INTERSECTION AND COHERENCE BASED TIME SYNCHRONIZATION OF BODY SENSOR NETWORK

Arvind Singh, Amitabh Sharma
M-tech Department of I.T,C.E.C Landran, Mohali, India
Associate Professor Department of I.T,C.E.C Landran, Mohali, India

ABSTRACT

Due to inherent nature of the process of data collection of dynamic biometrics using body sensors lead to multiple issues that need to be handled properly for monitoring subject of health. One of the main problems includes the time series data synchronization and time lag. There are numerous methods of time series synchronization .However, not all methods maintain the shape that may be distorted to due interference etc. Most of the previous methods are iteration based and can vectorized for fast output. More over the data is to collected from multiple sources and must be secured with key management which may lead to higher complexity of algorithm with large overhead delay or time lag in sending and receiving time series data of respective biometric reading. Therefore, to solve this issue the process and reduce the complexity and still maintain security .This paper propose a new algorithm to overcome this challenge. We have used use coherence metrics that checks the shape reliability of signal like ECG in conjunction with intersection method of time series for synchronization reducing time lag and aligning the signals before they finally processed for health monitoring. The results show that the usage coherence metric is really helpful in getting the bio signal communication reach destination with spectrum Characteristics maintained, and energy consumption is reduced as delay is reduced due to proper synchronization of all signals.

KEYWORDS:-*Time synchronization, Wireless body sensor network (WBSN)*

I. INTRODUCTION

In body sensor network recent development in miniaturization and low powered electronics have lead to the development of wireless health monitoring system called body sensor network. These biosensor nodes are worn on or implanted in the human body and are designed to measure diverse physiological values like blood pressure blood oxygen level. Internet of things is a scenario in which objects, animal or people are provided with unique identifiers and the ability to transfer data over a network without required human or human to computer interaction. It is concept that makes body network possible. These sensors have application in medical field. When attached or ingested with human or animal body, they can capture human bio medical vital signal of the subject, these bio signals may captured from special/target part of human body like heart. The signal from heart are called Electrocardiogram (ECG) Body sensor network (BSN) are distributed system where biosensors nodes are distributed in different positions to collect health data from the human body and deliver the information to a remote medical centre. Due to medical data regulations security of body sensor network (BSN) is very important .Biosensors nodes BSN have limited features and traditional security technologies need upgrading in context of Wireless sensor network are providing interface for the disabled integrated patent monitoring diagnostics also drug administration in hospitals monitoring movements and internal process of insects or other small animals Tele-monitoring of human physiological data and tracking and monitoring doctors and patents inside a hospitals. The body sensors network are composed of some biosensors nodes which are micro scale electronic equipment integrated with biosensors and wireless transceivers. These biosensors nodes are implanted in the human body, and are designed to measure divers physiological values including blood pressure, electrocardiogram,

blood oxygen level, activity recognition. In BSN, a wireless micro network formed by biosensor nodes, can provide with two convenient services one is automated continuous human monitoring the other is intelligent treatment, such as drug delivery that can execute injection of drug automatically. Wireless sensors to e-health have the regulation of E-health. E-health refers to healthcare practice supported by electronic processes and communication because data exchanged in e-health contain a great deal of sensitive health information the health insurance portability and accountability mandated that e-health data must be protected [1].

II. ORGANIZATION OF PAPER

This paper is organized in such a manner, that it discuss about the issues and problems related to development of wireless body sensor network introduction, and then ,we list research gaps and define scope of work. After, the review section (which has tabular summery also) a novel method is demonstrated to overcome the limitation of previous algorithm result with discussion and with interpretation of graphs is given, the paper ends with discussion and conclusion. Based on the scope of work identified for this research work.

