION

As a complement to existing wireless technologies, the WBAN plays a very important role in ubiquitous healthcare applications and enjoys a huge potential market in the area of consumer electronics. Its advancements have been the result of interdisciplinary research and development. In this paper, we have designed a ZigBee based human health monitoring system with three sensors named temperature sensor, blood pressure sensor and heart beat sensor. Our proposed system is accurate and portable easy to carry. We can interface more sensors and data can be sending through GSM and internet with more modifications.

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