ISSN:0975-9646

Improved New AODV (INAODV) Routing Protocol for Collision Free Wireless Sensor Body Area Network for Health Monitoring

Shubhangi sonone
Arya college of Engg and Information Technology
Rajashthan Technical University (Kota)

Vivek KR. Sharma
Ass. Prof. , CS Dept. Arya college of Engg and Information Technology
Rajashthan Technical University (Kota)

ABSTRACT: In our previous work we have taken the review of wireless body area network in details. In addition to previous work, in this paper we are presenting the practical results for existing as well as proposed method presented. Apart from this, by referring our previous paper we are discussing the important components of WBANs such as single processing, network architecture, data processing and analysis, Mac and routing protocols etc. Basically WBANs is composed of group of sensor nodes which are basically used to measure the heartbeat, body temperature, or related parameters. With the use of such networks, a patient does not required to stay longer time in hospital. This network remotely monitors everything on behalf of hospital. The data communication in WBANs is done using the efficient routing protocols, thus in this paper we are discussing about WBAN routing approaches as well. The performance results are calculated using NS2. The protocols which we have simulated here are AODV, DSR and proposed improved method. The results computed here for energy consumption, throughput, end to end delay, packet delivery ratio etc. The proposed improved proposed protocol which is presented here is called as NIAODV [New Improved AODV].

Keywords: ***WBAN, CSN, Network Architecture, Implementation Challenges, Data analysis, AODV, DSR, NIAODV.***

I. INTRODUCTION

The concept of WBAN is nothing but the wireless sensor network which is consisting of various networks as well as wireless devices in order to enable the remote monitoring of person body functionalities and corresponding environment. Technological advancements in sensors, low-power integrated circuits, and wireless communications have enabled the design of economically viable miniaturized sensor nodes that can measure vital physiological parameters. These sensor nodes can be seamlessly integrated into wireless body networks WBANs for remote health monitoring [1]. WBANs can transform health care by providing inexpensive, non-invasive, continuous, ambulatory health monitoring with almost real time updates of medical records via the Internet. Though there are many socio-economic issues about WBAN, yet there are many technical issues to be considered in order to have flexible, reliable, secure, and power-efficient WBANs suitable for medical applications [2].

In this paper our main aim is to present review of technical concepts such as signal processing, network architecture, data processing etc. In addition to this we are discussing about the routing protocols. To provide a better insight into the network architecture of WBAN details system architectures, protocols, design layers and integration of hardware and software would be explained [3] [4]. However, setting up such a network comes with many challenges like power management, reliability, QoS, time synchronization and energy efficiency and these challenges would be discussed elaborately [1].

The routing protocols used for WSN and MANET already studied previously extensively. But for the WBANs, due to their stringent requirements imposes the constraints over its routing protocol design. And hence this designing routing protocol for WBANs is research challenge. Thus we cannot use the same WSN or MANET routing protocols to WBAN in same way. During the past decade, there are many routing protocols are designed and presented for WBANs. These routing protocols are classified into many categories. In this paper we are summarizing the details about it as well. In below sections, in II we are presenting the overview of WBAN network architecture and its components. In section III, the challenges of WBAN are discussed, followed by it, in section IV WBAN signal and data processing is discussed. Finally in section IV we are presenting the results obtained during our simulation work.

II. WBAN ARCHITECTURE

Following figure 1 is showing the example of health monitoring system using the concepts of WBANs. The system spans a network comprised of individual health monitoring systems in WBAN(first tier) that connects with a Personal Server (second tier) which in turn communicates to a medical server tier that resides at the top of this hierarchy, an example of WBAN integrated into a broader multitier telemedicine system [4].

