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Body Sensor Network: Monitoring and Analysing Real Time Body Parameters in Medical Perspect

Ashwini Singh, Ajeet Kumar, Pankaj Kumar, M.A Mujeeb

Abstract— As because of modern emerging technologies, low power integrated circuits and wireless communication has enabled a new generation of sensors network. The incorporation of these sensors networks in Health care is very popular and plays a vital role in breath breaking situations. The deployment of monitoring and analysing hardware incorporated with various wireless standards plays a key role in regard to monitors body parameters and collects the data for analysing related issues. The goal of our paper is to develop a wireless system that provides the heartbeat rate, body temperature and body acceleration with real time data which helps to control situation of emergency and all these information will send to the caregivers by various wireless techniques.

Index Terms— Wireless Body area Sensors network, Zigbee , Activity Monitors, WSN.

I. INTRODUCTION

Now a days, Wireless Sensors Network (WSN) has becomes a assured technology in the realm of advanced applications. The one of its latent position is in the form of unguided biomedical sensor network to determine physiological sign. Wireless Body Area Network (WBAN) is a unguided network utilized for interaction among sensor nodes in or about the human body in order to supervise critical body parameters and activities. These supervising signs are collected by a personal server, e.g. PDC or Smart phones which acts as a sink for the information of the sensors and send them to caregivers for proper health supervising.

The personal server have some memory in which some results are arranged which it gives to the patient at the time of emergency it acts like a feedback, if the situation is not handle by the PDC then it transfers the signal to caregivers by unguided media. There are different issues highlighted in the employment of WBAN technology. One of the main advantages of a WBAN is to monitor patients remotely using an intranet or the internet. A typical WBAN consists of a number of inexpensive, lightweight, and miniature sensor platforms, each featuring one or more physiological sensors: acceleration sensors(X, Y, Z direction), electrocardiographs (ECGs), and temperature sensors.

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Ashwini Singh, Electronics & communication engineering, National Institute of Technology , Patna, India.
Pankaj Kumar, Electronics & communication engineering, National Institute of Technology Patna, Patna, India.
Ajeet kumar, Electronics & communication engineering, National Institute of Technology Patna, Patna, India.
Prof. M.A. Mujeeb Associate professor National Institute of Technology Patna India.

The sensors could be located on the body as tiny intelligent patches, integrated into clothing, or implanted below the skin or muscles. The paper is organized as follows. Section II discusses the remote patient monitoring network based on the WBAN architecture of our system. Section III presents the system architecture and the simulation model. Section IV presents some simulation results, and conclusions and discussions are presented in the section V..

II. SYSTEM ARCHITECTURE

The architecture of the WBAN-based health monitoring system at home is multi-tiered – similar to the one described in [1] [2]. Tier 1 encompasses a set of tiny, smart, wireless sensors that are strategically placed on the user's body. These sensors sample, process, and store information about user's physiological signals. The WBAN sensors communicate directly to a WBAN gateway that may be plugged into either a home server or a wired or wireless network appliance (Fig.1). The WBAN gateway provides time synchronization services and forwards messages to a home server and/or a medical server. If a user moves out of the WBAN gateway range, the sensors automatically begin buffering data locally. When the user returns and the WBAN link is re established, the sensors automatically upload stored sensor and event data.

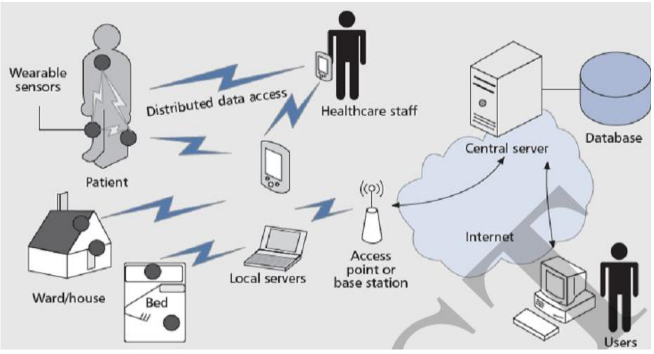


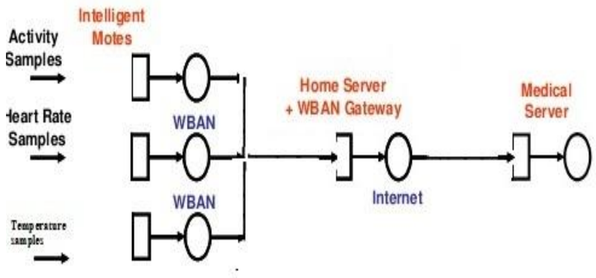
Fig.1. System for health monitoring at home.

