Original Article

ENERGY AND QOS AWARE LINK QUALITY BASED CLUSTERING PROTOCOL (EQ-LQBC) IN WIRELESS BODY AREA NETWORKS

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Abstract

Wireless Body Area Networks are networks of sensor nodes embedded in and around the human body that collect bio-signals for a range of applications including patient monitoring, gaming, and so on. Many developers around the world are researching the WBAN network concept. WBAN has had a technological boom in the previous decade as a result of developments in MEMS and wireless communication technology. In the Wireless Body Area Network, there are a few key elements to keep in mind. Unlike wireless sensor networks, the WBAN monitoring environment is limited to the human body, has a heterogeneous data rate, requires biocompatible sensor devices, and has a more changeable network topology due to body movement. This paper presents a method based on queue length, distance nearest from sink and energy of the node use of the parameters to select the optimum cluster head. EQ-LQBC selects the cluster head dynamical based on time interval. In the next step to achieve the same step repeat on intra cluster network on WBANs. The obtained results show a major improvement of EQ-LQBC in terms of network stability, network life time, throughput, end-to-end delay and packet delivery ratio.

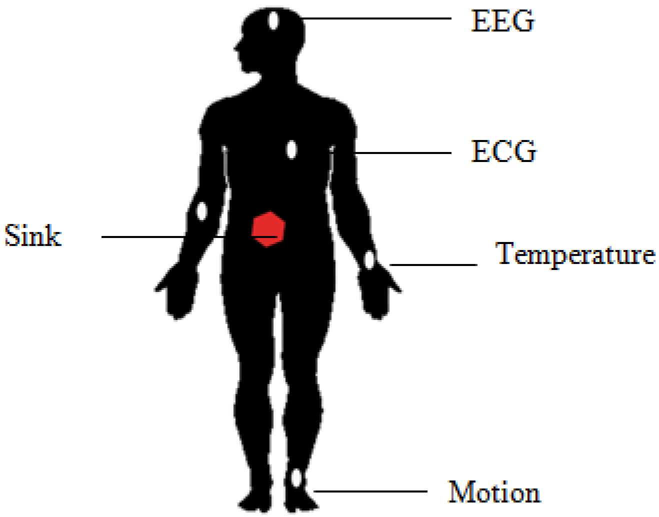
Keywords: WBAN, Energy-efficient, Cluster, reliability, EQ-LQBC

Introduction

The notion of being linked everywhere at any time is driven by future communication systems. This is finite, even in the medical. The introduction of wireless communications in medical healthcare is wireless medical communications helping people function and removing wires in a hospital.
The growth of Wireless Body Area Networks (WBANs) has been promoted by the growing use of wireless networks and the continuous miniaturization of electrical devices. Figure 1 represents different sensors are connected to these networks. Such devices provide the patient or medical staff with continuous health monitoring and real time feedback. Numerous new, functional and creative applications are enabled by the wireless design of the network and the wide range of sensors to enhance healthcare and the quality of life. The sensor tests certain human body parameters, either externally or internally. Examples include pulse measurement, body temperature Measurement, or prolonged Electrocardiogram (ECG) recording. Several sensors are mounted directly on a person's body or under the skin in clothing and calculate temperature, blood pressure, heart rate, ECG, EEG, breathing rate, levels of SpO2, etc. The patient has actuators that act as drug delivery systems next to sensing machines.
The medication can be administered at preset times, prompted by an external source or instantly when a problem

is detected by the sensor. A sudden drop of glucose is tracked by the sensor and a signal can be sent to the actuator in order to start the insulin injection process. As a result, patients will experience fewer nuisances due to their illness. Also, a medical WBAN that is used for tracking patients.

Figure 1 Body sensors



To provide assistance to the disabled, a WBAN may also be used. Paraplegia can, for example, be fitted with sensors that assess the location of the legs or with sensors attached to the nerves. Moreover, the muscles can be activated by the actuators placed on the thighs. Interaction between the sensor data and the actuators enables the ability to move and to restored. Support for the visually impaired is another example. An artificial retina can be inserted into the eye under the surface of the retina, consisting of a matrix of micro sensors. The artificial retina converts neurological signals into electrical impulses. In the field of public safety, where the WBAN can be used by firefighters, policemen or in a military setting, another area of use can be found. For instance, the WBAN measures the level of toxic substances in the air and alerts firefighters or soldiers if a life threatening level is identified. Furthermore, the implementation of the WBAN allows the training schedules of professional athletes to be more efficiently tuned.