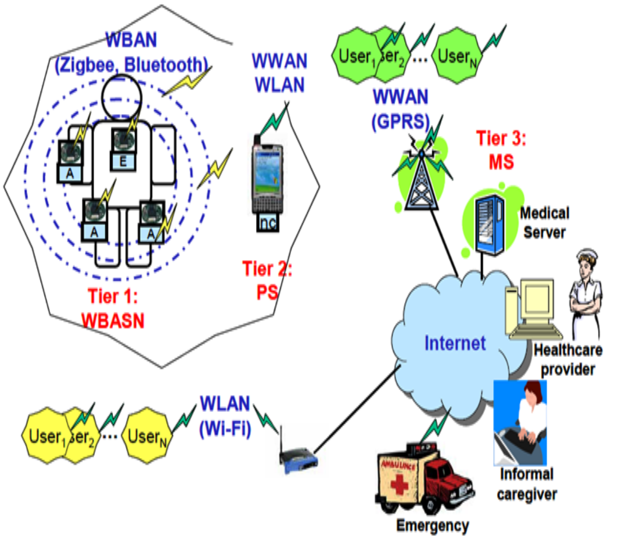


Figure 1: Architecture of Health Monitoring System Network

Below figure 2 showing the more simplified architecture of WBAN network. It consists of a number of sensors/actuator nodes, a body gateway and a host. The nodes and the body gateway are connected wirelessly within the body zone in a star or mesh network topology and relaying data packets to or from each other. Most bi-directional communication is between the gateway and the nodes, but two nodes could also communicate directly, e.g. in a sensor actuator setup where a measured parameter by sensor-node-A (drop of glucose level) implies a consequent action to be performed real-time by actuator node- B (injection of insulin). Likewise, the gateway is connected wirelessly to the host in a bi-directional point-2-point connection. In this architecture, to satisfy the key attributes for WBAN like reliability, scalability, interoperability, security, power efficiency, and ease of use and configuration, Time Synchronized Mesh Protocol (TSMP) has been proposed in [5], now being integrated into the emerging IEEE 802.15.4E standard. Key components of TSMP are:

- Time synchronized communication
- Frequency hopping
- Automatic mode joining and network formation
- Fully-redundant mesh routing
- Secure message transfer

In TSMP each transmission, transacted in a synchronized specific timeslot, contains a single packet and acknowledgements which are generated when a packet has been received unaltered and complete. Use of frequency hopping reduces the impact of interferences and increases the effective bandwidth. Aggressive use of duty-cycle and timeslot based principles makes the protocol very power efficient. A key attribute of TSMP is its self-organization mesh routing that makes it easy to add/remove nodes. Finally, TSMP support encryption, authorization and integrity with regards to secure message transfer.

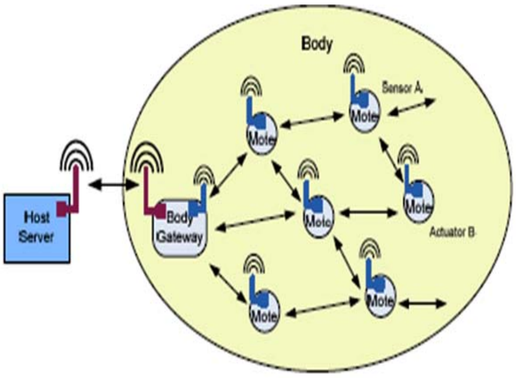


Figure 2: Simplified Architecture of WBAN

The gateway performs the following main functions:

- Configuration and synchronization of the BAN
- Controlling and monitoring of the nodes
- Collection and further processing of the sensors data
- Forwarding of processed and aggregated data wirelessly to the host for further processing and interpretation
- Reception of commands from the host

This requires hardware that includes a transceiver supporting the communication within the WBAN (nodes), a transceiver supporting the communication with the host, a powerful processor including memory and storage, and a power supply unit including a (rechargeable) battery.

