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Development of Efficient Query Processor in Cell Phone for Sensor Data Processing Over a WSN

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Abstract. A query processor is designed for query-based multiple vital signs monitoring system to query sensor network and collect data. This monitoring system performs a local vital signs data analysis using cell phone over wireless sensor network (WSN) technology and code division multiple access (CDMA). In order to control vital signs accurately, query processor assigns unique dedicate communication channels for each of them. There is reliable communication between query processor, sensors and medical monitor devices in this system to process and interpret the data gathered by sensor network. The process of reading, gathering and managing health data are critical because this closely relates to data quality. A data visualization GUI is designed in cell phone to present measured data in a meaningful visual representation.

Keywords: query processor, wireless sensor network, health data

1. Introduction

New technologies such as Bluetooth, Zigbee, RFID, UWB, Wireless Local Area Networks (WLAN), Wireless Metropolitan Area Networks (WMAN) and Wireless Wide Area Networks (WWAN) are being used to enable the automation of the observation and support for elderly and home bound people through the use of sensors, actuators, distributed intelligence, databases, ubiquitous connectivity and friendly interfaces. All connected mainly via a variety of wireless networking technologies. Wireless Sensor Network is currently one of the most attractive targets to apply to healthcare application. The development of new communication technologies has increased opportunities to monitor patients at home. This technology takes the form of an appliance used in conjunction with other devices, like blood glucose meters to ask the patient a series of simple questions about their vital signs and symptoms. The demand for wireless medical monitor devices has seen significant growth in recent years and is expected to continue to increase by 58% per year for the next five years [1].

In this paper, a reliable query processor for multiple vital signs monitoring system is designed and implemented. Researches have noted the benefits of designing a query processor in sensor network and the needs for sensitivity to limited power and computational resources [2]. This collaboration is very beneficial for limited-resource cell phone because it has low power consumption. Query processor is able to communicate in advance with sensors and medical monitor devices. We describe each of the main communications in our system design in Section 2. Section 3 discusses the experimental result and performance analysis. Finally, conclusion is presented.

2. System Specification

Figure 1 illustrates the conceptual view of our proposed multiple vital signs monitoring system. There are three main areas of this system that we will discuss in details: Health-data Sensing, Health–data Collection and Health-data Management.

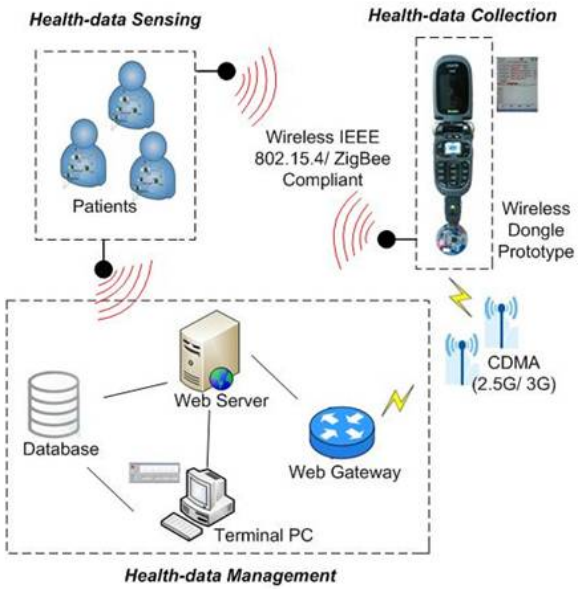


Fig. 1: Overall system architecture.

1.1. Health-data Sensing

Sensor connects to wearable monitor devices on a real human body to form a wireless network. A query processor is designed inside cell phone to control vital signs selectively by identifying unique channels id for each of them. Figure 2 shows query structure sends from query processor to sensors. Action field defines the type of action to be performed upon the arrival at motes. In order to increase system power efficiency, on-command "IDLE_MODE" and "SELECT_CHANNEL" feature had been incorporated, which enables sensor to transfer data only when desired and sleep for the rest of the time. Channel field contains parameter to control ECG, blood pressure or blood glucose respectively.

Fig. 2: Packet structure for command message.