SURVEYS ON ENERGY AND QOS AWARE LINK QUALITY BASED CLUSTERING PROTOCOL

Numerous research articles had been designed based on different routing approaches in WBAN by various researchers. The conventional routing approach in WBAN is mostly based on the clustering technique. Few research work related to existing routing scheme in WBAN will be elaborated below.

Uttara Gogate *et al.* (2016), Healthcare progressions have viably entered the Wireless age through usage of Wireless frameworks.

Urgent restorative administrations organizations, for instance, remedial data assessment are helpful checking and prepared organizations are today conceivable today to common residents through this utilization of Wireless frameworks. These frameworks will generally change Healthcare by giving components of compactness, flexibility and steady watching. A cost capable, imperativeness compelling and diminished framework is shown to energize further progression of this world view.

Prashant S Bibave *et al.* (2016), In this paper a review on Human wellbeing checking and Structural wellbeing observing is appeared by utilizing remote sensors system. Distinctive applications by remote sensors for social insurance framework are examined. Specialized difficulties with respect to social insurance framework are clarified. Use of omnipresent for basic checking likewise clarified. The focal points and utilizations of remote Sensor Network framework additionally examined.

Nitya *et al.* (2013), In this paper, the authors propose a system architecture for smart healthcare based on an advanced Wireless Sensor Network (WSN). It particularly targets helped living occupants and other people who may profit by consistent, remote wellbeing observing. It displays best practices in remote sensor system outline for human services applications. Taking into account the most vital angles like force productivity and security which control the advancement of a remote sensor system based applications.

Kumar *et al.* (2009) proposed an EEHC (Energy-Efficient Heterogonous Clustered) protocol for a tri-level network to evaluate the benefit of node energy heterogeneity in WSN. A probability threshold function is used to select a cluster head based on sensor node residual energy. In terms of network lifespan improvement, EEHC outperforms LEACH as a heterogeneous technique. Similarly, Sharma *et al.* (2018) presented Traffic and Energy-Aware Routing (TEAR) to refine the stability interval, assuming sensor nodes with variable initial energies and traffic origination rate disparities as useful to overcome the system complexity limitation.

In addition, for heterogeneous clustering networks, Dutt *et al.* (2018); Tanwar *et al.* (2019) and Hong *et al.* (2013) developed the CREEP (Cluster-head Restricted Energy-Efficient Protocol), LA-MHR (automata-based Multilevel Heterogeneous Routing), and EDCS (Efficient and Dynamic Clustering Scheme) protocols, respectively. Through two-level heterogeneity, CREEP focuses on minimizing the number of cluster heads per round to improve network longevity. In comparison to mobile and stationary HWSN scenarios, the comparison results improve network lifespan. Based on an autonomous learning, LA-MHR introduces a multilayer heterogeneous node paradigm. During the operation of LA-MHR, an S-model dependent learning method is used for cluster head election, and the base station assigns the cognitive radio spectrum to elect CHs. Finally, they evaluated the network's lifetime and firmness while taking into account the energy hole issue. EDCS, on the other hand, presents an energy forecasting technique to save node energy and extend the lifetime of the network. However, because real-world network circumstances are dynamic and diverse, determining the longevity of a network is difficult.

A multi-objective and multi-constraint optimization routing technique is proposed by Kavi *et al.* (2017). To determine routing protocol quality, performance factors such as traffic load, link quality, and residual energy are used. It ensures that packets are delivered quickly and that the link is stable.

Hong *et al.* (2016) proposed a clustering-tree topology Control Based on the Energy Forecast (CTEF) for network load balance and energy savings while taking into account a variety of parameters (e.g., PLR and link dependability). In addition to a traditional CH selection mechanism and cluster construction, the central theorem and log normal distribution procedures are used to accurately estimate the network's mean energy when the difference between the actual and ideal average residual energy is taken into account.