The form factor and weight of the gateway should be tailored to be wearable with minimal impact on the body comfort, e.g. like a modern Smartphone or smaller. The second network does not strictly differentiate the hierarchies as the first one but the functions of each level in both are essentially the same [5]. Also, the second network refers to a body gateway(which can also be implemented on a PDA like smartphone) at the intermediate level which performs the same function as the personal server in the first structure .Thus the above two network architectures are almost similar except the use of different protocols: the second network uses TSMP(and mesh network topology) as opposed to the first one first network using Zigbee or Bluetooth(that uses mainly star topology).TSMP has the added advantage of time synchronization though it might have the disadvantage of slightly higher costs of setting up the higher number of links in a mesh topology than that of the star topology in Zigbee/Bluetooth. Also, TSMP being a more recent protocol has not yet undergone mass deployment and hence its performance evaluation still needs further assessment.

III. CHALLENGES AND REQUIREMENTS FOR IMPLEMENTATION

For the implementation, medical sensor needs to satisfy the requirements such as wearability, reliability, security, interoperability, functionality and some corresponding challenges like time synchronization, energy efficiency (low power constraint),interference, physical layer communication, bandwidth constraint, regulatory issues and low cost. We are describing these parameters below as well:

3.1 Wearability: To achieve non-invasive and unobtrusive continuous health monitoring, wireless medical sensors should be lightweight and small. The size and weight of sensors is predominantly determined by the size and weight of batteries. In turn a battery's capacity is directly proportional to its size which leads to the challenges of energy efficiency and miniaturization discussed in later sections.

3.2 Reliable communication: in WBANs is of utmost importance for medical applications as these are subject to very sensitive information about patients. It could be dangerous, even fatal, for false readings to appear on a patient's glucose monitor output. The same is true of erroneous images being projected in the eye or for any other function of the biomedical sensors. Medical sensors vary with required sampling rates, [6] from less than 1 Hz to 1000 Hz. One approach to improve reliability is to move beyond telemetry by performing on-sensor signal processing. In addition to reducing heavy demands for the communication channel, the reduced communication requirements save on total energy, expenditures, and consequently increase battery life. A careful trade-off between communications and computation is crucial for optimal system design.

3.3 Security: The problem of security arises at all three tiers of a WBAN-based tele-medical system. At the lowest level, wireless medical sensors must meet confidentiality requirements mandated by the law for all medical devices and must guarantee data integrity. Though key establishment, authentication, and data integrity are challenging tasks in resource constrained medical sensors, a relatively small number of nodes in a typical WBAN and short communication ranges make these tasks achievable. Hence strict security mechanisms are desirable that would prevent malicious interaction with these systems. Although it may seem attractive to encrypt all of the data, [7] any meaningful, strong encryption would be too computationally intensive to be practical for these uses.

3.4 Interoperability: Wireless medical sensors should allow users to easily assemble a robust WBAN depending on the user's state of health. Standards that specify interoperability of wireless medical sensors will help to integrate different types of medical services and also promote vendor competition that would eventually result in more affordable systems.

3.5 Functionality: most of today's bio sensors act as simple gateways, passing on the information to a central hub where the data is converted into actionable information. By adding intelligence to the sensors, they can take decisions locally and the signaling overhead in terms of data and latencies can be reduced.

3.6 Physical Layer Connection in WBAN: The main challenge in ensuring communication comes in establishing the Physical Layer Communication (Signal Propagation) in WBAN**.** If the sensors are implanted inside the body, they can communicate through electromagnetic coupling or radio frequency (RF) communication depending on the applications. [3]In EM coupling, the implant is powered by the coupled magnetic field and requires no battery for communication. Data is transferred from the implanted device by altering the impedance of the implanted loop that is detected by the external coil and electronics. It achieves the best power transfer when using large transmits and receives coils. However, it is impractical when space is an issue or devices are implanted deep within the patient. In such cases RF communication enables a two-way data link that allows an implant to initiate a communication session.