III. RELATED WORK

Huawei Zhao, Jing Qin [1] Security of BSNs is an important part of e-health eco systems, and its challenge is key management. Due to serious limitation of operational resources, a low-energy key management scheme is necessary for BSNs. In this paper, an energy efficient key management scheme for BSNs is proposed based on a hybrid multi hop network structure. In the scheme, two new mechanisms, energy-based multi hop route-choice and biometrics synchronization mechanism based on weak time synchronization are used to balance Energy of routes and reduce the energy consumption in transmission, respectively. Performance simulation and security analyses show that the proposed scheme can be used to build an efficient secure system for BSNs.

Okundu Omeni [2] This paper presented a new energy-efficient MAC Protocol targeted at wireless body area sensor networks focused on pervasive healthcare applications. The protocol exploits the attributes of this type network to implement a very low power architecture which is still capable of fast reaction to sporadic Alarm events. The concept of 'wakeup fallback' time is also presented here in the paper acts as a means of reducing the complexity of time-slot management in the presence of link failures resulting from Alarm events or other interference. The MAC has been implemented as part of a larger SoC (Sensium™), and measured results were validated the effective operation of the new MAC protocol as per the claim of paper. **Hossein Mamaghanian [3]** This paper proposed a complete system level comparison between a new CS-based and the state-of-the-art DWT-based embedded ECG compression algorithms. As expected, *non adaptive* CS-based compression was found to exhibit inferior compression performance compared to its *signal-adaptive* DWT based counterpart for a given reconstructed signal quality. The presented results, however, were obtained using the default basis pursuit de noise algorithm for sparse reconstruction, where no attempt was been made to exploit the highly structured nature of the ECG signal or use reference signal. Despite its inferior compression performance, CS-based compression was found to exhibit the best overall energy efficiency due to its lower complexity and reduced CPU execution time for Shimmer WBSN platform. Results validated the suitability of CS for real-time energy-efficient ECG compression on resource-constrained WBSN motes. More importantly, They suggest the relevance of pursuing an "analog CS" implementation for the joint sampling and compression of ECG in the context of WBSN applications. **Hui Dai[4]** In this paper, the authors have introduced a light-weight bidirectional time synchronization service TSync for networked wireless sensors. TSync's comprehensive service consists of two components, namely a push-based HRTS protocol and a pull-based ITR protocol. Both approaches can be flexibly parameterized to suit the time synchronization needs of a given application according to the paper text. They show that the service can synchronize all the sensor nodes to within an average accuracy of around 21 μsec over a single hop and 29 μsec over three hops using push-based HRTS synchronization .The performance is comparable to reference broadcasting in terms of accuracy while the overhead of HRTS is far less than RBS. HRTS scales remarkably well because its number of messages is constant per broadcast domain.They also present results from a

GPS-enabled framework for evaluating the accuracy of TSync in a live sensor network. **Kun Sun, Peng Ning[5]** In this paper, the authors presented the design, implementation, and evaluation of TinySeRSync, a secure and resilient time synchronization subsystem for wireless sensor networks running TinyOS. TinySeRSync includes a comprehensive suite of techniques, including a secure single hop pair wise time synchronization protocol based on hardware-assisted, authenticated MAC layer time stamping, and a secure and resilient global time synchronization protocol based on a novel use of the μTESLA broadcast authentication protocol. These techniques exceed the capability of previous solutions. In particular, unlike the previous attempts, the secure single hop pair wise synchronization technique can handle high data rate such as those produced by MICAz motes. Moreover, the use of μTESLA in global time synchronization successfully resolved the conflict between the goal of achieving time synchronization and the fact that μTESLA requires loose time synchronization as per claims of this paper. The resulting protocol is secure against external attacks and resilient against compromised nodes.