The properties of QoS-based routing protocols for WSNs were critically evaluated by Moussaoui & Boukeream (2015); Yang *et al.* (2017) and Wang *et al.*(2017). SPEED is a geographic location-based QoS protocol proposed by He *et al.*(2005). The concept of a neighbour table has been added in this protocol. Every node's single-hop neighbours' position and latency are saved in the neighbor tables. It is also taken into account the trade-off between optimal delay delivery and load balancing.

Chen (2016) presents a hard real-time protocol called SHE (Self-stabilizing Hop-constrained Energy efficient). In this technique, after a cluster-formation phase, the traffic packets from CHs to the base station are routed through different paths. AT (Aging Tag) is specified and used to acquire QoS need.

Faheem & Gungor (2018) proposed a clustering technique based on the Energy-aware QoS Routing Protocol (EQRP). This protocol is influenced by real-world Bird Mating Optimization (BMO) and is reliant on exceptionally dependable infrastructure. For WSNs, the proposed routing protocol can improve throughput and network reliability, decrease packet retransmissions, improve packet delivery ratio, and decrease end-to-end time.

The DEEC (Developed Distributive Energy-Efficient Clustering) and EDDEEC (Enhanced Distributive Energy-Efficient Clustering) protocols were developed by Qing *et al.* (2006) and Javaid *et al.* (2013), respectively. The average network energy and a probability function based on node beginning energy are formulated in DEEC. Cluster heads are defined as nodes with a high energy ratio. DEEC, on the other hand, does not take network energy into account in each round. The threshold function based on a super node, an advanced node, and a regular node was further extended by EDDEEC. For each of the three node categories, a different threshold function is shown.

This survey works is discussed about routing approach in WBAN based on clustering technique.