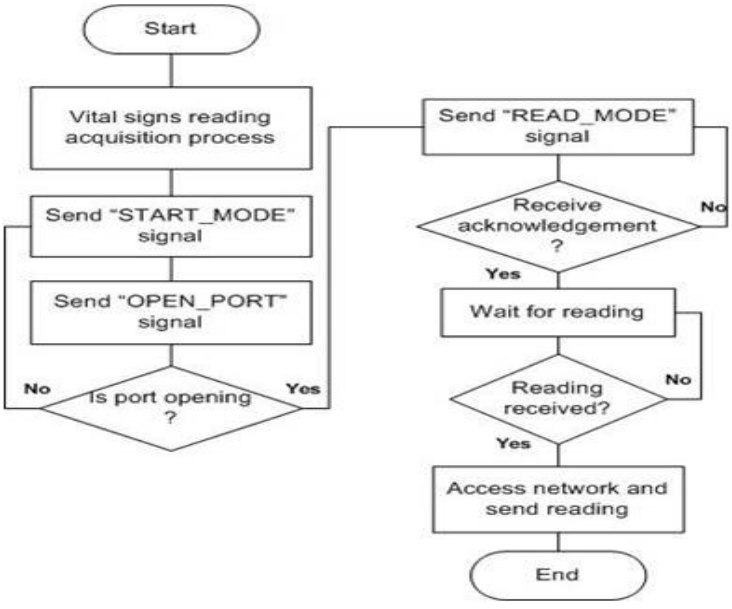
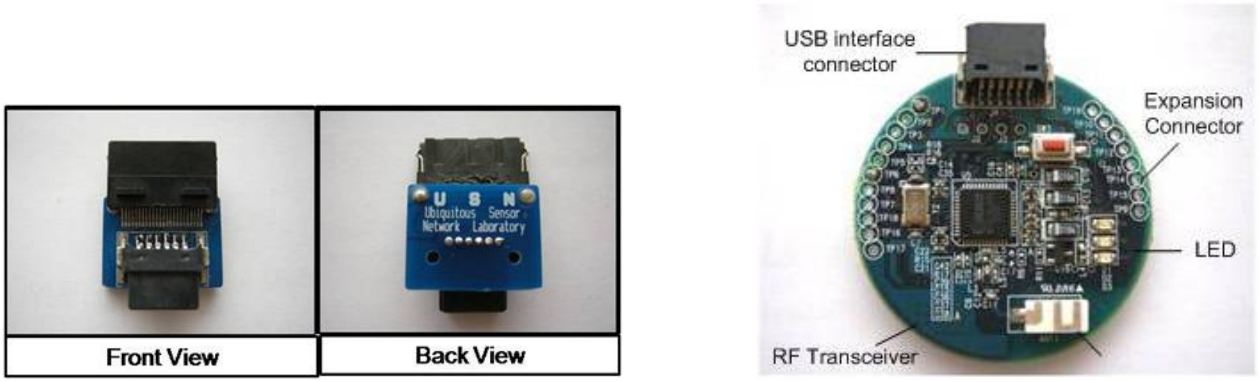


Fig. 3: Communication between medical monitor device and sensors flow chart.

Commercially available medical monitor devices are used to provide sensor readings for the system. Monitor device include a serial port connection that facilitates bidirectional communication at 15200 kbps. When status of sensor node is “SELECT_CHANEL” action mode, it starts to communicate with monitor device on this serial link to start the reading process and receive patient’s measured data readings. Once the readings are received, sensor node communicates with the network and transmits them to the query processor through base station. Figure 3 shows the reading process between monitor device and sensor. Sensor node sends a “START_MODE” signal to the monitor device to switch it to “READ_MODE” communication status. Sensor node sends a command to open communication port. When communication port is opened, monitor device is ready to receive commands to acquire vital signs measure data. Once the reading process has completed, sends the readings to the sensor node.

1.2. Health-data Collection

It is a term used to describe a process of preparing and collecting data. Query processor implemented in cell phone which plays a main role to collect sensor data via base station. Figure 4(a) shows RS-232 interface is used to connect between cell phone and base station (see Figure 4 (b)). A separate thread from GUI thread is used to maintain constant monitoring of the serial port. When a message is received, the type of vital signs is determined by extracting data and identifying the channel ID. This process is necessary as it ensures the data gathered is both defined and accurate and that subsequent decisions based on arguments embodied in the findings are valid. Figure shows an interface between the base station and cell phone is implemented using Java to display measure data values.



(a) (b)

Fig. 4: Screen captured of our lab designed (a) RS-232 interface and (b) base station.

1.3. Health-data Management

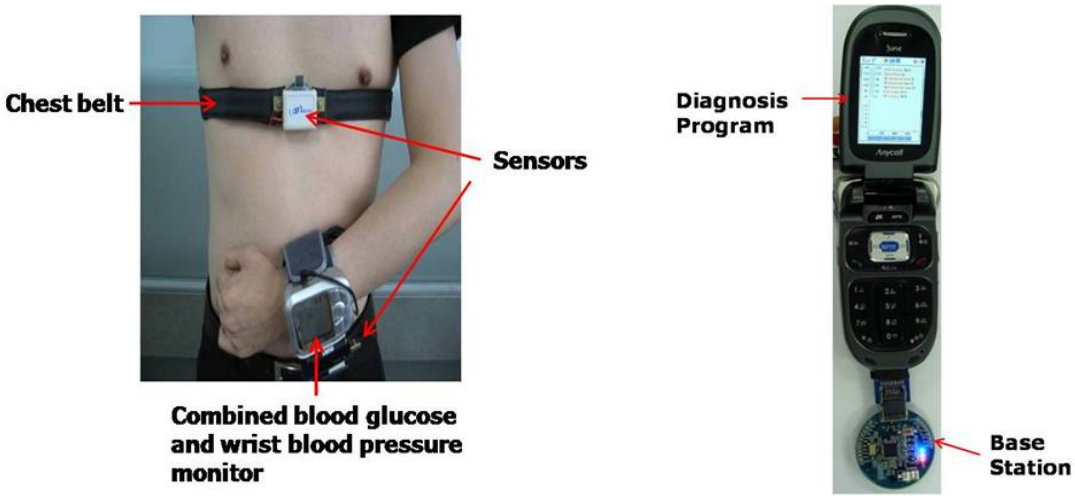
Fig. 5: Monitoring program analyzes ECG signals in desktop PC.