Table 1[Tabular summary of literature survey]

		Huawei Zhao[1]	Okundu[2]	Hossein[3]	Hui Dai[4]	Kun[5]
1	Time Synchronization Method	Fuzzy Commitment Weak Synchronization	Wakeup fallback Algorithm	No	Hierarchy referencing/ITR protocol	μTESLA broadcast authentication protocol
2	Signal Integrity Check Method	Refreshes metric	No	No	No	No
3	Signal shape Check method	No	No	Digital wavelet transform	No	No
4	Usage of Reference Signal	No	No	No	Yes	Yes
5	Type of signal	ECG	ECG	ECG	Electromag-netic	Wireless packet signal

IV. GAPS IN STUDY

Limited work has been reported in literature survey regarding the use of reference signal and real time synchronization of signal with statistical methods vector intersection at given time in BSN.
Limited work has been reported where coherence metrics check the shape of signals, vectors for checking cross spectrum characteristics of two time series.

V. SCOPE OF WORK

Most of the previous methods are not vectorized and are iteration based ,which leads to more overhead and complexity .This needs to be taken care of by using methods this checking disturbance noise, shape and coherence between the reference signal and real time signal being transmit at given time. Hence, the work demonstrated here will be limited to building an algorithm that overcomes these particular issues in wireless body sensor network and help in reducing energy consumption by reducing time lag and proper synchronization.

VI. IMPLEMENTATION STEPS

In this section, we will explain the steps taken to overcome the limitation mentioned in the section and illustrates the method employed to complete the scope of work case has been follow proven methods for establishing experimental step and to do pre processing of the bio signals for running the experiments demonstrating the new method for time synchronization.

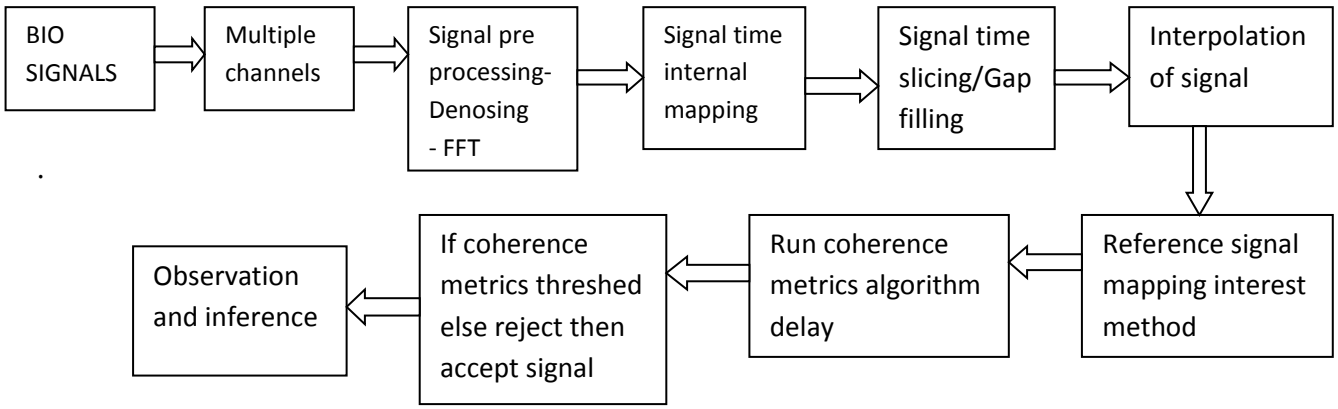

Figure 1: steps to overcome the limitations

- Experimental setup
  - Matlab 13b
    - statistical tool box
    - signal processing tool box
- Data base of bio signal
  Source : physic.net
  Characteristics of data set

Table 2

S.no	Signal Type	Duration	Frequency	Reference
1.	Reference ECG Bio signal	20 sec	500Hz	[http://physionet.org/physiobank/database/ecgiddb]
2.	Real Time	20 sec	500Hz	Simulated