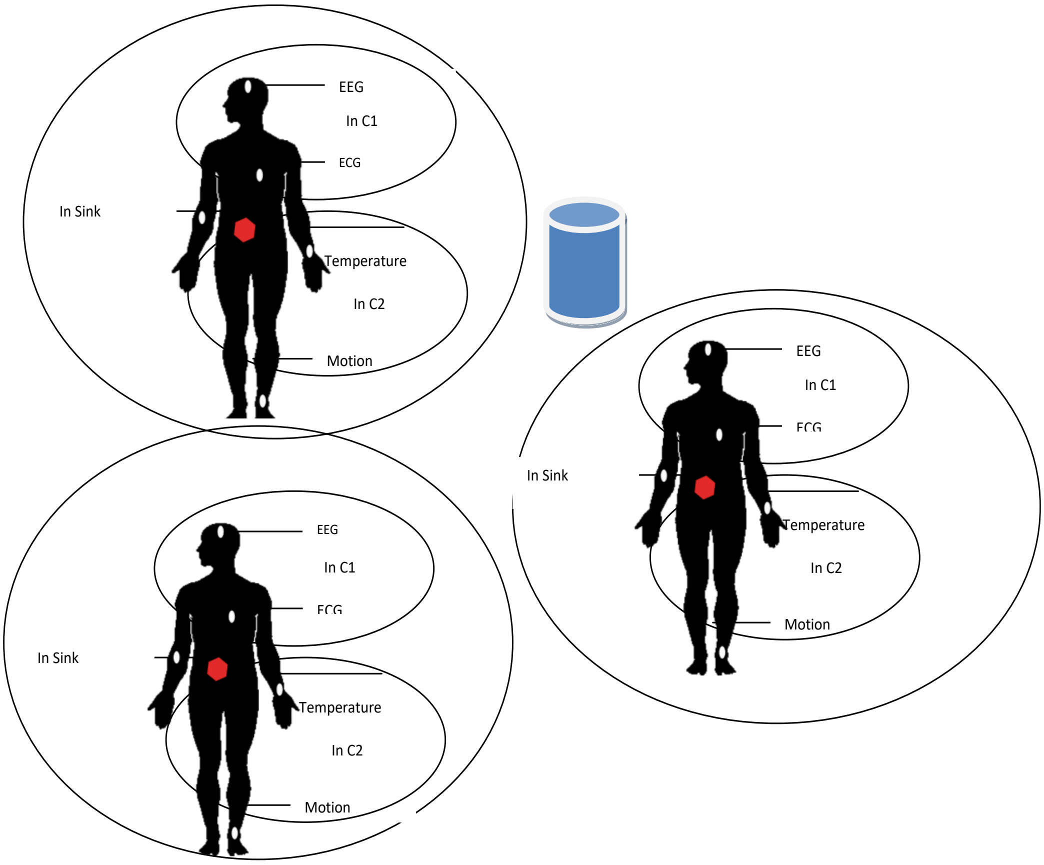
Proposed Work

WBAN plays an essential role in today's medical world. According to WBSN various sensors can be fitted in a human body to monitor the human body functions such as body temperature, blood pressure, heart rate and body movements etc. Before this there was a lot of cluster based WBSN in which we transfer data over the network after we evaluate the node energy. But in our proposed system its link quality is measured before the node selection. Link quality is calculated based on three parameters that are Energy (E), Distance from Sink (D) and Queue length (Q). The WBAN network working in our proposal in two stages

- Internal Communications
- External Communications

The first step is to divide the sensors in a human body into two parts, the upper part as one connection and the lower part as another association.
These two associations act as cluster. This cluster selects the cluster head according to our protocol. This sink node, which sends the selected cluster head information to the common sink node for both, is called the local sink node. The local sink node will store the information. Local sink act as a cluster member in phase two. We will divide it into clusters depending on the area in which it is located. In this cluster, our proposed protocol selects the cluster head and sends the information to the main sink.

Figure 2 Propose cluster network



In cluster head processing, each node first updates its neighboring node, use the beacon message to first find out which node is in a single hop node. It updates the neighboring node with a beacon message when installing the network and adding a new node. So that the distance between the node and local sink can be seen. We calculate the distance using this following formula

$$d = 10^{\wedge}((T_p - ss\ )/10 + 5) \qquad (1)$$

$$ss = T_p - 10_5 \lg db$$

where, d is the distance between two nodes, T_p is the transmission power of the node, ss is the signal strength of the receiving BEACON and choosing 5 is the path loss index based on environment. Calculate the energy level of the nodes closest to the sink. To calculate the energy level, the energy used by the node has to be subtracted from the initial energy of that node. Energy used is the multiplication of the sum of packets to be sent, the time taken to send the packet and the energy taken to send the packet.

$$E_R = E_0 - E_C \qquad (2)$$

$$E_C = \prod(t, P_s, T_p)$$

where, E_C is used energy, E_0 is initial energy, E_R is reaming energy. Used energy is calculated based on the formula three product of transmission time (t), count of sending packets (P_s) and Power of transmission (T_p).

After calculating the energy, the queue length of each node must be calculated. A queue is a collection that temporarily stores a data packet. It sends a piece of data to the public and stores it in packets, the length of which is fixed in the array, when the specified size exceeds the packet overflow. This will cause packet loss and to avoid this you need to select the node with the longest queue length. Use the formula in the key to calculate the queue length

$$q_{al} = (1-t_q)*q_{al} + t_q * q_i \quad (3)$$

where, $q_{al\,i}$ is the queue length of the node average, t_q is the time constant of low pass filter and q_i was initial queue length.

After calculating the average queue length, the node with the highest energy and the queue length closest to the sink node should be selected as the leading node. Since energy and queue length are negative for distance, a value called cluster head value (CHV) is calculated and thereby the cluster head is selected

$$CHV = (E_R * q_{al})/d \quad (4)$$

Algorithm

Input: Number of Nodes (N), Node Energy (E_0), Queue Length (q_i).

Output: Cluster Head (CH)

// Find distance of the nodes

For (i=0:n-1)

$d = 10^{\wedge}((T_p - ss\ )/10+5)$

End

//Calculate E_R , $q_{al\,i}$ in single cluster

E_0 =100, q_i =150;

For (i=0:n-1)

$E_R = E_0 - E_C$

$q_{al} = (1-t_q)*q_{al} + t_q * q_i$

$CHV_i = (E_R * q_{al})/d$

If($CHV_i < CHV_{i+1}$)

$CHV_i = CHV_{i+1}$

Else

CH=Ni

End

End

SIMULATION

This work was tested with the Network Simulator version 2 tool. The simulation is done using the parameters given in the Table 1 below.