3.7 Interference: Between all of the proposed applications for biomedical wireless sensor networks and the great number of people affected by diseases that might be helped with the use of these networks, it is not unreasonable to expect hundreds of thousands of these networks in place in the next decade. This can lead to the problem of interference between wireless networks in people standing next to each other or even the possibility of colliding signals within one person.

3.8 Time Synchronization is a common requirement for wireless sensor networks since it allows collective signal processing, sensor and source localization, data aggregation, and distributed sampling. In wireless body area networks, [6] synchronized time stamps are critical for proper correlation of data coming from different sensors and for an efficient sharing of the communication channel.

3.9 Energy Efficiency: Energy consumption is one of the fundamental design constraints in wireless sensor networks since sensor nodes have size restrictions and can be operated by either battery or wireless power transfer. To extend each node's lifetime, it is necessary to reduce power dissipation as much as possible. If the node is implanted in the body, it is not practical to replace the battery as often as would be required. [7] Passive power sources, such as solar and vibration, provide insufficient power for continuous operation. Wireless sensor networks require some form of energy for various functions in each node, including running the sensors, processing the information, and data communication. Ideally, this power will be evenly distributed and consumed among the nodes in the network. An even consumption of power would allow the nodes to be recharged simultaneously, thereby reducing the use of bandwidth for recharging.

3.10 Regulatory Requirements: Food and Drug Administration (FDA) regulates the testing and use of biomedical sensors .There must be some evidence that these devices will not harm, and potentially help the test subjects. Procedures for protecting patients have been developed for clinical trials.

3.11 Bandwidth: The frequency range selected for communications plays an important role in the design and performance of WBAN as there is a direct relationship between frequency and tissue warming. The higher the frequency of the EM signal, the higher is its absorption by the tissue and more the tissue warming. Hence it is desirable to use lower frequencies for communications. However, the lower the frequency, the larger will the antenna dimensions have to be. Therefore there is a trade-off between antenna dimensions and greater tissue warming.

3.12 Low Cost [8]: A major reason for this is the low volume of the market so far, but another more technical reason is that there are no commercially available packaging technologies that can efficiently integrate such heterogeneous components as batteries, MEMS, processors, and radios in a single package.

IV. PROPOSED APPROACH OF IMPROVEMENT

In this paper we are presenting the improved method for WBAN routing protocol with aim of improving energy efficiency of WBAN network as compared to existing routing protocols. Here we added the new energy efficient function in existing AODV routing protocol. Here we have taken two routing protocols under investigation such as AODV, DSR and the modified AODV routing protocol. Following is the algorithm which is added to this AODV routing protocol for the improvement of energy and hence the other parameters. For a packet P, we use hc(P) and lvl(P) to represent the two additional fields of the packet, respectively. The algorithm needs to access other fields in a packet, such as the source, destination, sender and sequence number. Similarly, in the algorithm, they are represented by s(P), d(P), nid(P) and seq(P). We use s-d (P) to represent the source-destination pair of the flow that the packet belongs to. An “overhear table” is maintained at each node.