Step 1:- Time synchronization requires the broadcasting of time information by the bio sensor device. When BSNs need accurate time synchronization, all biosensor nodes will receive the broadcast frequently and introduce significant energy consumption. At present, the majority of existing research does not offer viable solutions to these issue and few have claimed that their scheme could work without a need for time synchronization of signals. However, the key management scheme used to refresh keys cannot work well without time synchronization. That is, lack of time synchronization will throw the key management schedule into give more overhead and more energy will be used. In addition, protocols designed in the initial deployment stage, rekeying stage and node addition stage require timestamps to prove the freshness of the messages, which could not be correctly realized without time synchronization. The same problem may exists where a message as Timestamp (TS), is used to prove the reply of an old message and time synchronization has been ignored.
It is assumed that the observations over uniform time intervals As a result, one common prerequisite for times Series is to take an initially raw input matrix and transform it into discrete time intervals analyse in this in our context of research work is using common time series vectors method which get most of the intersecting point from both signals. It may happen that, the length of the matrices may be slightly different due to time lag or initiation of stimuli response. In this our context of research, the two matrix considered are as follows interpolated hence mathematical they need to addressed with interpolated values.
a) Reference bio signal of ECG
b) Incoming real time bio signals
Step 2:- The bio signal spectrum become more informative if it is processed in frequency domain hence, FFT algorithm is used for this purpose .the fast Fourier transformation converts as original signal from its original domain (may be time or space) to a representation in the frequency domain

and vice versa .this is done by computing transformation by factorization the discrete Fourier transform matrix(DFT).

Step3:- The third step is mapping of bio signal for synchronization. Mapping is the process of taking a given time stamp and mapping it into a given interval sequence. In our work we have considered inclusive method to handle the bio signals from human body sensors network. This step helps in reducing time lag and reduce energy wastage.

Step 4:- This step basically of building approximation of the bio signal function by simple function, the original formula for the said bio signal as a function is known as reference function, we can approximate it into a real time function of the signal been transmitted , this way we are able to estimate from reference signal and reduce the estimation by using common set of vector for constructing signal. This steps helps in better synchronization of the process.

Step 5:-The fifth step is to calculate the coherence matrix. This steps helps to calculate the cross spectrum of the pair of real valued time (signal) series (real time and reference) in this step ,we also calculate the auto spectrum of each bio signals. It is basically calculating cross correlation or cross variance between the two series .This way we are able ensure quality of signal is checked which is reaches monitoring station. This step helps to maintain refreshness of signal with much delay, this helping to reduce wastage of energy.

VII. RESULTS

It is apparent from simulations these all basically a main events where the body sensor network loses its energy are:-

(a) Energy consumption while sensing stimuli and Maintain of links/discovering service etc:- Sensor-actor/stimuli communication must meet refreshness factor value to that synchronization of signal remains application specific quality parameter bond. The sensor must timely act sense the 'stimuli' and transmit the stimuli application specific QOS parameter. Hence , the coordinated communication protocols are imperative among sensor stimuli sensing process and needs to be energy efficient following table/ graphs shows the energy consumption in acquiring 'sensing data' and then sending it to monitoring system, as the proposed time synchronization scheme is in place.