Table 1 Represents the parameters used for simulation

No. of Nodes	50,75,100,125 and 150
Area Size	1000 X 1000
Transmission Range	250m
Simulation Time	50 sec
Traffic Source	TCP
Packet Size	512 bits
Data Rate	100 bps
Initial Energy	100J
Transmission Power	0.001J

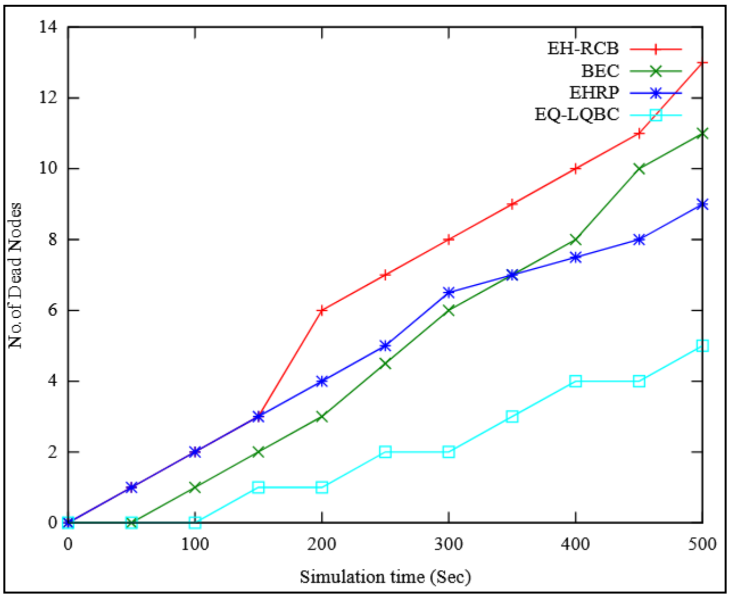
The area of the network used is 1000 * 1000, with the off node and the 250 m transmission zone ranged, each node being 512 bit pocket size, with 100 J of energy. 0.001 J Energy close for each transmission. The total simulation time was 50 seconds. The number of the nodes were tested at different levels as 50, 75,100,125,150.

Result and discussion

Network Life Time

Network life time depends on the dead state of the nodes, the more dead nodes in a network the greater the data loss on that network. This is because a dead node is a node that has no energy or enough energy to send a packet, so that node cannot communicate with the other node.

Figure 3 Simulation time Vs. Number of dead nodes



In analyzing our result, the EQ -LQBC protocol, which is more than the existing protocol, has a much smaller death node.

To calculate this, the reaming energy of each node has to be calculated and check it with threshold energy. Threshold energy is the energy required to send a packet to each node. Use the formula below to find out if the energy of a node must be greater than threshold energy.