In order to evaluate the overall system performance and specifically its ability, reliability, robustness, and scalability we have built a system prototype. The main component of the WBAN-based system prototype and the data flow are illustrated in Fig. 2. The prototype features an activity (motion) sensor, temperature sensor and a heart rate (ECG) sensor. The motion sensors can be used to differentiate user activity states (e.g., sitting, walking, running, lying), or estimate intensity of his/her activity.

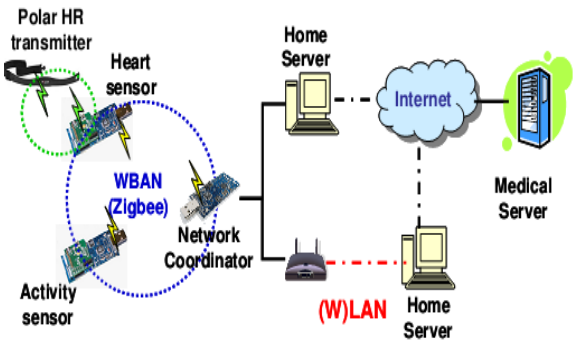
Depending on the target application, the activity sensor can be attached to the user's belt, an ankle, a knee, or the trunk. More activity sensors can be deployed to achieve a more robust state differentiation and a better estimation of the user's activity. Once the deployment scenario is determined (exact position of the user's body), a user-specific sensor calibration may be needed to allow reporting of energy spent in calories.

The temperature sensor measures the real time body temperature in degree Celsius and compare it with the normal human body temperature which is 37degree C. The heart sensor monitors heart activity. One version of the heart sensor has a single-channel bio amplifier for three lead ECG. This sensor is capable of sending either raw ECG signal (signal is filtered) or R-peak events recognized by the on-sensor feature extraction software modules. The other version of the heart sensor interfaces a standard Polar belt and it can record each heart beat. As it does not require ECG electrodes (and thus increases the user's comfort), we used this heart sensor in our experiments. The user typically carries the heart sensor in his/her shirt pocket (close to the Polar belt). The WBAN gateway is implemented using a standard wireless platform. Finally, the home health server application runs on a personal computer.

The prototype may be used to monitor recovery and compliance of patients undergoing cardiac rehabilitation at home and who have been prescribed an exercise. It can also be used in many other health monitoring applications with minimal or no modifications. In addition, the WBAN system is energy efficient, scalable, and its current implementation can accommodate more than a dozen sensor nodes as described in [4].



(a)



(b)

Fig. 2. WBAN data flow (a) and the prototype (b).

III. HARDWARE AND SOFTWARE ARCHITECTURE

A. HARDWARE

The activity WBAN sensor encompasses an intelligent daughter card with accelerometers and a connected to Zigbee wireless platform from XBee [3]. The daughter card samples acceleration in the X, Y, and Z axes; the raw signals are filtered and sent to the Zigbee Transciever. The Zigbee platform performs further processing (e.g., AEE computation, step detection, etc) and wirelessly transmits the processed data to the network coordinator. The Zigbee module shown in fig.3 The WBAN heart sensor encompasses a heart rate daughter card attached to a Zigbee platform. The heart rate daughter card receives signals from a Polar Wear Link wireless transmitter. The Zigbee platform performs heart beat detection, time-stamping, and coordinates WBAN communication. The WBAN network coordinator is implemented on a Zigbee network platform. It is responsible for WBAN gateway access and providing time synchronization services to the sensors in the WBAN. It can be connected directly to the home server or it can be connected to a Zigbee connect appliance from XBee [3] and then accessed over the home network

Fig.3 .Zigbee Tx/ Rx module

B. SOFTWARE

The embedded sensor software is responsible for sampling and acquisition, real-time processing, event queuing, and WBAN communication. This software runs on the intelligent daughter cards and the Zigbee platforms. Software running on sensor platforms and the network coordinator is developed using matlab. This implementation follows a general software architecture and WBAN communication protocol described in [1] [4]. The home health server is responsible for communicating with sensors in the WBAN, fusing sensor event messages as they arrive, generating per-user health monitoring session files, and providing visual and quantitative feedback to home users. In addition, it may include an agent responsible for data uploads to the medical server. The software runs on a home PC and was developed using Visual C# and Microsoft .NET 2.0framework. The .NET framework facilitates our handheld PDA version of the home health server as we have described in [1]. The home health server is capable of WBAN communications using either a direct connected network coordinator (USB) or a remote network coordinator connected via a *Zigbee*. In the latter scenario, messages are transported over the local network using reliable TCP/IP sockets.

C. SIGNAL PROCESSING

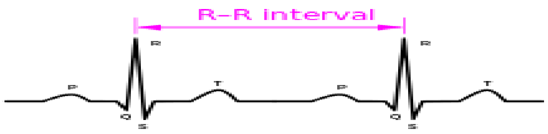
The WBAN prototype provides three parameters of user's activity: (a) activity-induced energy expenditure (AEE), (b) RR-intervals for heart activity and (c) temperature variations. AEE. The AEE feature is calculated by processing accelerometer signals in real-time on WBAN sensor nodes.