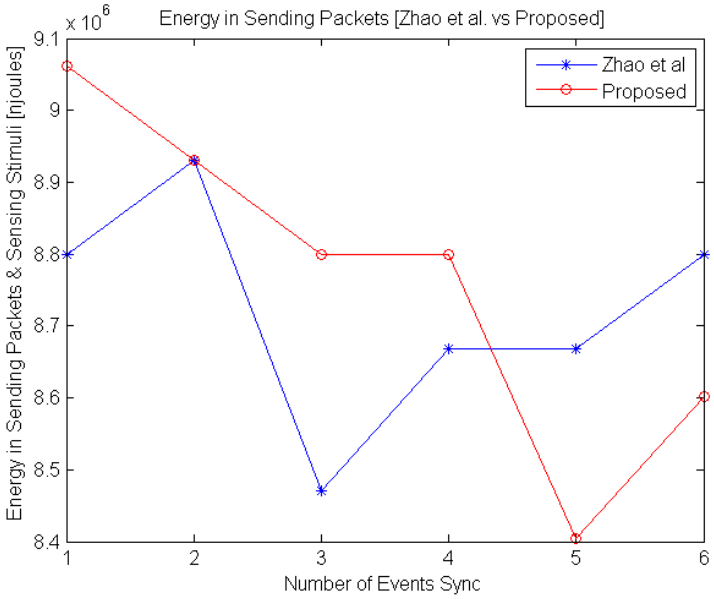

Figure 2: Energy consumption comparison for sending packets

(b) Energy loose while access receive packets. It should be noted, that Some energy is also consumed \when drop of packets due to congestions or other transmission errors, or over head.

Sensor nodes in our context of research transmit higher number of packets to monitoring station, collected as 'stimuli data' from various bio signal stimuli(EEG) in this process there might be some forwarding node/ or intermediate node that need to collect packet and resend to distribute node or monitoring system ,Hence the task of this node is to receive and again relay packets. If more packets are in communication the energy consumption is more and there is need to maintain the shape, integrity of messages. Following are the observation from the series of simulations, But it noted that typically there might be over bearing task being processed by the node, the node may drop some traffic due to over head in this task schedule during events synchronization.

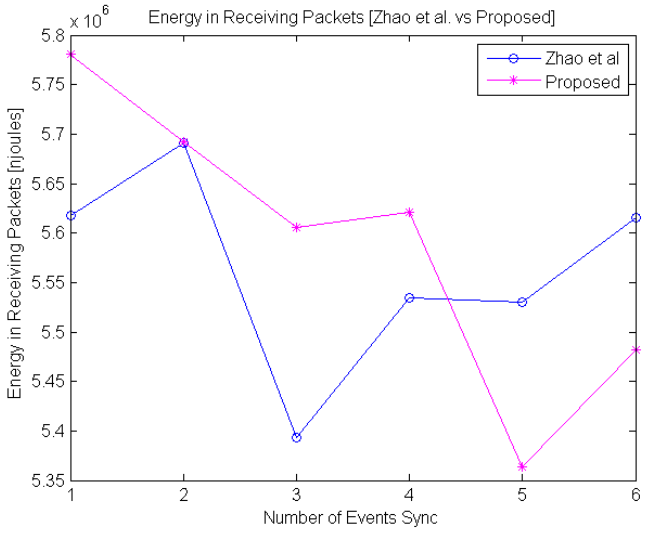

Figure 3: Energy consumption comparison for receiving packets

All the above events are tracked for the proposed algorithm and following all the graphs, based on big-o notation food computation.

VIII. INTERPOLATION OF GRAPHS

The concept of synchronization has been applied successfully based combined approach, in which similarities of trajectories(coherence) (real time signal and reference signal) phase space will constructed to check shape and then by using intersection method time lag is reduced. The result is that, there is less wastage in provisning of stimuli. Data for sending and receiving data, as shown below. Less delay implies less time in processing some number of packets. Hence less energy consumption in sending and receiving to validate the effectiveness of work. Six session of event synchronization were conducted with five pairs of EEG signals(simulated) and energy reading n were observed as follows for sending and receiving. It is apparent from both the graphs the shape in nearby shape in both cases showing consistency in the trend of stimuli been send and received and its energy consumption pattern is actually less as compared to the processing work. For calculating the energy consumption we have used big o notation based calculations to reach at calculating for each energy loose points.

IX. DISCUSSION

By using this methodology, we were able to check the similarity between the real time signal and reference bio signal as a function of the lag relative to the other .By using common vector based interpolation we able to reduce the problem of time lag and energy wastage. Hence, time synchronization based in this concept worked well. As a result of this process in this work, the two real valued function 'f'(real time signal stimulus) and 'g' difference only by an unknown shift along x-axies .We able to use cross correlation to find how much 'g' must be shifted along x-axies to it identical to 'f'(synchronized). If this shift is too much the signal quality is low/degraded and the

signal is discarded for further processing .The formula essentially slides the 'g' function along x- by calculating the integral of there product at each position. When the function matches of (f*g) is maximized .This way peaks (position areas) are aligned they make a large contribution to the integral and vice versa in case of negative area. Since ,there is reduced delay reduced task processing time less energy is consumed.