$$D_N : E_R < E_{th} \qquad (5)$$

D_N -> Death node

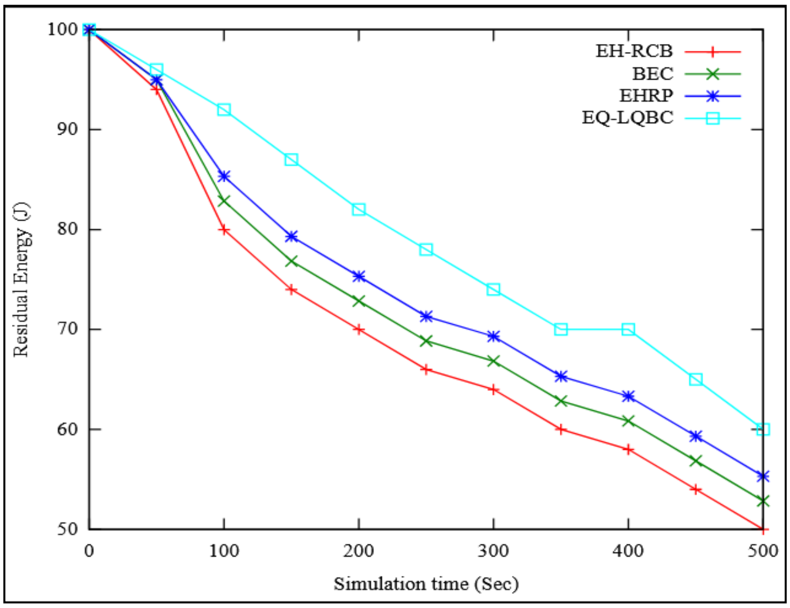
E_R -> Reaming energy of node

E_{th} ->Threshold energy of nodes

Residual Energy

Residual energy is an important property of a node in a sensor network. If the energy of a node is high, the life time of that node will increase here, the life time is how long a node is active in that network. In our EQ - LQBC the result is 14% more energy than the result. Use the Formula (1) to calculate this.

Figure 4 Simulation time Vs. Residual energy



Throughput

Throughput is how much of data to be received from one node to another node per second. To calculate the throughput, the node must multiply the viewing packet count and its packet size by the time it takes to obtain that number of packets. It can be calculated by the formula given below;

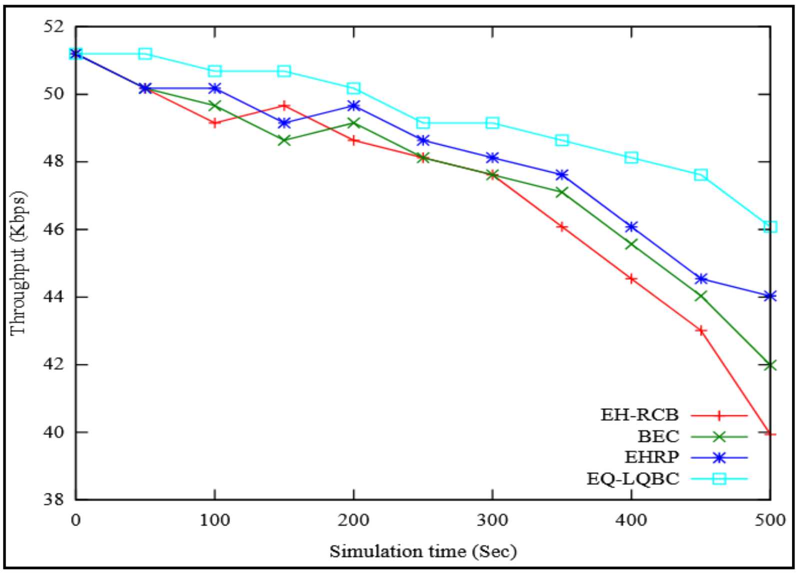
$$N_T = (R_p * 512) / TT \quad (6)$$

N_T -> Network Throughput

R_p -> Receiving packet count

TT-> Time of Transmission

Figure 5 Simulation time Vs. Throughput



End to End delay

End to End delay is the time it takes for data to be exchanged between two nodes in the network. Sometimes sending data by network traffic is delayed, network traffic is waiting for the data packet queue when one node is the intermediate node for many nodes that waiting time called as delay. Delay can be calculated using packet sending time and packet receiving time.