Algorithm: When node i overhears packet P,
BEGIN
Step 1: Lookup s-d (P) in overhear table;
Step 2: IF no match, add entry e’: s-d(e’)=s-d(P), seq(e’)=seq(P), ov-list(e’) initialized with first entry <hc(P),lvl(P),nid(P)>. GOTO END;
Step 3: (Assume a match is found at entry e.) IF seq(P)<seq(e), ignore P. GOTO END;
Step 4: IF seq(P)>seq(e), update e as the following:
seq(e)=seq(P), ovlist(e) reset as having only one
entry <hc(P),lvl(P),nid(P)>. GOTO END;
Step 5: IF seq(P)==seq(e), do the following:
Step 5.1: Add entry <hc(P),lvl(P),nid(P)> into ovlist(e);
Step 5.2: IF ovlist(e) has three entries A, B, C satisfying the following conditions, a better sub-path is found.
1)hc(C)==hc(B)+1==hc(A)+2;
2)lvl(node i)≥MAX(lvl(A),lvl(C));
3) (lvl(node i)-lvl(B))≥2. Activate this new subpath. Delete entry e from overhear table. GOTO END;
Step 5.3: IF ovlist(e) has two entries A and B, such that hc(B)==hc(A)+1 and lvl(node i) ≥ MAX(lvl(A),lvl(B)+2), add this indicator I in the WaitingIndicator list: candidate(I)=B, seq(I)=seq(e), s-d(I)=s-d(e). GOTO END;
Step 5.4: IF ovlist(e) has two entries B and C, such that hc(C)==hc(B)+1 and lvl(node i) ≤ MAX(lvl(B)+2,lvl(C)), node i broadcast one SHORT informing packet Q as follows: candidate(Q)=B, seq(Q)=seq(e) s-d(Q)=s-d(e); When node i receives a SHORT informing packet Q, BEGIN
1. Compare fields of Q with any valid entry in Waiting Indicator list;
2. IF there is no match, ignore packet Q; ELSE a better subpath is found.

V. PRACTICAL RESULTS

We have implemented the new NIAODV routing protocol and compare its performance against AODV and DSR routing protocols. We have used the NS2 and AWK scripts for the simulation of this work. We have measured following performance parameters for each of this routing protocol and compared their results for different network scenarios such as 10, 20, 30, 40 and 50 nodes. The MAC protocol which we considered here is 802.11.

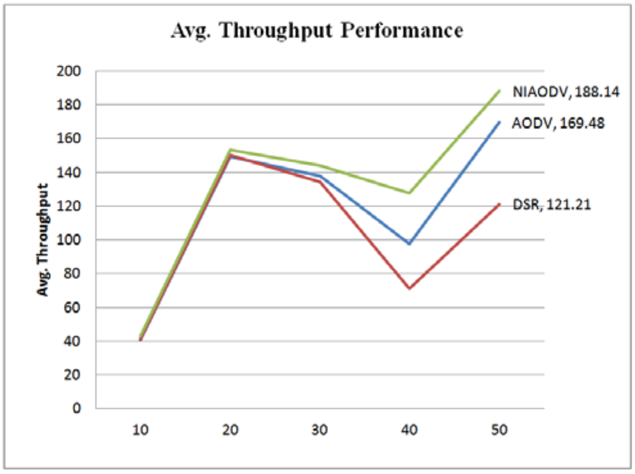


Figure 3: Average Throughput Performance

The above graph in figure 3 is showing the performance of average throughput for AODV, DSR, NIAODV routing protocols by varying WBAN network scenarios. From this result it is clear that performance of throughput of proposed NIAODV is more as compared to existing routing protocols. Same results we can get for other performance metrics those are depicted in below graphical results. From all this results it is clear that the new routing protocol outperformance the existing routing protocol. From the figure 5 in which the energy consumption is computed for each WBAN network and it is shown that new routing protocol achieves the better performance as compared to existing routing protocols.

VI. CONCLUSION

The WBAN is widely used for the applications of tele-medical system which provides the flexible, inexpensive, efficient patient monitoring in day to day life. Due to the use of WBAN patients needs to be wait or stay longer time at hospitals. In this paper we have outlined the architecture of such systems. The technique aspects of WBAN are discussed, working of signal and data processing in WBAN is presented throughput this paper. In addition to this, in briefly we are presenting the categories of WBAN routing protocols. We categories these routing protocols in BANs into five categories such as temperature based, cluster-based, cross layer, cost-effective and QoS-based. In addition to this, we have proposed new routing protocol which shown better performance as compared to other existing routing protocols such as AODV and DSR.