X. CONCLUSION

When there are no observation or missing observation points in a signals. It is on indication of lack of coherence, integrity shape and synchronization in a signal, our approach in this paper, try to overcome this issue by mapping the input bio signal time series to proper time internals. To aid in the addressing there challenge our algorithm works well with compromising the security freshness of the signal. Results show our approach is better in seeking synchronization time slots for the signal in wire body sensor networks. This is clear from the observation the lesser the delay lesser is energy consumption due to proper synchronization.

XI. LIMITATIONS

In this research work, calculations and observations related to key management have not be illustrated due paucity to of time , main contribution has been to observe energy consumption pattern in sending and receiving stimuli data in an hybrid multi hop network structure. The work thus also not focus on security analysis on not key management related observation have been considered.

XII. FUTURE SCOPE

In the current work the main focus is on developing a framework that take cases of signal spectrum Characteristics while doing time synchronization plus is keeps the trade off of overhead while incorporating the key management scheme to safe guard the integrity of the signal for further processing. Hence, for future work, We suggest that other aspects must also be addressed like management of bandwidth of channels and its optimal using some nature inspired algorithm that help in sending bio signal with maximum throughput with less of its spectrum Characteristics.

REFERENCE

[1] Huawei Zhao, Jing Qin, and Jiankun Hu, Member, IEEE, "An Energy Efficient key management scheme for body sensor networks," IEEE transaction on parallel and distributed system, vol.24,no.11,November 2013
[2]Okundu Omeni, Member, IEEE, Alan chi wai wong "Energy Efficent Medium Access Protocol for Wireless Medical Body Area Sensor Networks," IEEE transactions on bio medical circuits and system,vol.2,no.4,DECEMBER 2008
[3] Hossein mamaghanian, nadia Khalid, "Compressed sensing for real time energy efficient ECG compression on wireless body sensor nodes," IEEE transaction on biomedical engineering,vol.58,no.9,sep 2011.
[4] Hui Dai , Richard Han " A light weight bidirectional time synchronization service for wireless sensor networks"
[5] Kun Sun, Peng Ning "Secure and resilient time synchronization in wireless sensor network" *CCS'06,* October 30–November 3, 2006, Alexandria, Virginia, USA.
[6]Mohammed mana, mohammed feham "trust key management scheme for wireless body area network," international journal of network security, vol.12,no.2,PP.71-79, Mar. 2011.
[7]Hassan ghasemzadeh, Eric guenterberg," energy efficient information driven coverage for physical movement monitoring in body sensor networks," IEEE journal on selected area in communication,vol.27,no.1, jan 2009.
[8] S.M.K. Raazi, H. Lee, S. Lee, and Y.K. Lee, A Scalable and Locally Distributed Key Management Scheme for Clustered Sensor Networks," Annals Telecomm., vol. 65, nos. 1/2, pp. 101-116, Feb. 2010.
[9] J.Y. Sun and Y.G. Fang, "Cross-Domain Data Sharing in Distributed Electronic Health Record Systems," IEEE Trans. Parallel and Distributed Systems, vol. 21, no. 6, pp. 754-764, June.2010.
[10] Sana Ullah, Pervez Khan, Niamat Ullah, Shahnaz Saleem, "A Review of wireless Body Area Networks for Medical Applications," International J. Of Communication, Network and System Sciences (IJCNS), vol.2, no.8: 797-803.) july 27,2009.