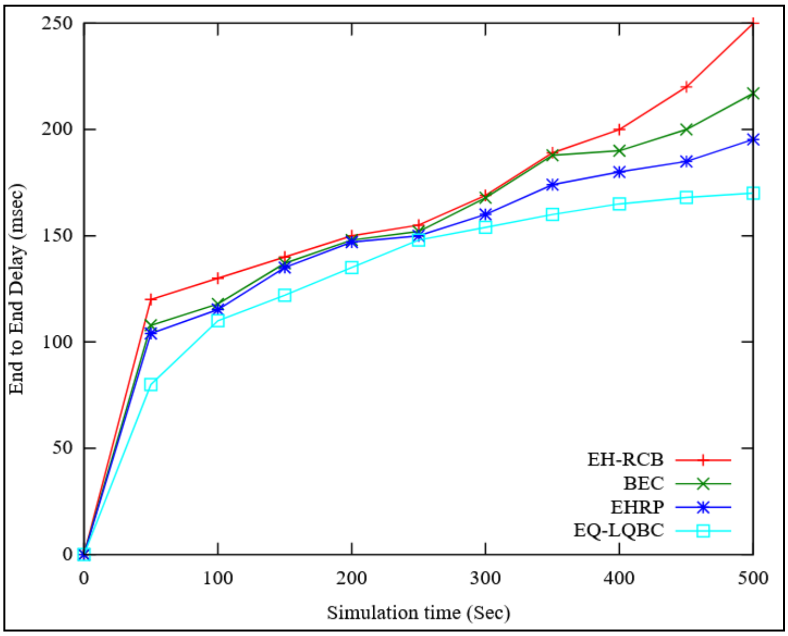
$$E2E = R_T - S_T \quad (5.7)$$

$E2E$ -> End to End Delay

R_T -> Packet Receiving Time

S_T -> Packet Sending Time

Figure 5.6 Simulation time Vs. End to end delay



In our proposed algorithm EQ -LQBC the end to end delay is less than the Existing process.

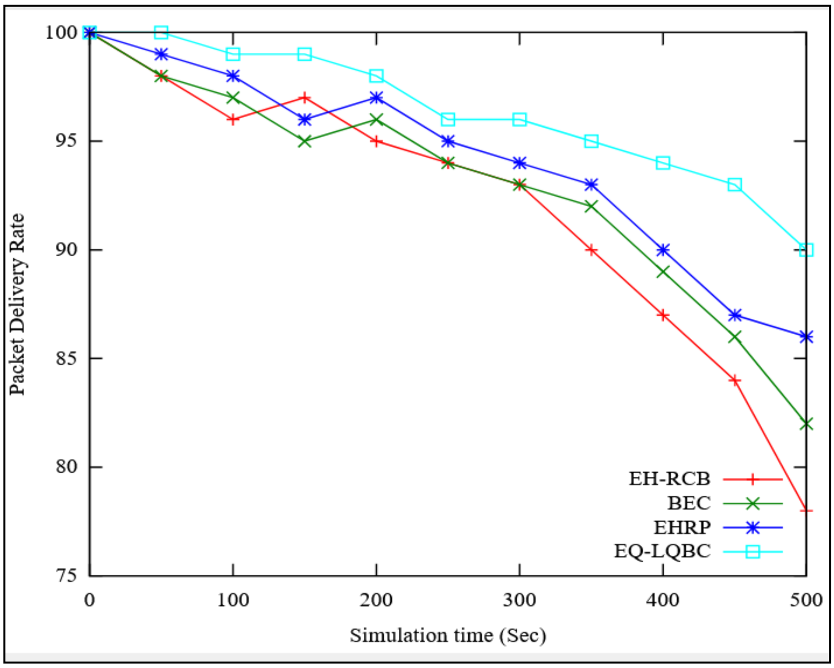
Packet Delivery Ratio

The packet delivery ratio is very important in a network, depending on the packet exchange that takes place between the two nodes. This can be calculated by the ratio between the sending pocket and the receiving packet,

$$PDR = (R_P / S_p) * 100 \quad (8)$$

R_P / S_p -> Receiving Packet / Sending Packet

Figure 7 Simulation time Vs. Packet delivery ratio



Conclusion

This paper has analyzed and described a linear integer optimization approach for the maximization of network lifetime and throughput and the minimization of energy consumption of WBAN. In the proposed work, Energy and QOS Aware Link Quality Based Clustering Protocol (EQ-LQBC) are presented. This protocol mainly propose a new method based on queue length, distance nearest from sink and the energy of the node use of this parameters to select the optimum cluster head. EQ-LQBC selects the cluster head dynamical based on time interval. On the next step to achieve the same step has to repeated on intra cluster network on WBANs. The performance of the proposed system and can be verified and analyzed using NS2 tool. The obtained results show a major improvement of EQ-LQBC in terms of network stability, network life time, throughput, end-to-end delay and packet delivery ratio.