Employing embedded signal processing in this fashion extends battery life by reducing costly message transmissions (AEE updates every d=10 seconds versus 100Hz raw sampling rate) and also promotes system scalability by minimizing processing and storage requirements from central server resources. Each axis is sampled at 100Hz and pre-filtered using simple low-pass averaging functions to remove frequencies above 20Hz. The resulting data stream is passed through a high-pass filter with an ultra low cutoff frequency (0.01Hz) for the sole purpose of separating AC and DC signal components. The DC signal represents static acceleration due to gravity and is preserved for determining sensor orientation, discerning category of user activity, and step recognition. The AC signal component represents acceleration induced by user activity and is used in our AEE algorithm originally proposed by Bouten, et al [5]. It is described in Eq. 1, where AC(ax), AC(ay), and AC(az) are AC components of accelerations on x, y, and z axes.

$$AEE_t = \int_{t-\delta}^{t} \sqrt{AC(a_x)^2 + +AC(a_y)^2 + AC(a_x)^2}.dt\ldots \quad \text{Eq.1}$$

In our prototype, an activity event records AEE for d=10 seconds. A 4-byte AEE value is accompanied by a 4-byte time-stamp. It should be noted that the time-stamp may be redundant as the home health server may know the value of the time window d used for AEE calculation, so just the first time-stamp in a session would suffice. However, in cases of a sensor malfunction or lost radio packets we might benefit from having time-stamps, thus achieving an increased level of confidence in our readings.

RR-intervals. The heart sensor detects and records R-peak events. An R-peak event is described by two fields: an exact 4-byte timestamp of the R-peak and a 2-byte RR-interval (distance from the previous R-peak). The redundant format of the R-peak event allows full data recovery in all single occurrences of lost event messages.



The Temperature sensor, we use in this system is LM35 ranges between -50^0C to $+150^0C$ which can sense the very small variation of temperature and give quick results in the form of waveform or mathematical value, According to our need we can set the threshold of this sensor.

IV. RESULTS

A. EVENT STORAGE

Buffering analysis for activity sensors. If an activity sensor node has not received a beacon message from the network coordinator, the current AEE sample with the corresponding time-stamp (8 bytes total) is buffered in a local buffer in on-chip RAM memory. Once the local buffer is full, the samples are stored in external flash memory. With d = 10 seconds, we calculate the maximum out-of range operating time before event data is lost. The size of the local buffer is determined by the application requirements and for the activity sensor it is over 6 KB. With 8 bytes produced every 10 seconds, we can store up to 192 minutes of time-stamped AEE samples [(6144 B)/32 B/min = 192 min] in the local memory. If the external flash is employed, its capacity of 1 MB would allow over 20 days of buffered time-stamped AEE samples.

Buffering analysis for heart sensors. One heart beat produces a 6-byte record. Assuming a typical heart rate range between 30 bpm and 220 bpm, and similar memory budgets to the activity sensor, we can buffer from 4.65 min [6144 B / (6 B/b*220 b/min)] to 34.2 minutes of heart activity in the local RAM buffer, and from 13 hours [1 MB / (6 B/b * 220 b/min)] to 4 days if the external flash is used.

B. WBAN TESTING

WBAN testing involved several users wearing the activity and the heart sensors for extended periods of time at home. Below are results for two typical sessions.

Experiment #1. Fig. 4 shows AEE and heart rate of a healthy user in his early 30s during 15 minutes of augmented activity in laboratory conditions. The experiment includes the following sequence of activities: 3 minutes of sitting, 1 minute of standing, 2 minutes of slow walking, 2 minutes of fast walking, 3 minutes of slow running, and 3 minutes of sitting. Increases in heart rate can be clearly seen at the beginning of periods with more activity (slow walking, fast walking, and running) simultaneous with increased AEE. The user spent most of the time in a relatively close proximity of the network coordinator (distance less than 50 feet). Approximately 0.5% event messages were lost (10 out of 1,962 messages). All 10 of these lost packets were R peak event messages. Of these, only two were consecutive packets allowing full recovery of 9 out of 10 lost R-Peak events (by utilizing redundant RR-interval message fields).