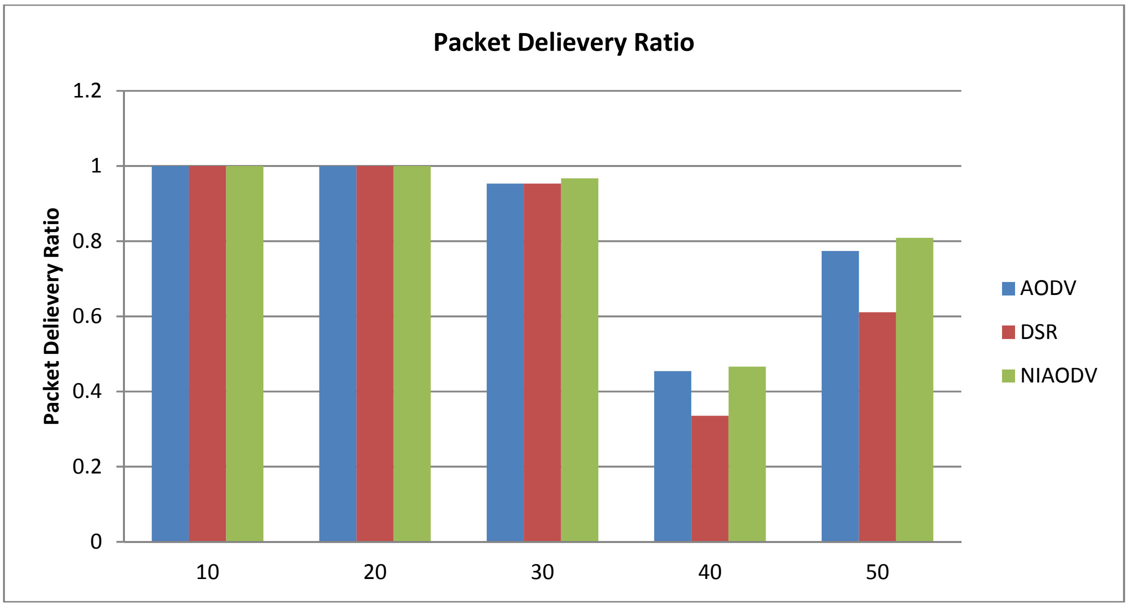
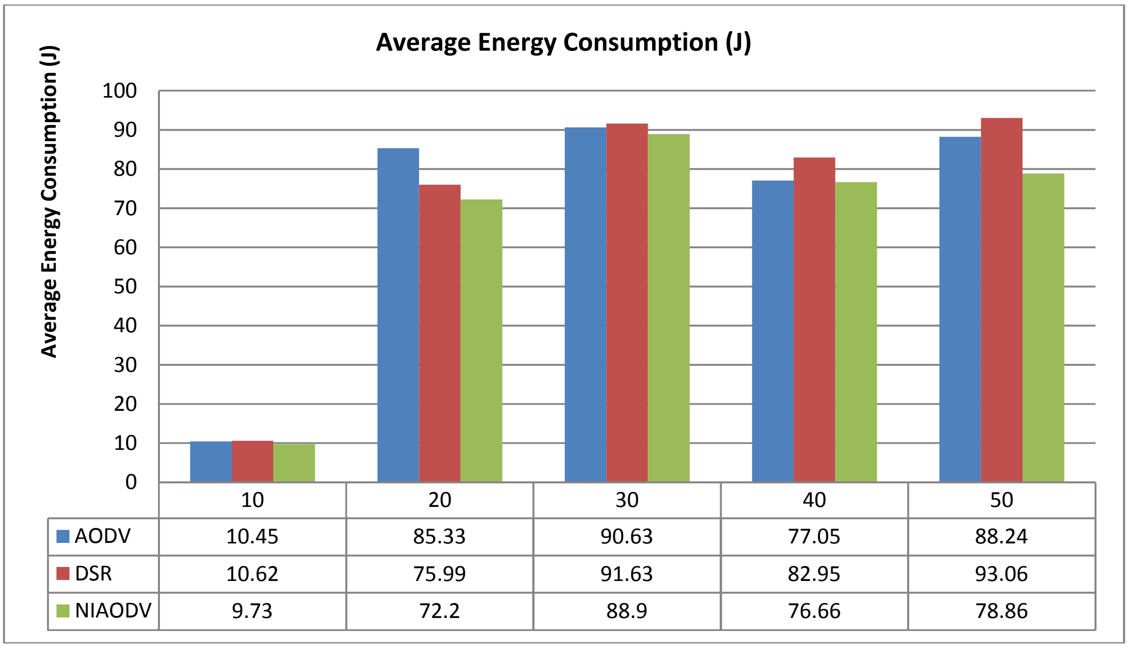