References

1. Reza Khaliliam,AbdalhosseinRezai,EhsanAbedini,"An Efficient Method to Improve WBAN Security, "vol.64,pp 43-46,2016.
2. AnuragTiwari,PrabhatVerma , " Security and Privacy in E-Healthcare Monitoring with WBAN",Internatinal Journal of Computer Applications,February,2016.
3. AdwanAlanazi"Optimized Node Selection Process for quality of service provisioning over wireless multimedia sensor networks"IEEE International Conference on Mobile and Secure Services,pp- 1 – 5,2016.
4. MuhammadMoid Sahnadu NadeemJavaid, Muhammad Imran, Mohsen Guizani ,Zahoor Ali Khan, Umar Qasim " BEC: A Novel Routing Protocol for Balanced Energy Consumption in Wireless Body Area Networks" ,IEEE,pp653- 657, 2015.
5. Ilkyu Ha "Technologies and Research Trends in Wireless Body Area Networks for Healthcare: A Systematic Literature Review" International journal of Distributed Sensor Networks vol.2015,pp 14 ,2015
6. Mehreen Shah "Interference Aware Inverse EEDBR protocol for Underwater WSNs" IEEE International Conference on Wireless Communications and Mobile Computing,pp- 739 – 744,2015.
7. Sobia Omer "An LQI based dual-channel routing protocol for Wireless Body Area networks" IEEE International Conference on Telecommunication Networks and Applications,pp- 320 – 325,2015.
8. Xiaofei Chen "Design and implementation of a body monitoring baseband system for human body communication" IEEE International Conference on ASIC,pp- 1 – 4,2015.

9. ChirihaneGherbi“Distributed energy efficient adaptive clustering protocol with data gathering for large scale wireless sensor networks” IEEE International

10. NidhiGoel“Smart grid networks: A state of the art review” IEEE International Conference on Signal Processing and Communication,pp- 122 – 126,2015.

11. Karthiga I.“A study on routing protocols in wireless body area networks and its suitability for m-Health applications” IEEE International Conference on Communications and Signal Processing,pp- 1064 – 1069,2015.

12. NavpreetKaur “BERP: Balanced Energy Routing Protocol for routing around connectivity holes in wireless sensor networks”IEEE International Conference on Recent Advances in Engineering & Computational Sciences (RAECS),pp- 1– 6,2015.

13. M. Ambigavathi “Priority based AODV routing protocol for critical data in Wireless Body Area Network” IEEE International Conference on Signal Processing, Communication and Networking,pp- 1 – 5,2015.

14. Kshitiza Singh “An energy efficient fuzzy based adaptive routing protocol for Wireless Body Area Network” IEEE International Conference on Electrical Computer and Electronics,pp- 1 – 6,2015.

15. MadhumitaKathuria “Reliable delay sensitive loss recovery protocol for critical health data transmission system” IEEE International Conference on Futuristic Trends on Computational Analysis and Knowledge Management,pp- 333 – 339,2015.

16. Pengfei He et al. “Performance analysis of wban based on aodv and dsdv routing protocols” IEEE International Conference on Future Information and Communication Technologies for Ubiquitous HealthCare,pp- 1 – 4,2015.

17. Kiran ,Pooja“ A Review on Wireless Body AreaNetwork”,vol 3,Issue 6,June 2015.

18. PriyaJuneja“Tree based energy efficient routing scheme for body area network”IEEE International Conference on Computer Engineering and Applications,pp- 940 – 947,2015.

19. Md. TanvirIshtaiqueulHuque et al. “Body Node Coordinator Placement Algorithms for Wireless Body Area Networks” IEEE International Conference ,pp- 94– 102,2015.

20. S. Yousaf“CEMob: Critical Data Transmission in Emergency with Mobility Support in WBANs” IEEE International Conference on Advanced Information Networking and Applications, pp-915 – 919,2014.

21. JagadeeshKakarla “A voronoi diagram based efficient coordination mechanism for WSAN” IEEE International Conference on Networks & Soft Computing,pp- 226 – 230,2014.

22. ZhijunXie ,Guangyan Huang, Jing He ,Yanchun Z hang, “ A Clique Based WBAN Schduling for Mobile Wireless Body Area Networks , ” Elsevier ,vol 2014,no 1, 2014.

23. G. Subramanian, “Efficient and Secure Routing Protocol for Wireless Sensor Networks using Mine detection,” IEEE Trans. Netw., vol. 10, no. 7, 2014.

24. AashimaArya, Naveen Bilandi,“Wireless Body Area Network for healthcare ”,vol 2,issue 4,April 2014.M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.