[11] VAHID AYATOLLAHITAFTI, MD ASRI NGADI, AND JOHAN BIN MOHAMAD SHARIF, "Requirement and challange in body sensor networks,"Journal of theoretical and applied information technology, vol.72 no.2 20 february 2015.
[12] Mehmet R. Yuce & Steven W. P. Ng & Naung L. Myo "Wireless Body Sensor Network Using Medical Implant Band" Springer Science, 25 July 2007
[13] Shih-Lun Chen, Ho-Yin Lee, Chiung-An Chen, Hong-Yi Huang, *Member, IEEE*, and Ching-Hsing Luo, *Member, IEEE "*Wireless Body Sensor Network With Adaptive Low-Power Design for Biometrics and Healthcare Applications" vol. 3 NO. 4, DECEMBER 2009
[14] CHRIS OTTO, ALEKSANDAR MILENKOVIĆ, COREY SANDERS, EMIL JOVANOV "SYSTEM ARCHITECTURE OF A WIRELESS BODY AREA SENSOR NETWORK FOR UBIQUITOUS HEALTH MONITORING" Journal of Mobile Multimedia, Vol. 1, No.4 (2006)
[15] Chiu C. Tan, Haodong Wang, Sheng Zhong, Qun Li "Body Sensor Network Security:
An Identity-Based Cryptography Approach" *WiSec'08,* March 31–April2,2008,Alexandria, Virginia, USA.
[16] Jerald Yoo, *Student Member*, *IEEE*, Long Yan, *Student Member*, *IEEE*, Seulki Lee, *Student Member*, *IEEE "*A 5.2 mW Self-Configured Wearable Body Sensor Network Controller and a 12 □W Wirelessly Powered Sensor for a Continuous Health Monitoring System" IEEE JOURNAL OF SOLID-STATE CIRCUITS, VOL. 45, NO. 1, JANUARY 2010
[17] Benny P.L. Lo, Surapa Thiemjarus, Rachel King and Guang-Zhong Yang "A WIRELESS SENSOR PLATFORM FOR PERVASIVE HEALTHCARE MONITORING" Department of Computing, Imperial College London, South Kensington Campus
[18] M. Cerny, M. Penhaker "Wireless Body Sensor Network in Health Maintenance Systems" http://dx.doi.org/10.5755/j01.eee.115.9.762, *ISSN 1392 – 1215, 2011. No. 9(115)*
[19] H. Baldus, K. Klabunde, and G. Müsch "Reliable Set-Up of Medical Body-Sensor Networks" Philips Research Laboratories Aachen Weisshausstr. 2, 52066 Aachen, Germany, Springer-Verlag Berlin Heidelberg 2004
[20] Hassan Ghasemzadeh, *Student Member*, *IEEE*, Roozbeh Jafari, *Member*, *IEEE*,and Balakrishnan Prabhakaran, *Member, IEEE "*A Body Sensor Network with Electromyogram and Inertial Sensors: Multi-Modal Interpretation of Muscular Activities" IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, VOL. 00, NO. 00, 2009
[21] Omer Aziz, Benny Lo, Rachel King, Ara Darzi, Guang-Zhong Yang "Pervasive Body Sensor Network: An Approach to Monitoring the Post-operative Surgical Patient"IEEE.2006
[22] Edmund Y. W. Seto, Annarita Giani, Victor Shia, Curtis Wang, Posu Yan,
"A Wireless Body Sensor Network for the Prevention and Management of Asthma"
Department of EECS, University of California, Berkeley, CA 94720

AUTHORS

Amitabh Sharma is presently working as associate professor in the department of Information Technology in Chandigarh Engineering College, Landran , Mohali, Punjab(India).He has over 15 years of experience in the field of teaching. His area of interest is Data Structures, Software Engineering, image processing, networking, mobile computing and sensor networks. He has already published 21 research papers in many international journals of repute. He has also contributed in international and national conferences.

Arvind Singh did diploma in I.T from Punjab technical board, Punjab,(India) in 2010 and B-Tech and M-Tech degree in I.T from Punjab technical university, Punjab,(India)in 2013 and 2015 and currently working on area of sensor network.