This step involves determining how data will be organized and achieved. We need to ensure that data sets can be efficiently collected, processed, stored and then easily retrieved through time people who want to

use them. Cell phone plays a role as local processor which embedded with multi-parameter diagnosis algorithms enables patient to be monitored and analyse signals locally. However, cell phone has lower processing power compare to desktop PC due to smaller memory and size. When any suspected patterns of signals are detected, cell phone performs simple data analysis first and then immediately routes these signals to monitoring program in medical centre for physicians' careful diagnosis as shown in Figure 5. Collection of patient's records can be saved in the database in the server for further review.

2. Experimental Result

Our experimental set-up uses wireless sensors connects to chest belt and combined blood glucose and wrist blood pressure monitor devices on a real human body as illustrated in Figure 6(a). ECG sensor board is attached to Maxfor's TelosB Mote (TIP 710CM) to measure ECG parameter while blood pressure and blood glucose interface is attached to Hybus's TelosB mote (Motev) to measure blood pressure or blood glucose parameter. The wireless sensors capture vital signs channels accordingly and transmit those signal data to the base station that connected to cell phone with embedded diagnosis program (see Figure 6(b)).



(a) (b)

Fig. 6: (a) Tester wore medical monitor devices connect to sensors to measure vital signs health data. (b) Data are transmitted from sensors to cell phone through base station.

The query time required for establishing a connection from base station to the sensor is 1 second. Starting from the time of receiving data from sensors and display on GUI in the cell phone ranged from 1-3 seconds on average of 20 times experiments are listed in table 1.

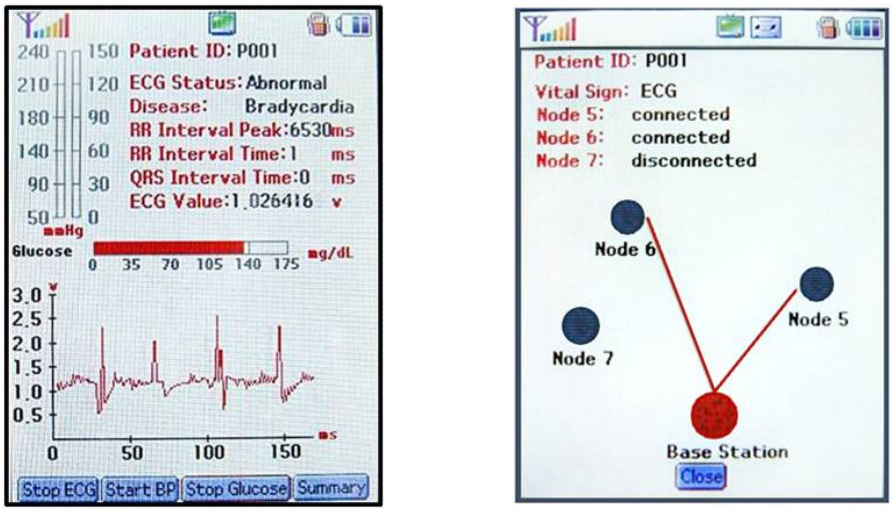
Table 1: Data Transfer Time

Number of Testing: 20	
Vital Signs	**Average Time (s)**
ECG	2.53
Blood Pressure	1.17
Blood Glucose	2.33

Figure 7(a) presents the main control and data visualization windows of the mobile unit. Blood glucose measure data is represented in the bar chart is displayed in middle area. The bottom area plots the ECG waveform and also the patient can measure vital signs selectively by controlling the command buttons. This system allows patient to measure ECG and blood pressure or blood glucose simultaneously. Mapping of the apparent connections between the sensors of a network are evidenced by the path that data appears to take when travelling between the nodes (see Figure 7(b)).

3. Conclusion

Our whole focus is bringing only affordable solutions to the health care market. Cell phone becomes popular to facilitate as a query processor to query sensor network. We have presented our designed embedded query processor in cell phone collaborates with Multiple Vital Signs Monitoring System which posses multiple vital signs measurements on real time. Large quantities of patients' data are generated and processed daily. Therefore, the method to manipulate health data from reading, collecting and managing stages is concerned because it relates to data quality.



(a) (b)

Fig. 7: (a) GUI displays ECG signals in waveform and blood glucose measure data in bar chart. (b) Network topology view of base station connects to sensor nodes are displayed.

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