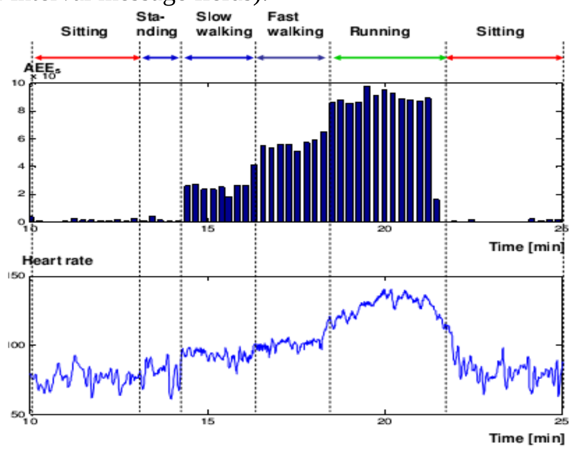


Fig.4. AEE and heart rate collected on the home health server for 15 minutes with different types of activity.

Experiment #2. Fig. 5 shows AEE and heart rate for a 2 hour session. The user has been working in his office (sitting) with short periods of fast and slow walking. The bottom graph shows the number of received messages by the network coordinator per one minute. In this experiment the user walked out of the WBAN gateway range twice for relatively short periods of time (several minutes). Increases in the number of messages correspond to automatic uploads of buffered events once the user re-enters the WBAN gateway range.

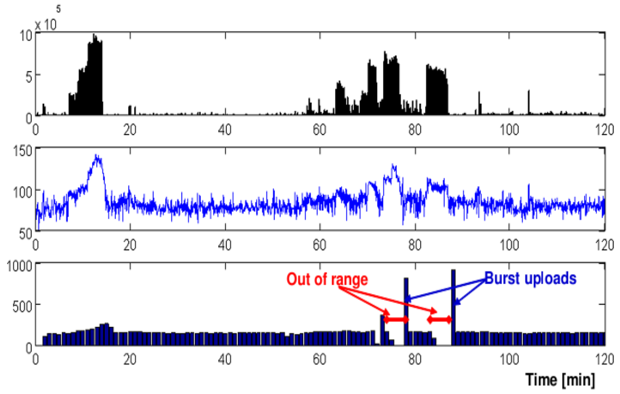


Fig. 5. AEE (top), heart rate (middle), the number of received packets by the network coordinator per minute (bottom) for a 2-hour session.

V. CONCLUSION

Based on testing, our WBAN-based prototype represents a viable system for health monitoring at home. Our experiences suggest potential for high user and patient compliance. The sensors are wireless and unobtrusive. In addition, system features such as event buffering and automatic uploads allow users to carry out normal activity. By providing temperature sensors, motion sensors and heart rate sensor, the system is already very useful for home health monitoring. Further research is required, however, in order to correlate activity and actual caloric consumption. Additionally, research is required to perform accurate step recognition and discern user activity states through software algorithms.

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REFERENCES

1. C. Otto, A. Milenkovic, C. Sanders, and E. Jovanov, "System Architecture of a Wireless Body Area Sensor Networkfor Ubiquitous Health Monitoring," Journal of Mobile Multimedia,
2. E. Jovanov, A. Milenkovic, C. Otto, and P. C. d. Groen, "A Wireless Body Area Network of Intelligent Motion Sensors for Computer Assisted Physical Rehabilitation," Journal of NeuroEngineering and Rehabilitation.
3. www.MaxStream.net
4. A. Milenkovic, C. Otto, and E. Jovanov, "Wireless Sensor Networks for Personal Health Monitoring: Issues andan Implementation," Computer Communications .
5. C. V. C. Bouten, K. T. M. Koekkoek, M. Verduin,R. Kodde, and J. D. Janssen, "A Triaxial Accelerometer and Portable Data Processing Unit for the Assessment of Daily Physical Activity," IEEE Transactions on Biomedical Engineering.
6. S. Warren, "Beyond Telemedicine: Infrastructures for Intelligent Home Care Technology," Pre-ICADI Workshop on Technology for Aging, Disability, and Independence, The Royal Academy of Engineering, Westminster, London, England, June 2003.
7. E. Bielli, F. Carminati, S. La Capra, M. Lina, C. Brunelli, M. Tamburini, "A Wireless Health Outcomes Monitoring System (WHOMS): development and field testing with cancer patients using mobile phones," BMC Medical Informatics and Decision Making, 2004, 4:7,

AUTHORS PROFILE

Ashwini Singh, receive the B.E. degree in Electronics and communication Engineering from Bhopal and persuing M.Tech in Communication Systems from National Institute of Technology PATNA, india.

Ajeet Kumar.:-The author is a student and Teaching Asst. in Master of technology , department of communication system, National Institute of Technology ,India ,and is interested in the Area of Wide Area Wireless Sensor Network

Pankaj Kumar The author is working as a Teaching Astt and a PG Student in Dept. of Communication System, National Institute of Technology Patna ,India. Author is interested in the field of AdHoc Networks and Cross-Layer optimization methods.

Prof. M.A. Mujeeb is working as a Associate Prof. in National Institute of Technology Patna INDIA
Mail id:- abdmuujeeb@yahoo.com