Figure 4: Packet delivery ratio performance



	10	20	30	40	50
🟦 AODV	10.45	85.33	90.63	77.05	88.24
🟥 DSR	10.62	75.99	91.63	82.95	93.06
🟩 NIAODV	9.73	72.2	88.9	76.66	78.86

Figure 5: Average Energy Consumption Performance

VII. REFERENCES

[1] J. G. Cleland, K. Swedberg, and F. Follath, ”A survey of the quality of care among patients with heart failure in Europe. Part 1: Patient characteristics and diagnosis,” The Euro Heart Failure Survey Programme, Euro Heart Jour-nal, pg 24, pp. 442-463, 2003.

[2] http://www.foxnews.com/story/0,2933,142436,00.html Date Visited, 15 December 2008.

[3] C. Otto, A. Milenkovic’, C. Sanders, and E. Jovanov, “System architecture of a wireless body area sensor network for ubiquitous health monitoring,” J. Mob. Multimed., vol. 1, pp. 307–326, January 2005.

[4] J. Xing and Y. Zhu, “A survey on body area network,” in 5th International Conference on Wireless Communications, Networking and Mobile Computing, 2009. WiCom ’09., pp. 1 –4, Sept. 2009.

[5] Dust Network “Technical Overview of Time Synchronized Mesh Protocol”,Doc.nr. 025-0003-01, June 20, 2006, http://www.dustnetworks.com/technology (June 2010).

[6] Otto Chris, Milenković Aleksandar, Jovanov Emil, *“ Wireless Sensor Networks for Personal Health Monitoring:Issues and an Implementation,”* www.ece.uah.edu/~milenka/docs/milenkovic

[7] Schwiebert L, Gupta Sandeep K. S. , Weinmann Jennifer, *“Research Challenges in Wireless Networks of Biomedical Sensors”,* Proceedings of the 7th annual international conference on Mobile computing and networking, ACM New York, NY, USA ©2001

[8] Mehmet R. Yuce , "*Implementation Of Wireless Body Area Networks For Healthcare Systems",*Sensors and Actuators A 162 (2010) 116–129

[9] National Council on Radiation and Measurements, *"A Practical Guide to the Determination of Human Exposure to Radio Frequency Fields,"* Report no. 119, NCRP, Bethseda, MD, 1993.

[10] Xu Yong, Lu Yinghua, Zhang Hongxin, Wang Yeqiu , "*An Overview of Ultra-Wideband Technique Application for Medial Engineering*," IEEE/ICME International Conference on Complex Medical Engineering, 2007.

[11] Fish and Richardson white Paper, *"Wireless Medical Technologies: Navigating Government Regulation in the New Medical Age,"* Fish's Regulatory & Government Affairs Group: mahn@fr.com1

[12] A. Bag and M. A. Bassiouni, "Energy efficient thermal aware routing algorithms for embedded biomedical sensor networks," IEEE International Conference on Mobile Adhoc and Sensor Systems (MASS), pp. 604 –609, Oct. 2006.

[13] M. Abolhasan, "A review of routing protocols for mobile ad hoc networks," Ad Hoc Networks, vol. 2, no. 1, pp. 1–22, 2004.